RESEARCH REPORT 41

ECONOMIC INCENTIVES AND WATER QUALITY MANAGEMENT PROGRAMS

By

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1969

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Prepared for

The Division of Environmental Protection
Department of Natural Resources
State of Wisconsin

Prepared by

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May 1969

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May 22, 1969

Mr. Thomas G. Frangos
Administrator
Division of Environmental Protection
Department of Natural Resources
551 Hill Farms
Madison, Wisconsin

Dear Mr. Frangos:

This letter accompanies a report, Economic Incentives and Water Quality Management Programs, by Dr. Ved Prakash and Mr. Robert H. Morgan, Jr., which was prepared under the auspices of the Water Resources Center. The study on which this report is based was supported by a grant from your agency, received by the University in June, 1968.

The report does not presume to provide a definitive basis for policy action with regard to the application of economic incentives to foster the improvement of water quality. However, through the application of principles of public finance and economic theory to a number of proposals that have been made and to other studies, it provides a good assessment of the limitations and advantages of alternative types of economic incentives.

Although the report was supported fully by your agency, the undertaking of the project by the Water Resources Center was made possible by the basic support the Center receives from the University and from the Office of Water Resources Research of the U. S. Department of the Interior. Furthermore, this study has both profited from and contributed to a program of studies dealing with water quality management institutions supported in large part by grants from the Office of Water Resources Research.

Sincerely,

Irving K. Fox
Irving K. Fox
Associate Director

IKF:pae

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CHAPTER I

INTRODUCTION

As evidenced by recent major federal legislation--the Water Quality Act of 1965 and the Clean Water Restoration Act of 1966--the nation has embarked upon a systematic effort toward water pollution abatement. Under the 1965 Act, each state is setting standards for its interstate and boundary waters. Once these standards are approved by the Federal Water Pollution Control Administration, U. S. Department of the Interior, the industrial firms, municipalities and other government agencies will be required to comply with such standards and this will make it necessary for most waste dischargers to treat their wastes before discharging them into the lakes and the rivers.

The State of Wisconsin has long been one of the leaders in the field of water pollution abatement. In 1965 legislation was enacted by the State to strengthen its capability to deal with water management problems. In accord with this legislation, arrangements for regulating waste discharges to waterways were modified and certain new policies were adopted. Among the provisions of this legislation was a request for the study of "effluent charges" as an incentive toward achieving desirable levels of water quality for the State. The term "effluent charge" is generally defined as a levy upon any waste discharged into waterways. The intention of the charge is to discourage uneconomic use of waterways for waste disposal purposes. The study reported on herein was sponsored to help meet the requirements of the foregoing provisions of the legislation.

An effluent charge system is only one method of influencing water quality and it is conceivable that this system could be used in conjunction with other methods of control that already exist such as direct regulation, grants, and tax incentives. Furthermore, charges of some type including effluent charges may be used to help finance water quality improvement measures such as treatment facilities, sewage interceptors, and mechanical aeration equipment. The utility of an effluent charge system as a means of influencing water quality could not be assessed without comparing it with other methods of control and examining the relationship between the use of charges for quality control and for financing quality management facilities. For this reason, the study has been broadened to include an examination of direct regulatory practices; positive economic incentives such as tax preferences, loans, and grants; effluent charges for quality control purposes as well as a source of financing water quality management programs.

Inasmuch as this report is based largely on available literature, its objectives are limited. The purpose of the second chapter is to review the operation of direct regulatory systems so as to show the range of existing programs and to provide a basis of comparison with programs that include economic incentives. The third and fourth chapters review and appraise the full range of positive and negative economic incentives that could be used to achieve desirable water quality levels. The third chapter also includes an analysis of existing federal and Wisconsin tax policies as they affect investment decisions in pollution abatement facilities. The fifth chapter examines the use of charges to finance joint treatment facilities and assesses the implications of such a system for the alternative objective of influencing quality. This analysis is based in substantial part upon past and current experience with sewage charges. The concluding chapter of this report provides a summary.

Before proceeding to an analysis of alternative water quality programs, a few concepts that will be used throughout this report deserve comment.

Water has been called "polluted" if materials or energy are introduced into a water resource so as to affect adversely the utility of the resource in one way or another. As a practical matter, the term "pollution" is a dubious one to use for analytical purposes. There is no sharp line between water that can or cannot be used because of quality characteristics. Cold water is more valuable for cooling purposes than warm water, but warm water may still be useable. If dissolved solids causing hardness are low, then lesser amounts of soap or detergent will be required for cleaning purposes than for water with more dissolved solids. High levels of dissolved oxygen are desirable for the propagation of fish and other forms of aquatic life, but some fish will live satisfactorily with less oxygen than others. Thus, it is difficult to say with precision when water is unuseable for a given purpose and therefore "polluted."

Another disadvantage of the term pollution is that it connotes a nuisance or an evil whereas the use of a waterway for the disposal of wastes may be a valuable use of the resource. Therefore we are seeking a balance between the use of the waterway for waste disposal purposes and use for other purposes such as recreation, municipal water supply, irrigation, and so on. Our interest, therefore, is not in whether materials and energy have been introduced into the water resource, but in the quality characteristics of the water after such introduction and the effects of changes in these characteristics on the use of the water resource for other purposes. For these reasons, we have tried to use the term "water quality characteristics" rather than pollution as a phrase which is neutral and which reflects more accurately the policy concerns of water management.

"External diseconomies" is a term widely used in economic theory. It is generally accepted that because of certain economic characteristics of waste disposal, market forces by themselves do not foster the adoption of the best means for handling municipal and industrial wastes. In particular, in the absence of some form of public action, waste producers have no direct incentive to take into account costs or damages that may be imposed upon other water users by the waste producer's discharge. The costs or damages incurred by downstream users due to upstream waste discharges are called "external diseconomies" or more simply "externalities."

To take into account these externalities and protect downstream users, state governments have designed policies and programs to control waste discharges and achieve desirable water quality levels. Since there are a large number of different ways by which waste discharges might be influenced and controlled, a basis is needed for comparing alternative methods. Generally speaking, two distinct criteria are applied, one concerned with efficiency and the other with fair and equitable treatment of those affected. In this report a third criterion of financing effectiveness will also be applied. These concepts are difficult to define and utilize in a rigorous, analytical way.

An efficient system can be defined as one which provides a larger quantity of net benefits to society as a whole than any available alternative. In judging efficiency in accord with this concept, all costs and all returns incurred, both public and private, must be taken into account. This concept is difficult to apply to water quality management because of the problem of measuring both costs and returns, and especially the returns. How does one measure the benefits of water quality management? Because of this difficulty of measuring benefits, this report assumes that desirable water quality levels will be determined through political and administrative processes and that the efficiency objective is concerned with the cost of achieving a specified water quality standard. The emphasis is placed upon these costs on the assumption that they can be quantitatively measured reasonably well. In other words, it is assumed that the most efficient water quality program is the one which achieves the specified level of water quality at a minimum cost.

Equity is a concept of "fairness" and "impartiality" and deals with the distribution of benefits and costs associated with public programs. Although it is possible to define what is a "fair" division of costs and benefits in an abstract sense, it is not possible to do so operationally with universal agreement because beside measurement problems, it involves a value judgement and such a definition may vary from one person to another.[1] What is "fair" or "equitable" or "impartial" has therefore to be designated by the policy makers. For purposes of this report, in considering the objective of "equity" as affected by alternative policies, an attempt will be made to assess the distribution of costs for each alternative policy without trying to indicate what distribution is "best."

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1. See for example, I. M. D. Little, A Critique of Welfare Economics (Oxford: Clarendon, 1957), 2nd Edition.

Since charges may be levied to finance the provision of water quality management facilities, the effectiveness of a system of charges from this point of view must be considered. This constitutes a third criterion applicable to a system of charges and is measured in terms of (a) simplicity or difficulty of administration and (b) capability of the system to raise the funds required to finance specified facilities.

In short, in the remainder of this paper two criteria will be applied as described above to various techniques of controlling or influencing water quality, namely the criteria of *efficiency* and *equity*. For effluent charges and charges for financing joint facilities, the criterion of *financing effectiveness* will also be applied.

With these definitions in mind, the following section proceeds with an examination of direct regulatory programs.

CHAPTER II

DIRECT REGULATORY PROGRAMS

Introduction

In considering the role of public programs for achieving desirable levels of water quality, it is important to have in mind at the outset the reasons that it is necessary for government to intervene and participate in the management of water resources to achieve the kinds of water quality which best serve the overall public interest. The characteristics of water resources and the economic features of waste discharge which make public intervention necessary to realize overall public objectives have been analyzed and described elsewhere.[1] A brief summary of these factors will therefore serve the needs of this paper.

The foremost reason that waste discharges to a waterway require public action is that these discharges may impose costs or damages upon others which the waste producer does not take into account in calculating his own costs of doing business. Under classical economic conditions, the producer of a product bears all the costs of production and weighs these costs in deciding what should be charged for the product. In the case of waste discharges to a waterway, costs or damages may be imposed upon other water users, or upon the ecology of the waterway which is of long-term interest to society; and unless motivated to do so in some manner, the waste producer has no incentive for taking into account these costs and damages. The imposition of costs or damages on downstream waste dischargers may result in inefficient use of the waterway. In other words the costs imposed may be less than the benefits derived therefrom. The question of equity also arises. The benefits from using a stream for waste disposal purposes may accrue to a particular firm, community or economic areas whereas the costs or damages may be borne largely by another set of water users.[2]

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1. Allen V. Knnese and Blair T. Bower, Managing Water Quality: Economics, Technology, and Institutions (Washington, D. C.: Resources for the Future, Inc., 1968), Chapter 5.

2. Ibid., Chapter 6.

The oldest method of dealing with damages to downstream users caused by upstream discharges has been through adversary proceedings. Under the Common Law, as it is still recognized in most states, any individual adversely affected by a waste discharge may bring adversary proceedings in the courts to stop the action which is causing the damage and/or to collect for the damages suffered.[3] However, beginning in the 19th century in the United States, it was recognized that the Common Law was an inadequate tool for dealing with the adverse effects of wastes discharged to waterways, evidently due to the difficulties of proving the cause of damage and the costs of court proceedings. For this reason, most states decided to initiate some form of public regulation to supplement the Common Law.

Besides regulation, government intervention in the handling of wastes has, on occasion, realized economies through the treatment of wastes in large scale joint facilities as opposed to smaller operations. It would, with present technology, be impracticable for each household to have its own treatment facility. Often industrial wastes can be handled more economically through a large community treatment plant than through construction of separate treatment facilities for each firm. Such joint facilities tend to be natural monopolies and therefore require some type of public control to assure that they are managed in the overall public interest.

Public Regulation

In the period since public regulation has been adopted as a means of dealing with the adverse effects of waste discharges to waterways, a variety of specific techniques have been devised. These are briefly summarized in this section. Before proceeding to examine the alternative regulatory systems in general, however, the system used in Wisconsin will be discussed briefly.

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3. A detailed study of this topic is currently underway at the University of Wisconsin by Professor Peter Davis of the Law School.

The type of direct regulation now used in the State of Wisconsin is called an *order system*. The order system approaches the control of waste dischargers on a case-by-case basis. The history and operation of the order system in Wisconsin is well documented by Carmichael's article, "Forty Years of Water Pollution Control in Wisconsin: A Case Study,"[4] and Murphy's book, Water Purity.[5] The simplified description below is taken from Carmichael's work.

Basically, the order goes through three stages. First, the department collects detailed data to determine the effect an individual waste producer's effluent has on stream quality. The agency may also collect information on the type of treatment facilities used by the waste producer and the operational efficiency of those facilities.

Second, public hearings are held which allow the department to present general information on the river basin in question and a résumé on each waste producer describing treatment facilities and operational efficiency and suggesting means for improving their treatment system based upon prehearing conferences. Waste producers and other interested citizens are also allowed to give testimony and evidence at the hearing.

Finally, the agency staff reviews the testimony given at the hearing and proposes individual orders. These orders are then reviewed by officials in the department and sent to the waste producers.

The order usually requires three things of the waste discharger. First, minor corrections may be needed in the existing treatment facilities or in its operation. Second, the waste discharger is typically required to review his treatment system and present plans for new

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4. Donald M. Carmichael, "Forty Years of Water Pollution Control in Wisconsin: A Case Study," Wisconsin Law Review, Vol. 1967:350.

5. Earl F. Murphy, Water Purity (Madison: Univeristy of Wisconsin Press, 1961).

facilities. These plans are submitted to the department and reviewed. Third, after the submitted plans have been approved by the department, a specified period of time is allowed for the waste producer to construct the new facilities in accordance with the approved plans.

Carmichael has stated that "...an order is a bare outline for the control of a particular case of water pollution. The substantive content of an order evolves over time through the enforcement process as the agency adjusts its demands to the realities of the situation and negotiates with the polluter for what the agency feels is the optimum pollution reduction possible under the circumstances."[6] From this point of view, the order system provides the opportunity to make the best use of the available resources to maximize stream quality.

It is noteworthy that the State of Wisconsin has a rather unique arrangement for regulating some forms of waste disposal to waterways. If a waste discharger is not under an order from the Department of Natural Resources, a conservation warden, who decides that waste disposal to the waterway by a given discharger is contrary to the public interest, may bring the discharger before a circuit court and request that the action be enjoined. The party responsible for the discharge may be fined. At the present time, we know of no analysis that indicates how well this system has worked. A study of this practice has been undertaken by the University of Wisconsin and a report should be available within the next year.

Water Quality Standards

The objective of a water quality management program is to adapt the water resources of a region to the needs of the citizens of the region and the state. In achieving this objective, the possible uses of a waterway (including use for effluent disposal) must be weighed and their inter-relationship assessed to arrive at a pattern of "best" use from a

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6. Carmichael, op. cit., p. 369.

state and regional point of view. This generally entails consideration (usually on a judgement basis) of the beneficial and adverse effects of alternative patterns of use. Out of this consideration emerges a judgement of the water quality levels that should be sought so that the patterns of use derived can be sustained. This process in many states results in the establishment by a specified state agency of water quality standards which must be met to permit this pattern of use. Both the state of Wisconsin and the federal government, in discharging its responsibilities for interstate and boundary waters, follow this practice.

Water quality standards are statements of the minimum water characteristics that must be maintained to make waterways suitable for designated uses. Their adoption was based on available scientific knowledge--comments by health authorities, fish and wildlife biologists, other professional persons, and public hearings.

The five sets of water quality standards that have been established by the Wisconsin Department of Environmental Protection designate minimum requirements.[7] When two or more uses are defined for the same section of a river, the more stringent standard takes precedent.

Stream Standards

In order to develop the water quality standards for specific rivers or lakes, the existing and potential uses of the river, or more appropriately sections of the river, must be defined. A stream standard then represents the level of water quality in a specific river for selected water uses.[8] It is the general practice to establish stream standards regardless of the method used for water quality control. The effectiveness of a water quality program depends upon its ability to achieve

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7. For a detailed description of the five categories of water quality standards see: Wisconsin Administration Code, Section RD 2.02.

8. A discussion of the theoretical basis of the stream standard is contained in Chapter IV.

the established stream standard which in turn is a measure of the suitability of the water for certain uses.

It is also possible to use the stream standard as the basis for determining the amount of reduction in effluent discharge required of individual waste producers. In a section of a river where there is only one or a few major effluent dischargers, this method may prove fully effective in achieving the standard. The dischargers are required to keep their waste loads below the point where they would violate the standard at critical points in the river. An advantage of this method is that it allows the waste producer the maximum utilization of the stream carrying capacity for the discharger's waste load.[9] It has been shown that at low water quality levels, this system is almost as efficient as the least-cost solution.[10] This approach may also be efficient if there are no economies to be realized throughlarge scale facilities or through treatment of the waterway itself, i.e. flow augmentation.

Where dischargers are many and closely spaced along one section of a river, however, the stream standards approach by itself may be difficult if not impractical to apply.[11] Since the stream standard states only that certain water characteristics may not be violated, it is possible for an upstream polluter's waste load to use the maximum allowable assimilative capacity at critical points in the stream, forcing other downstream dischargers to withhold all their wastes or violate the standard. The high cost of reducing waste loads in such a drastic fashion and the economic consequences of such action may then result in permissive violation of the standard, i.e. a violation that is overlooked

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9. State of California, Water Quality Criteria, ed. Jack E. McKee and Harold W. Wolf, State Water Quality Control Board, Publication No. 3-A, 1963, p. 30.

10. Rolf A. Deininger, "Water Quality Management--The Planning of Economically Optimal Pollution Control Systems," American Water Resources Association Proceedings, 1965, p. 267.

11. Allen V. Kneese and Blair T. Bower, op. cit., p. 135.

by regulatory authorities. If the standards are enforced, the efficiency criterion may be violated because there is no assurance that the approach will produce a least-cost result. With regard to the equity criterion, the costs would be borne by the waste dischargers but these costs may be unequally distributed among them. However, the regulatory agency may regulate the effluent discharges so as to equalize the burden among waste dischargers. This leads to consideration of effluent standards.

Effluent Standards

In order to alleviate some of the problems caused by complete reliance upon stream standards, effluent standards have been established to complement that method. Traditionally, there have been two types of effluent standards.[12] The first type limits the strength and/or amount of a particular substance that can be discharged. For example, strength could be limited by some maximum concentration for a given waste based on a dilution factor either in mg/l or pounds per day dictated by the volume of flow in the receiving water course.

The second type of effluent standard typically requires uniform waste treatment (or waste reduction by changes in industrial processes), usually stated in percentage terms, by all waste dischargers in one stretch of a river. The degree of treatment required is calculated by determining the reduction of total wastes necessary to meet the stream standard at critical points in the river.

One advantage of the effluent standard approach is that it is relatively simple to administer. However, it does pose problems of efficiency and equity. In general, uniform treatment will not result in a least-cost system for achieving a specified water quality standard.[13] A recent

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12. State of California, op. cit.

13. The economic criteria for a least-cost system for a single stream reach requires that the marginal cost of waste reduction by each waste producer be equal. A uniform treatment program could satisfy this criteria only if all waste dischargers have identical cost functions for waste reduction. This would be highly improbable. For a further discussion of the least-cost criteria, see Chapter IV.

empirical study of the Delaware Estuary compares the costs associated with uniform treatment and other alternatives and demonstrates the foregoing to be true.[14] Also, this method of control does not allow waste producers to make full use of the assimilative capacity of the stream.[15] While full use of the stream's assimilative capacity may not be a specific goal of water quality, it does imply that the total expenditures by polluters for treatment facilities to attain some stream standard may be higher using a uniform treatment approach than under other systems. Furthermore, unless this program is supplemented by other measures (such as joint treatment facilities or in-stream treatment) it does not take advantage of the economies provided by such alternatives.

In terms of equity, the cost of improving water quality is borne by the waste producers, but the incidence of cost may be relatively uneven. Costs of treatment may vary substantially among plants and communities because of differences in scale, types of wastes, and technical opportunities. For instance, the cost per capita, for municipal primary or secondary treatment of sewage, may vary greatly depending on the size of the community.[16] The same is true for industrial firms and is further complicated by differing production processes.

Permit System

The use of effluent standards is not limited to the description above. It is possible to design a system of effluent standards which are based on case-by-case studies rather than uniform treatment.

Busch argues that uniform standards are too inflexible to maintain

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14. Edwin L. Johnson, "A Study in the Economics of Water Quality Management," Water Resources Research, Vol. 3, No. 2 (Second Quarter 1967).

15. State of California, op. cit., p. 31.

16. For an analysis of the cost of municipal sewage treatment see Robert Smith, "A Compilation of Cost Information for Conventional and Advanced Wastewater Treatment Plants and Processes," a report prepared for the Federal Water Pollution Control Administration, (Cincinnati: Cincinnati Water Research Laboratory, mimeographed, 1967).

stream quality in an area where the size and/or the number of waste discharges are growing, thus putting greater burdens on the assimilative capacity of the stream. Busch suggests a permit system where each municipality or industrial firm would have a permit stating the waste producer's discharge limits. The permit would be of a temporary nature and subject to revision as the quality of the stream changed.[17]

To determine how much waste any polluter could discharge, periodic conferences would be held between the dischargers and the regulatory agency to review the permit in light of current overall conditions. Implied, though not specifically stated, is that changes in the permit would relate to a number of different factors, including the cost of greater treatment of wastes by the discharger, the ability of other waste producers to reduce or treat their wastes and the goal for stream quality.[18]

It is possible to expand on Busch's description of a permit system. Once the permits were distributed to existing firms and municipalities and the system checked by the regional authority to be sure the stream standard was not being violated, the system could conceivably become almost self-regulating by making permits transferable through purchase and sale on the market.[19] In order for new firms to locate or for existing firms to expand within the region, they would either have to buy a portion of a permit from another polluter or locate on a section of the river where discharge permits were still available from the regional authority. The authority would regulate the sale of permits between waste dischargers only to be sure that additional permits acquired by waste dischargers would not allow them to violate the stream standard.

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17. A. W. Busch, A Suggested Approach to the Problem of Water Quality Standards, a report presented to the 23rd Industrial Waste Conference, Purdue University, May 7-9, 1968, (mimeographed).

18. Ibid.

19. For a further discussion of this concept see: J. H. Dales, Pollution, Property and Prices (Toronto: University of Toronto Press, 1968), pp. 93-97.

As this system has never been tried as a method of pollution control, it is difficult to judge how effective it might be. It could conceivably be both more efficient and more equitable than a uniform effluent standard. If the market functions reasonably well, it would offer a positive economic incentive to firms to adopt improved waste treatment practices. If waste discharges can be reduced at a cost that is less than the value of the portion of its permit governing the volume that might be reduced, the plant has an incentive to reduce its discharge and sell that portion of its permit. By itself, the system does not assure realization of scale economies or the use of instream treatment measures, but it may encourage such action. Cost would be borne by the waste dischargers, but the distribution among them would depend upon the principles which govern the assignment of permits.

The degree of success would rest with the ability of the regulatory staff to make discretionary decisions about the size of the permits with few, if any, simple policy rules to follow. It is important to note that this system would eliminate much of the risk involved in installing pollution abatement equipment by firms. Once the system was initiated, a firm would never need to increase its treatment facilities unless it decided to increase its operation or sell part of its permit to another waste discharger. In effect, the growth of waste producing firms discharging waste into a particular stream in the region would be limited by the number of permits available, which in turn would be limited by the stream standard.

Order System

The order system has already been discussed in the description of the regulatory system used in the State of Wisconsin. Basically, it is the same as a permit system except instead of requiring specific discharge limits, the order system requires the installation and operation of specific pollution equipment, based on individual case studies.

Summary

Based on the previous discussion, a few general points should be emphasized which relate to the economic effectiveness of direct regulatory programs for water quality control.

It has been shown that neither programs based on stream standards as the sole criterion for determining the amount of reduction required for individual waste producers, nor those based on effluent standards which require uniform treatment, satisfy the efficiency criteria. Furthermore, the incidence of costs among dischargers may be relatively uneven.

The relative economic effectiveness of permit and order systems is not as obvious as the previous two programs, since these systems are based on case-by-case evaluation of discharge requirements and thereby offer greater flexibility in program design. Even with this increased flexibility, it would be difficult to establish criteria for program design that will provide what most would consider to be an equitable distribution of costs and maximize the efficiency of the system.

If a direct regulatory system attempts to maximize efficiency by basing individual discharge limits on the least-cost solution, serious questions arise with regard to the distribution of costs. On the other hand, if a regulatory system attempts to satisfy accepted concepts of equity by requiring that the total cost of waste reduction to individual producers be proportional to the amount of waste that producer discharges into the water course, there may be a significant reduction in efficiency.

All systems of direct regulation face a number of difficult problems. With regard to efficiency, there are three major limitations. First, a regulatory system does not make explicit provision for taking advantage of economies of scale in treatment. Second, it makes no provision for taking advantage of jointly beneficial instream treatment measures such as flow augmentation and mechanical aeration. Third, a regulatory system is handicapped in encouraging industrial process changes to reduce waste discharges because of the amount of technical knowledge required on the part of regulatory personnel to understand the opportunities for such charges.

With regard to equity, a number of other problems arise. Of foremost importance is the question of how the burden of dealing with wastes should be distributed among waste discharges. Related to this question is an emerging feeling that these costs should not be imposed upon waste dischargers alone but should be more widely distributed to society generally. In particular, there is a concern that many local communities cannot afford the costs of treatment to desired levels and that by requiring large reductions in waste discharges by industrial firms, which may constitute more of an economic burden than these firms can handle, there may be consequent adverse effects upon the communities and regions which they serve.

This complex of efficiency and equity considerations has led to grants to local communities for waste treatment by the federal government and some states and tax benefits to industries for treatment facilities in a number of states including Wisconsin. It has also led to much more intensive consideration of the role of economic incentives (both positive and negative) in water quality management. In addition, for some time "sewage charges" have been used to finance some jointly used waste treatment and conveyance facilities. Opportunities for expanding the use of regional facilities raises the question of whether the use of charge systems should be more widely applied to finance such facilities. Such a possibility raises the further question of the relationship between a system of charges designed to finance joint facilities and charges designed to provide an incentive to reduce waste discharges to desirable levels. The remainder of this report examines these issues.

CHAPTER III

POSITIVE ECONOMIC INCENTIVES FOR WATER QUALITY IMPROVEMENT

Introduction

Improved water quality cannot be accomplished without very large expenditures in the next several years. The Federal Water Pollution Control Administration in a recently published report estimated that the treatment costs for municipal wastes during the five year period from 1968 to 1973 may be around \$15.6 billion (\$14.2 and \$1.4 billion for capital and operating costs respectively.) The costs for industrial waste treatment during the same period were estimated to be between \$5.6 and \$8.1 billion (\$2.6 - \$4.5 billion for capital costs and \$3.0 - \$3.6 billion for operating costs.) The cost details are shown in Table I. It is partly in light of the magnitude of the anticipated expenditures for water quality improvement in the near future that Congress and legislatures in several states have expressed a desire to develop incentive programs to promote compliance with water quality standards created under the law.

In the past several years, considerable political attention and support have been centered upon the development of positive economic incentives to waste dischargers to encourage compliance with pollution abatement standards created under the law. In recent sessions, numerous bills have been introduced in both Houses of Congress to provide additional assistance or incentives to the industry for pollution abatement.[1] The proposed devices involve subsidies in the form of tax relief through accelerated depreciation allowance (rapid tax writeoffs) and tax credits.

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1. See H. W. Mantel, Industrial Incentives for Water Pollution Abatement, (New York: Institute of Public Administration, 1965). Since World War II, over 80 bills have been introduced into Congress to stimulate private pollution control investment by means of tax incentives, usually through accelerated depreciation or some form of investment credit.

Some states including Wisconsin have enacted legislation of this kind and several more have these matters under consideration. The general investment credit was recently suspended by the federal government for several months, but "an exception was made for devices to abate air and water pollution."[2] In addition, the federal and some state governments give direct grants to municipalities for either or both capital and current expenditures associated with waste treatment facilities. In cases where these municipal plants also serve industries, such grant-in-aid programs may lead to indirect subsidies for industrial waste treatment.

An incentive program is aimed at encouraging an individual (or a firm) to do something he (or the firm) would not do in the absence of such a program. In this sense, incentives may "be either positive or negative; there can be bonuses for good performance or penalties for unacceptable behavior."[3] This section focuses upon positive incentives. Negative incentives, i.e., a system of charges or taxation intended to influence the behavior of the waste dischargers, will be discussed in the next chapter.

Incentive programs should be distinguished from assistance programs. The main objective of any incentive program is to change behavior whereas assistance programs are conceived primarily in the context of social and/or economic justice and equity. Welfare programs such as unemployment compensation are good examples of assistance programs in that a recipient loses welfare payments when he earns income and therefore it does not provide any incentive for him to seek employment.

Although the distinction between an incentive and an assistance program is possible in an abstract sense, it is extremely difficult to

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2. ABT Associates, Inc., Incentives to Industry for Water Pollution Control: Policy Considerations (Cambridge, Massachusetts: ABT Associates, Inc., 1967), p. 3.

3. Ibid, p. 3.

TABLE I

Cost Estimates in 1968 Dollars for Waste Treatment for the Five-Year Period Ending in 1973

	Type of Expenditure	Cost Estimate
	Treatment of Municipal Waste[a]	
Capital Costs	Capital outlay for upgrading existing facilities, reducing current unmet needs and providing for increases in urban population	$6.8 billion
	Sanitary sewers for urban dwellers not connected to municipal sewers	$6.2 billion
	Replacement of depreciated facilities	$1.2 billion
	Total Capital Costs	$14.2 billion
Operating Costs	Operating and maintenance for new and existing municipal treatment facilities, five-year total	$1.4 billion
Total Capital and Operating Costs		$15.6 billion
	Treatment of Industrial Waste[b]	
Capital Costs	Capital cost to overcome existing deficit in industrial waste treatment, and to keep pace with industrial growth	$1.8-$3.6 billion
	Replacement of depreciated facilities	$0.8-$0.9 billion
	Total Capital Costs	$2.6-$4.5 billion
Operating Costs	Operating costs for existing and new facilities, five-year total	$3.0-$3.6 billion
Total Capital and Operating Costs		$5.6-$8.1 billion

[a] Cost estimates based on the assumption that adequate treatment is equivalent to secondary treatment and that the total urban population will have its wastes treated. Cost estimates are for only those costs eligible for Federal grants under current programs and thus exclude land costs, relocation and other associated expenditures.

[b] Cost estimates based on the assumption that treatment facilities are required that will remove 85 per cent of suspended solids and of biochemical oxygen demand exerted by organic wastes. These costs exclude costs of dealing with the problem of industrial thermal pollution, which could cost close to $1.00 billion to abate by 1975, as well as not counting the costs of abating pollution from acid mine drainage, animal feedlot runoffs, and salinity produced by irrigation.

Source: U. S. Department of the Interior, Federal Water Pollution Control Administration, The Cost of Clean Water (Washington, D. C., January 1968), Table 1.

sort out these considerations in the analysis of many government programs. For example, various proposals for additional tax breaks are aimed at providing incentives to firms for pollution abatement as well as assistance. Similarly, the federal grants to municipalities for sewage treatment can be viewed both as assistance and incentive programs. Since some plants may have to close down because they are unable to assume the expenses of pollution abatement in spite of the existing and additional tax incentives, it may be appropriate to consider such marginal firms as special cases in the context of incentive and assistance programs. Such plants are generally small, use older technology, and may already be facing hardship in competing with larger and more modern plants. If it is considered desirable to give additional assistance to marginal firms as a matter of general public policy, then it is necessary to raise two questions:

1. Should additional assistance be rendered to such firms within the framework of incentive and assistance programs for pollution abatement or should they be provided assistance under some different programs?
2. Should additional subsidies to marginal firms be provided for shorter, limited durations or for indefinite periods?

Fiscal Incentives for Water Pollution Abatement

Fiscal incentives for pollution abatement may be classified into the following four categories:

1. Tax incentives,
2. Loans,
3. Grants to industrial firms, and
4. Grants to governmental agencies for construction of industrial waste treatment facilities.

Federal Tax Incentives

Under the current Federal Corporation (Business) Income Tax provisions, capital expenditure on pollution abatement facilities affords substantial tax savings to industrial firms undertaking such investment. The "investment tax credit" enacted in 1962 permits business investing in machinery and other equipment with an expected life of eight years or more to subtract from their income tax an amount up to 7 per cent of the investment value. In addition, the water pollution control equipment is included under the accelerated depreciation allowance for capital equipment and thereby permits the firms undertaking such investment to pay lower taxes during the earlier life of such assets. Such firms have more dollars to use in the near future and the tax savings in effect are equivalent of interest free loans. In other words, for such a firm there is a benefit equal to at least the interest rate it would have to pay to borrow funds (equal to tax savings) or the interest it could obtain if it were to loan the money or the internal rate of return on its own investment.

The impact of investment credit and accelerated depreciation (under different assumptions concerning the rates) for investment in waste treatment facilities is shown in Table II.

Under the existing tax laws, the present value to the firm of the tax savings for pollution control spending may be around 33 per cent of the capital outlays, (the percentage is between 30 to 45 and varies from one firm to another, depending upon the effective tax rate applicable, expected life of the asset, the firm's discount rate, and the method of depreciation utilized for tax purposes). Supposing that a firm is faced with a $1 million investment in treatment facilities, the net capital cost to the firm may be about $670,000. The balance $330,000 capital cost in this particular case would be borne by the community as a whole. As shown in Table II, if additional tax incentives were granted, this would further reduce the industry's share of pollution abatement costs and impose additional burden on the community at large.

Under the present Federal Business Income Tax structure, operating costs associated with pollution abatement also afford substantial tax savings to the firms who incur such expenditure. The firm with net profits up to $25,000 are subject to a 22 per cent tax rate whereas for firms with net profits over $25,000 the tax rate is 48 per cent. The net cost to a firm with net profits of up to $25,000 is 78 per cent of operating

TABLE II

Comparison of Subsidy (savings) to Industry Through Alternative Forms of Federal Assistance for Waste Treatment Plant Construction[a]

Type of Assistance	Subsidy or Savings as Per Cent of Capital Cost	Savings Per $1 Billion of Capital Investment	Rough Estimate of Likely Assistance to Industry for Hypothetical Investment of $1.8 Billion During 1968-73
		($ Million)	($ Million)
Existing 7% Tax credit	7	70	126
Normal Depreciation	26	260	468
Total - Existing Tax Structure	33	330	594
Accelerated Depreciation:			
5 years	37 (11)	370 (110)	666 (198)
3 years	41 (15)	410 (150)	738 (270)
1 year	48 (22)	480 (220)	864 (396)
Tax Credits:			
14 Per Cent	14 (7)	140 (70)	252 (126)
20 Per Cent	20 (13)	200 (130)	360 (234)
Accelerated Depreciation and Tax Credit Combined:			
7% tax credit and 5 year depreciation	44 (11)	440 (110)	792 (198)
7% tax credit and 3 year depreciation	48 (15)	480 (150)	864 (270)
7% tax credit and 1 year depreciation	55 (22)	550 (220)	990 (396)
14% tax credit and 5 year depreciation	51 (18)	510 (180)	918 (324)
14% tax credit and 3 year depreciation	55 (22)	550 (220)	990 (396)
14% tax credit and 1 year depreciation	62 (29)	620 (290)	1116 (522)
20% tax credit and 5 year depreciation	57 (24)	570 (240)	1026 (432)
20% tax credit and 3 year depreciation	61 (28)	610 (280)	1098 (504)
20% tax credit and 1 year depreciation	68 (35)	680 (350)	1224 (630)

[a] Assume 48% effective tax rate, 15 year functional life (straight-line) for pollution abatement facilities and 9% discount rate. Accelerated depreciation now available under existing laws--e.g. sum of digits or double declining balance not included in our estimates.

Figures within parentheses are additional subsidies (over and above now available under existing laws) associated with different alternative proposals.

costs and for the firms with net profits over $25,000, the net cost is only 52 per cent of such expenditures. Suppose, that a firm who invests $1 million in capital facilities for waste treatment, is also faced with $100,000 of annual maintenance and operating costs. The actual net cost in respect of the above operating expenditure may be either $78,000 or $52,000 depending upon the tax rate applicable to this firm. Thus the tax savings may be either $22,000 or $48,000. Since for tax purposes service charges (sewage or effluent) are treated in the same manner as other maintenance and operating costs, the net cost to the industrial firms may be 52 or 78 per cent of such charges depending upon the tax rate applicable to them.

It must be borne in mind that, in spite of the substantial tax savings to the industrial firms for pollution abatement expenditures, such expenditures result in net loss to the firms who undertake them. As shown in Table II, the actual net loss to a firm (after accounting for tax savings) may be around 67 per cent for investment in capital facilities. The net cost for maintenance and operating expenditures to a firm may be 52 per cent. Assuming that very significant additional tax incentives (20 per cent tax credit instead of the present 7 per cent and pollution equipment was allowed accelerated depreciation to be written off in 5 years) were offered, these would reduce the net capital costs to the firm by another 24 per cent, whereas the net cost for maintenance and operating expenditures would remain unchanged. In other words, a firm undertaking $1 million investment in capital facilities may still be faced with a net capital cost of around $430,000 plus the same maintenance and operating costs.

In view of the fact that even with substantially increased tax incentives, pollution abatement will remain a net loss item on the firm's account, it is doubtful if additional tax incentives can exercise significant influence on industrial behavior to undertake large pollution control expenditures. As one report correctly points out:

> ... It is difficult to see how a tax incentive could persuade any firm that favored a delaying strategy not to delay. Similarly, it is difficult to believe that any firm unable to raise the capital without such a tax incentive would be able to raise it if there were such an incentive. Thus the first important objection which can be made against all of the tax incentive schemes that have been proposed is that they do not provide real incentives to change behavior. [4]

In the past, tax incentives have been successfully employed to induce investments in general in the American economy. It is doubtful, however, that such incentives would work by themselves in the case of pollution control, because investment in pollution abatement is basically unprofitable. At best, "tax incentives can serve to make an initially attractive possibility still more attractive, or to make a marginally profitable opportunity worthwhile. For a pollution control investment, however, the firm sees an unprofitable program whether or not there is special tax assistance." [5] It is likely, however, that it will be somewhat easier for a regulating agency to induce a firm to invest in treatment facilities if there is some form of subsidy than if the firm must bear the whole cost.

Besides the doubtful effectiveness of tax incentives in inducing investment in pollution abatement, tax incentives suffer from additional deficiencies.

The impact of tax incentive schemes is such that it may lead to inefficient allocation of resources because after taxes, the net relative prices a firm faces in making pollution abatement investments are not the same as the real cost of the resources to the society, with the result that "the real cost of abating pollution will be higher than it has to be, even though the firm itself chooses the method that appears least costly." [6]

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4. ABT Associates, Inc., op. cit., p. 41.

5. Ibid., p. 42.

6. Ibid., p. 42.

This is especially so because the proposed additional tax incentive schemes are aimed at providing additional subsidy for capital outlays and not for maintenance and operating expenditures. The capital costs account for roughly one-third of the total cost of water pollution abatement. [7] Even with capital investments, the subsidy is applicable to depreciable assets only -- equipment and other facilities. Under the existing tax laws, land cannot be depreciated, so that investment in land is relatively more costly than investment in mechanical devices because the latter capital costs are made artificially cheaper by virtue of a tax write-off. The likely effect of incentive schemes would be increased expenditures on depreciable resources relative to alternative resources used in waste treatment like land, labor for operation and maintenance, labor for more careful control of production processes, chemicals used in operation, and investment in new productive facilities that produce less pollution.

Another example of inefficient use of resources may be seen where a particular firm has a choice either to treat the waste itself or to have it treated by a municipality or other government agency. The tax incentives may distort such choices. Assuming that joint treatment facilities provide potential scale and external economies and that charges for such facilities are based on full cost, extensive tax incentives in respect of capital facilities for internal treatment may "make them cheap enough, after taxes, for the firm to prefer to invest in its own facilities rather than have its waste treated by a central agency, even though before taxes the service charges for central treatment were lower than the cost to the firm of constructing its own treatment plant." [8] In spite of the fact that real costs as reflected in charges by central agency were lower, the firm is likely to decide

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7. The Working Committee on Economic Incentives, a Subcommittee of the Federal Coordinating Committee on Economic Impact of Pollution Abatement, Summary Report on Cost Sharing with Industry, (Washington, D.C.: November, 1967, mimeographed), p. 27.

8. ABT Associates, Inc., op. cit., p. 43.

to treat its own waste, with the result that more real resources would have been used than necessary to achieve specified pollution control objectives.

Almost all the proposals for providing additional tax incentives for pollution abatement would tend to discourage production process changes since the tax writeoffs are not applicable to such investments. Kneese and Bower point out that "many industries can reduce their waste loads most efficiently--at least over a considerable range--by altering production processes and/or recovering materials and producing by-products." [9] In these cases tax incentives would distort the efficient use of resources by favoring investment in facilities for treatment of wastes after generation.[10] Even if the scope of incentives was widened to include these investments, administration of such programs would be very complex and extremely difficult since "the Treasury Department would be faced with the difficult task of certifying the proportion of the cost attributable for pollution abatement or for disallowing any assistance for this kind of improvement.[11]

Finally, since different firms face different effective tax rates, the net present value of tax benefits would be greater for those firms who face higher tax rates with net profits over $25,000 than the firms whose effective tax rates may be lower.

State Tax Incentives

Tax incentives granted by some of the states are in the form of 1) exemption of industrial waste treatment and water pollution abatement plants and equipment from ad valorem property taxation, and 2) rapid amortization allowance for income tax purposes in lieu of depreciation.

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9. Allen V. Kneese and Blair T. Bower, op. cit., p. 177.

10. The bills introduced into Congress normally specify that tax credits and accelerated depreciation are not to be allowed on any equipment that contributes or adds to a company's profits, and this specification forecloses tax incentives for in-plant changes.

11. The Working Committee on Economic Incentives, op. cit., p. 27.

The State of Wisconsin enacted legislation in 1965 which enables substantial savings on pollution abatement investment. Under the provision of section 70.11(21), treatment plant and pollution abatement equipment including lagoon lands are exempt from property taxation, whereas sections 71.04(26) and 71.05(1)(6) provide for accelerated amortization for such investments for the state corporate tax purposes.

Subsection 70.11(21) concerning exemption from property taxation of treatment plants and pollution abatement equipment and lagoon lands reads as follows:

> (a) All property purchased, constructed, installed and operated with the approval of the committee on water pollution, state board of health, a city council, a village board or county board pursuant to s. 59.07(53) or (85) for the purpose of abating or eliminating pollution of the air, and all property purchased, constructed, installed and operated with the approval of the department of resource development for the purposes of abating or eliminating pollution of the air or waters of the state.

Exemption of pollution abatement facilities from local property taxation provides substantial savings to firms undertaking such investments. Assuming that life of these facilities averaged 15 years, and that during the life of such assets, property tax averaged at 3 per cent per year of their market values, the net present value of tax savings over the 15-year period discounted at 9 per cent may be about 12 per cent of initial investment.

Subsection 71.04(2b) concerning accelerated amortization of investment in pollution abatement facilities for corporate tax purposes provides that:

> In lieu of the allowance for depreciation for any taxable year or part thereof beginning after December 31, 1952, the owner may elect the write off of the balance not previously deducted in years prior to the 1966 calendar year or corresponding fiscal year for waste treatment plant and pollution abatement equipment purchased or constructed and installed pursuant to order or recommendation of the committee on water pollution, state board of health, city council, village board or county board pursuant to s. 59.07(53) or (85) in the 1966

> calendar year or corresponding fiscal year. Any waste treatment plant and pollution abatement equipment purchased or constructed and installed in the 1966 calendar year or corresponding fiscal year, or in a subsequent year, pursuant to order or recommendation of the committee on water pollution, department of resource development, state board of health, city council, village board or county board pursuant to s. 59.07(53) or (85) may be deducted in the year of cash disbursement for same.
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> (c) No deduction shall be allowed under this subsection on other than depreciable property, except that where wastes are disposed of through a lagoon process. Such lagooning costs and the cost of land containing such lagoons shall be subject to accelerated amortization provided for under this subsection.

The foregoing provisions on accelerated amortization on pollution abatement facilities also provide some additional subsidy to the firms undertaking such investments. Under the straight line method of depreciation for an investment in an asset with 15-year normal life, the net present value to the firm is about 3.7 per cent of the investment (discounted again at 9 per cent per year). The tax savings under the accelerated amortization provisions amount to 7 per cent of the capital cost.

The tax breaks provided by the State of Wisconsin and some other states are subject to similar limitations and objections as the proposed federal tax incentive programs for additional subsidies to industrial investment in pollution abatement.

In the light of the foregoing discussion, tax incentives are not considered effective means for inducing the industrial firms to undertake investments for water pollution abatement purposes. Besides being relatively ineffective, the type of tax incentives that are being proposed may impair efficient allocation of resources, making pollution abatement more costly to the society as a whole. Other researchers dealing with this question have also concluded that "tax breaks are blunt instruments for water quality management; they are potentially costly to the taxpayer; and they are very likely to induce inefficient means of control."[12]

Government Loans to Industry

Government loans to industry have the same objective as tax write-offs, in that they are designed to lower the cost of capital to the firms who are recipients of such loans. Assuming a 9 per cent discount rate or cost of capital to the industry, a 6 per cent, 15-year loan implies a 17 per cent subsidy.

There are two major sources of aid available to industry for water pollution abatement investments: (1) Small Business Administration and (2) Economic Development Administration.

As of early 1967, the Small Business Administration had made 21 loans for pollution abatement investment totaling $1.3 million, at an interest rate of 5 1/2 per cent per year.[13] The industry benefits from this program in three ways:

> First, industry can save half the difference between the 5 1/2% interest rate it pays on these loans and the higher rates it would have had to pay to obtain funds from the private sources. (Only half the interest difference is saved because all interest payments are deductible for corporate income tax purposes). Second, some small firms might have difficulty in obtaining any loan capital on the open market for pollution control investment because, especially when credit is tight, banks often "ration" available funds in favor of large borrowers. Third, such loans are frequently for longer periods than credit available in private capital markets.[14]

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12. Allen V. Kneese and Blair T. Bower, op. cit., p. 178. Also see ABT Associates, Inc., op. cit., pp. 43-46; and the Working Committee on Economic Incentives, op. cit., p. 29; and D.F. Bramhall and E.S. Mills, "Alternative Methods of Improving Stream Quality: An Economic Policy Analysis," Water Resources Research, Vol. II, (3rd October, 1966), pp. 355-363.

13. ABT Associates, Inc., op. cit., p. 24.

14. Ibid.

Under the Public Works and Economic Development Act of 1966, as well as under some prior legislation, Economic Development Administration (EDA) can offer financial assistance to any plant or firm, regardless of size, if pollution abatement actions should tend to limit modernization, expansion, or solvency of the facility. Also, loans can be made available for water lines and sewage systems for industrial parks. Ordinarily, a plant eligible for loan assistance from EDA must be in a county which is designated as a "depressed area." In all areas, including those outside of "depressed areas," EDA can pay 100 per cent of the cost of technical studies for the purposes of identifying least-costly methods of abating pollution for plants in towns or sections of cities threatened by reduced economic activity.

Like tax incentives, government loans to industry for pollution abatement do not meet some of the economic efficiency criteria. First, since loan assistance is restricted to certain types of capital investments only, it tends to distort a firm's choice among alternative methods of pollution abatement. Second, like taxes, loans also discourage production process changes because they are generally not available for such process changing investment. Third, the loans by providing a subsidy, may lead to inefficient allocation of resources (although the distortion would be relatively small compared to tax incentives).

However, compared to tax incentives, government loans offer certain advantages. First "loans could be used by firms without profits. Furthermore, firms paying the lower corporate tax-rates are not discriminated against as they are in any tax incentive program."[15] Second, loans assist the firms in raising the capital they need for pollution abatement investment when they might have difficulty in raising such funds in the open market. This would be specially so, if the interest rate on these loans is set at or near the market rate. If this is done, the firms which could borrow at the market rate in the open market would not apply, and

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15. Ibid., p. 49.

the smaller or poorer firms would be the ones to benefit from loan assistance programs.

Grants to Industry

Grant programs to industry for water pollution abatement purposes may be of two types: 1) indirect assistance programs for planning, research, development and so on; and 2) direct subsidy, bonus or cost sharing programs. There are a number of indirect federal grant programs to industry whereas there are none in existence at present of the direct type.

Indirect Assistance Programs

The major source of indirect grants for pollution abatement purposes is the U.S. Department of Interior. These grants are available for such purposes as comprehensive river basin planning, research, development, demonstration and so on. Of the $53 million current annual appropriation for water pollution control program, at least $10 million is allocated for industrial waste problems.[16] Demonstration grants authorized under the Clean Water Restoration Act of 1966 can be made available to industry for analyzing methods of prevention of industrial pollution, including treatment of industrial waste. The research and demonstration grant programs benefit the industry more or less directly in two ways:

> Some of the funds distributed go directly to industry, underwriting research on industrial pollution control problems. Other funds go to universities or to state or local agencies. But these latter programs also produce knowledge that can be helpful to industrialists seeking to abate their pollution at lower costs.[17]

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16. Working Committee on Economic Incentives, op. cit., p. 6.

17. ABT Associates, Inc., op. cit., p. 24. There are four types of grants for training, research and demonstration purposes: (1) research grants which support basic and applied research projects throughout the country and encourage investigators to explore neglected areas in the causes and controls and prevention of water pollution; (2) research fellowships which promote specialized training in the problems of water pollution; (3) training grants which expand training programs in universities, colleges, and institutions; and (4) demonstration grants which develop and support projects aimed at accelerating application of new knowledge to routine water pollution control practices.

In addition, a number of other agencies, e.g. Geological Survey, Department of Agriculture, Atomic Energy Commission, Bureau of Mines, and Bureau of Commercial Fisheries, provide a wide variety of information, including research reports, to assist industries in complying with pollution control legislation.

Direct Grants to Industry

Although there are no grant programs of the direct type in existence at present, it may be appropriate for purposes of this report to consider two types of direct assistance and/or incentive programs.

1) Cost sharing programs aimed at lowering the waste reduction costs to the industry and thereby providing incentives for water pollution abatement; and
2) Bonus payments or performance subsidies based upon the amount of waste reduction by industrial firms.

Cost-Sharing programs - Under the direct assistance programs of this type, the federal and/or the state government may provide a certain proportion of pollution abatement costs--either capital or maintenance and operating or both--as grants to the industry undertaking such costs. The effect of cost-sharing programs may be very similar to tax incentives and such programs would have the following major limitations:

1. Even if the government is willing to assume a very substantial share of the costs of pollution abatement over and above the share of the costs already underwritten by the current tax laws, it is difficult to see how a cost sharing grant will substantially change industrial behavior. Pollution control will remain a net loss to industry, and there will still be substantial incentives for firms to delay, awaiting new technology, more aid, or less enforcement pressure.
2. If cost sharing grants are tied to the costs of specific capital facilities and maintenance costs are excluded, they would have substantial adverse effects on the efficiency of the nation's pollution abatement program. Capital grants also lower the incentive to a firm to engage in process changes to lower its pollution load. Such grants also descriminate against methods which rely more heavily on operating expenditures.

3. Direct grants result in lower prices for goods whose production results in pollution than those that would reflect the costs of abating pollution. Thus, consumers will not face prices that reflect the real costs to society of the goods they buy and economic inefficiency will result.
4. Government grants to firms to construct their own facilities make it less likely that a firm will agree to have its wastes treated by a government agency for a price that reflects the real costs of the treatment. Even if self-treatment is more expensive at market prices, the grant program may make it less expensive for a firm to treat its own wastes (with the help of the grant), than to go along with central treatment. However, the latter might in fact be more efficient from society's point of view.[18]

The grant programs, however, offer certain advantages over tax incentives:

1. The amount of funds committed to the program is known in advance and under the direct control of Congress/legislature. Funds are necessarily appropriated each year after review of the programs. Hence a grant program allows more flexibility in adjusting to changing circumstances.
2. It might be possible to make operating expenses, and costs, etc., eligible for grant assistance while it would be difficult or impossible to do so through the tax laws. Hence a good grant program could have fewer adverse effects on economic efficiency than the usual tax incentive proposals.
3. Grant assistance is not limited to profitable firms as are tax incentives, nor do grants necessarily provide less aid for small firms paying the lower corporate income tax rate.

Bonus Payments or Performance Grants - It is possible to induce waste reduction by offering to a firm a payment or a subsidy of a certain

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18. Ibid., p. 46.

fixed sum per unit of pollutant withheld or removed from the waterways. In theory, such a subsidy program to reduce waste discharge will tend to minimize costs associated with waste disposal in a particular region.[19]

Although this type of subsidy program is likely to be economically efficient, it would be administratively impracticable because of the serious problem of measuring how much pollution abatement has been accomplished by a particular firm eligible for payment. As one report points out, it would be virtually impossible to measure what pollution levels would have been in the absence of the abatement program:

> Suppose one defines the base level to be the pollution load before the beginning of the payment program. This procedure penalizes exactly those firms that have made an effort in the past to limit their waste discharges. Some firms might even make an effort to increase their pollution in order to have a larger pollution level to reduce. Alternatively, suppose the base level is defined to be the pollution load entering the treatment facility operated by the plant. This method virtually eliminates incentives to the firm to engage in process changes to reduce waste.[20]

Alternatively, a performance subsidy based on the amount of treatment actually performed may be considered. Such a subsidy would provide the largest percentage of costs of treatment for plants that do a great deal of treatment at lower costs. A system of payments based on performance to be effective would require that the subsidy should pay 100 per cent of cost of treatment, otherwise in the absence of some other devices there would be no incentive to a firm because waste reduction would still be a net loss item. Performance subsidies may also create some undesirable side effects. For example, if such payments were above the abatement costs of some firms, this would encourage firms to produce waste and then treat it and thereby make it easy for the unscrupulous operator to benefit by exaggerating his potential waste load.[21]

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19. See Kneese and Bower, _op. cit._, pp. 98-101.

20. ABT Associates, Inc., _op. cit._, p. 97.

21. _Ibid._, p. 97.

Municipal Grant Program as an Aid to Industry

Under the Federal Water Pollution Control Act, as amended, grants for construction of waste treatment facilities, can be made to any state, municipality, intermunicipality or interstate agency. For the fiscal year 1968, Congress has appropriated $203 million for this grant-in-aid program. These grants are for capital facilities only and vary from 30 to 55 per cent of capital costs of municipal treatment facilities.

It has been estimated that roughly one fourth of industrial wastes are currently being treated through municipal and other government agency sewer systems like county and special sewage districts.[22] To the extent "that industries participate in such systems, aid to these programs can and should be seen as an important if indirect aid to industry to abate pollution."[23] The industries when they treat their wastes jointly with municipalities, benefit in two ways: First, when a municipality secures a construction grant for domestic as well as industrial waste treatment facilities and if the net rather than gross costs form the basis of charges for industrial waste, the industry pays charges at subsidized rates; and second, due to the tax exempt status of interest on municipal bonds, these bonds carry lower interest rates, and thus charges from industry may be lower than if the industry installed its own facilities.

Although federal assistance to municipalities for sewage treatment facilities can be justified on several grounds, these arguments apply mainly to domestic waste only and not necessarily to the industrial waste that may be treated through the municipal plants. It is pointed out that benefits of clean water accrue in larger amounts to the relatively rich than to the poor.[24] If the water pollution abatement programs are

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22. The Cost of Clean Water, op. cit., Table 8.

23. ABT Associates, Inc., op. cit., p. 50.

24. See Eva Mueller and Gerald Gurin, Participation in Outdoor Recreation: Factors Affecting Demand Among American Adults, Report to the Outdoor Recreation Resources Review Commission Study Report #20 (Washington, D.C.: U. S. Government Printing Office, 1962).

financed through service charges or through state and local property and sales taxes, the system would be more regressive than if this program was financed through federal taxes. Thus the greater progressivity of the federal tax system as a whole can provide a justification for subsidizing domestic waste treatment facilities.

Additionally, it is "argued that the state and local sectors are harder pressed for funds than the federal sector, and therefore the federal tax system should bear the burden of financing sewage treatment investment."[25]

However, indirect subsidy to industry when a municipality charges the industry on net (after government subsidy) cost rather than full cost basis is considered undesirable for the following reasons:

1. By reducing the net cost of waste generation, it would adversely affect production process changes. In the event that a process change was less expensive in reducing waste loads compared to municipal charges on full cost basis but more expensive when changes were based on net cost basis, the industrial firm would prefer the latter alternative although the former should be preferable from an economic efficiency viewpoint.
2. Charges which do not reflect full cost may result in treatment arrangements which are nationally or regionally less efficient. This would be the case, for instance, if the waste treatment cost for a firm with self treatment exceeded subsidized municipal charges but were lower than charges based on full cost. Under these circumstances, a firm would find it economical to tie into a municipal system although such an arrangement would be more expensive to the society at large.
3. As in the case of direct grants, product prices do not reflect full cost because of subsidized waste treatment charges. A misallocation of resources invariably results favoring those goods for which environmental pollution costs are higher.

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25. ABT Associates, Inc., op. cit., p. 52.

In cases where scale economies can be achieved by combining the domestic and industrial waste treatment facilities, it may be desirable that municipal charges for industrial waste treatment be based on full cost even when a municipality receives a federal construction grant. Alternatively, the federal grant may be determined on the basis of that proportion of construction cost which represents treatment for domestic wastes.

Summary

Across-the-board general fiscal incentives or subsidies to industry are difficult to justify on economic efficiency grounds. Of all the alternative incentive schemes considered in this section, loans and grants seem to be preferable to tax incentives. Since loan programs would aid firms which would otherwise experience difficulties in raising capital for treatment facilities, a restricted loan program might be the most desirable of the fiscal incentives for achieving water quality goals. A grant program incorporating special assistance for hardship cases may also be desirable. Most incentives tend to discourage production process changes and are biased in favor of capital facilities. It is desirable that an incentive program should be aimed at encouraging the widest possible techniques for pollution abatement and should thus include cost of nondepreciable assets (land) as well as maintenance and operating costs. Fiscal incentives should be limited to existing industry and new industries should be excluded from such schemes. This consideration requires that any fiscal scheme should continue for a specific number of years. The current municipal grant program should be restricted to treatment of domestic wastes only, and the industrial service charges should be based on full cost of such treatment.

CHAPTER IV

EFFLUENT CHARGES AS AN INCENTIVE TO WATER QUALITY IMPROVEMENT

Effluent Charges

Several economists concerned with the problem of water pollution abatement have frequently urged the levying of effluent charges as a means of fostering economically efficient behavior by waste dischargers.[1] While an effluent charge may be used to finance certain joint facilities, in this chapter we are only concerned with the use of the charge as a water quality improvement incentive. An effluent or an emission charge for this purpose is based on what a firm actually discharges into the stream so that the more the firm reduces its wastes, the smaller is the charge that the firm must pay.

The rationale for effluent charges is based upon the argument that water pollution causes certain external diseconomies or spillover effects. For example, upstream "municipalities and private firms can escape certain costs associated with waste disposal by passing the problem along to other parties, and may find it to their economic advantage to do so."[2] If the offsite (downstream) costs or damages exceed the costs of reducing waste discharged by the upstream users, then wastes are not being handled on a minimum cost basis. Furthermore, the costs may be borne by someone other than the dischargers.[3]

Under a free market economy, it is pointed out that external diseconomies do exist and may result in inefficient allocation of resources.

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1. For example see: David F. Bramhall and Edwin S. Mills, "Alternative Methods of Improving Stream Quality: An Economic and Policy Analysis," _Water Resources Research_ (Third Quarter 1966), pp. 362-363; Edwin L. Johnson, "A Study in the Economics of Water Quality Management," _Water Resources Research_ (Second Quarter 1967); and Kneese and Bower, _op. cit._

2. Allen V. Kneese and Blair T. Bower, _op. cit._, p. 97.

3. _Ibid._, p. 97.

Kneese and Bower use the following example to illustrate this point:

> When an upstream steel mill dumps its waste into a watercourse without consideration of the downstream costs imposed, it produces steel which is artificially 'cheap' because nothing is paid for the use of a valuable resource, i.e., for the waste dilution, degradation, and carriage capacity of the watercourse. From a social point of view, the value of this resource is measured by the alternative uses which can be made of water. *Failure of municipal and industrial waste dischargers to consider that subsequent water uses may be made more expensive or foreclosed entirely by their discharges is perhaps the basic element of the water quality problem.*[4]

They further point out that:

> When offsite costs are ignored, an excessive amount of waste tends to be deposited in receiving waters. Little effort is made to treat wastewater, to recover materials from wastewater, or to design and operate industrial processes that will reduce the generation of wastes, although studies of waste loads generated per unit of physical output by plants producing identical goods by different processes can show that a sizeable proportion of wastes can be 'engineered away.' *This emphasizes the importance of providing the appropriate incentives for such procedures.*[5] (Italics provided)

Efficiency in resource allocation can be improved (or inefficiency can be reduced) by minimizing the sum of offsite damage costs (external diseconomies) and the waste reduction costs. This point may be seen more clearly by considering a simple example.

Assume that a single firm owns and controls all activities using a particular river. Let us further assume that this firm owns a manufacturing plant upstream that discharges an effluent that is toxic to fish, that it also owns a fishing concern downstream, and that these are the only two activities along the river.

If the firm wishes to maximize the profits it receives from both

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4. Ibid., pp. 79-80.

5. Ibid., p. 80.

manufacturing and fishing (in this example, maximizing profits is assumed analogous to maximizing the net social return of the uses of the river in the general case), the firm will want to reduce the amount of toxic substances discharged upstream to increase the supply of fish downstream. The firm will continue to reduce its profits at its upstream plant by expending resources on pollution facilities as long as the cost of additional increments of abatement are more than offset by increased profits from fishing. At some point, the firm will not be able to increase its total profits by further abatement, and this will be the optimum level of stream quality for this particular set of activities. In this case, the diseconomies plus the cost of waste treatment would be minimized because the firm is forced to consider offsite costs when making decisions concerning the amount of waste that should be discharged by the upstream plant.[6]

It may be noted that external diseconomies exist because of the offsite damage (or cost) associated with unregulated waste discharge. For efficient use of resources, it is necessary that these offsite costs be reflected in the waste disposal decisions of individual firms and municipalities. In cases where a large number of firms and local government units discharge waste into a water body, external diseconomies may be so great as to justify public intervention. The main objective of a regulatory public agency then is to force waste producers to react to the major external costs associated with their waste discharges. A system of effluent charges is aimed at achieving this objective and attempts to induce the individual firms and municipalities to consider offsite costs in their decisions concerning waste generation, treatment, and discharge.

At this point, it may also be added that according to economic theory, the problem of externalities or technological spillovers can be tackled through a tax levy on the unit responsible for the diseconomy and through payment of a subsidy to the damaged party. If certain conditions are

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6. Ibid., pp. 81-84; 89-94; and 97.

met, the appropriate tax is just large enough to pay the appropriate subsidy.[7] However, from a purely economic efficiency viewpoint, it is not necessary both to levy a tax or an effluent charge on the waste discharger and pay a subsidy to the damaged party.[8] An appropriate tax or a charge alone would produce an efficient allocation of resources.

As pointed out in the preceding chapter, it is also possible to induce waste reduction by offering a payment or subsidy instead of levying a charge. In this scheme, a waste producer would be paid a set amount for each unit of waste that is withheld which was previously discharged into the watercourse. There is some disagreement among economists as to whether or not a payments scheme would accomplish the same results as an effluent charge.[9] In any case, a payment scheme would be difficult to administer and would "make it easy for the unscrupulous operator to benefit by exaggerating his potential waste load."[10]

Procedure for Determining Effluent Charges

Effluent charges are based on the quantity of wastes produced and damage caused by such wastes. The actual damage done by a unit of waste depends upon where it enters the stream and stream flow conditions as well as, whether it is degradable or non-degradable.[11] For a non-degradable

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7. James E. Meade, "External Economies and Diseconomies in a Competitive Situation," Economic Journal, March 1952.

8. See Kneese and Bower, op. cit., pp. 98-99.

9. For a discussion of the role of payments-charges, see D. F. Bramhall and E. S. Mills, "A Note on the Asymmetry Between Fees and Payments," Water Resources Research (Third Quarter 1966), pp. 615-616; M. J. Kamien, N. L. Schwartz, and F. T. Dolbear, Jr., "Asymmetry Between Bribes and Charges," Water Resources Research (First Quarter 1966), pp. 147-157; A. Myrick Freeman III, "Bribes and Charges: Some Comments," Water Resources Research (First Quarter 1967), pp.287-298; and Kneese and Bower, op. cit., pp. 98-107.

10. Ibid., p. 109. See also ABT Associates, Inc., op. cit., p. 97.

11. Nondegradable wastes are usually diluted when they enter a stream. Such wastes may change their form but not their weight. Degradable wastes are reduced in weight by biological, chemical or physical processes in the stream.

waste (assuming constant stream flow), the concentration at any downstream point is independent of where the waste is added upstream. In this case, the potential damage is uniform (linear) throughout the downstream reaches of the river beyond the point where the waste enters. In other words, the further upstream the waste enters the stream, the greater the potential total damage since larger reaches of the river are affected. For a degradable waste, the potential damage at successive points downstream decreases with an increase in the distance from the point of entry upstream. Also a unit of waste added along a critical reach of the river will do more damage than if it enters the river elsewhere. Since effluent charges are based on the amount of damage caused by waste dischargers in a particular stream reach, the implication is that the charges, although uniform within different reaches, would vary from one reach to another.[12]

Since the stream flows on any river vary during different times of the year, offsite damages caused by a unit of waste entering at a particular point upstream also vary seasonally. To increase the efficiency of an effluent charge system, charges would vary with the ratio of discharge to stream flow.

In theory, charges would not only vary over different reaches of the river and during different times of the year, but the charges would also vary over the short- and long-run. This is so because changes in the conglomeration of industrial and other activities as well as the variations in production processes of such firms would lead to variations in the waste generation, treatment, and discharge over a period of time and may thus substantially modify offsite damages or external costs.[13]

An optimal system of effluent charges requires that the charge be set at the level where a small increase in the cost of waste reduction

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12. ABT Associates, op. cit., pp. 97-98.

13. For a discussion of the long-run and short-run damage functions, see Kneese and Bower, op. cit., pp. 123-124.

by an individual waste producer is exactly equivalent to the decrease in the cost of damages caused by that waste discharger. Delineation of the "damage cost function" then is necessary in designing an efficient system of effluent charges, and may be seen in the following example which Kneese and Bower use to demonstrate the application of such a system.[14]

For simplicity, assume that (1) the damage function is linear (each additional unit of waste discharge results in equal increment of damage); (2) the waste discharged is non-degradable; (3) five plants are arrayed along a stream; and (4) the streamflow increases along the course of the stream. The calculation of damage function for this case is shown in Table III.

In Table III, damage per day is assumed to be in direct proportion to concentration, and a level of charges can be worked out for each level of flow and for each plant. For example, at flow level one, the charge for plant 1 is \$4.25 per pound of waste discharged which is the sum of the damages caused by plant 1 to plants 2, 3, 4, and 5. At the same flow level, the charge for plant 2 is \$1.625 per pound of waste discharged (Sum of damages caused by plant 2 to plants 3, 4, and 5, i.e., \$1.00 + \$0.50 + \$0.125). At flow level two, the charge for plant 1 is \$8.50 per pound and for plant 2 is \$3.25 per pound and so on. It may be noted that the charge for plant 1 is the same regardless of the level of discharge of the other plants. However, if plant 1 reduced its discharge by let us say half, charges levied against it would drop from \$4.25 to \$2.125.[15]

Once a charge is placed on the effluent discharged by a firm, that firm will attempt to minimize its total costs (internal treatment cost plus effluent charges) in order to maximize its profits (or to minimize

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14. Ibid., pp. 109-123.

15. Ibid., pp. 109-110.

TABLE III

Simple Illustration of Damage Distribution[a]

Plant no. (serially located along stream)	Chloride load discharged (1000 lb. per day)	Chloride load at plant intake (1000 lb. per day)	Stream flow (mill. gpd)	Chloride concentration (1000 lb. per mill. gpd)	Damage per day ($1000)	Total damage per day ($1000)	Stream flow (mill. gpd)	Chloride concentration (1000 lb. per mill. gpd)	Damage per day ($1000)	Total damage per day ($1000)
1	1.0									
2	0.5	1.0	1.0	1.0	1.00	1.00	0.5	2.0	2.00	2.00
3	1.5	1.5	1.0	1.5	3.00	4.00	0.5	3.0	6.00	8.00
4	1.0	3.0	2.0	1.5	3.00	7.00	1.0	3.0	6.00	14.00
5	0.5	4.0	2.0	2.0	1.00	8.00	1.0	4.0	2.00	16.00

	Flow Condition I					Flow Condition II				
	Damage Caused by:					Damage Caused by:				
Damages caused at	Plant 1	Plant 2	Plant 3	Plant 4	Sum dam. caused to	Plant 1	Plant 2	Plant 3	Plant 4	Sum dam. caused to
	($1,000)									
Plant 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plant 2	1.00	0.00	0.00	0.00	1.00	2.00	0.00	0.00	0.00	2.00
Plant 3	2.00	1.00	0.00	0.00	3.00	4.00	2.00	0.00	0.00	6.00
Plant 4	1.00	0.50	1.50	0.00	3.00	2.00	1.00	3.00	0.00	6.00
Plant 5	0.25	0.125	0.375	0.25	1.00	0.50	0.25	0.75	0.50	2.00
Sum of damages Caused by:	4.25	1.625	1.875	0.25	8.00	8.50	3.25	3.75	0.50	16.00

[a] Reproduced from Kneese and Bower, *op. cit.*, p. 108.

its losses).[16] Table IV presents a hypothetical example in which a firm is currently discharging five units of some waste into the stream. Column 2 shows the additional cost for reduction to the firm of each additional unit of waste. Column 3 shows the total cost associated with the removal of up to five units of waste by internal process changes and/or treatment facilities. If a charge of 5 cents per unit of waste discharged is placed on this effluent, column 5 shows the total effluent charges the firm will have to pay for reducing its waste by different amounts. In order to minimize the waste disposal costs, the firm will reduce its waste up to a point where incremental treatment costs (column 2) are equal to or less than, the effluent charge. In this case, the firm will reduce its waste by 3 units and incur a total cost of 18 cents (8 cents for internal treatment and 10 cents for effluent charges for 2 units of waste).

Different firms have different cost functions with respect to reducing their own waste either through production process changes or by installation of treatment facilities or a combination thereof. Therefore, a given effluent charge will induce these firms to reduce or withhold different percentages of their wastes. Those firms with high abatement costs will tend to withhold less and discharge more waste and pay corresponding effluent charges and *vice versa*. In this manner, the waste reduction cost on the last unit of waste withheld by each firm would be more or less the same and would tend to approach the point where such cost would equal the effluent charge.

Charges based on the quantity of pollution produced (measured in terms of offsite damage costs) seem most likely to result in efficient pollution abatement. However, the measurement of "damage cost functions" raises some serious practical problems if an effluent charge system is to be relied upon for water quality management programs. First, it is

16. The costs here refer to opportunity costs after the effects of taxation have been taken into account (See discussion in the preceding section on tax incentives.)

TABLE IV

Reduction in Units of Pollutant	Incremental Cost to Firm For Reduction	Total Direct Reduction or Waste Removal Cost to Firm	Effluent Charge Per Unit of Waste Discharged	Total Charge (Effluent) to the Firm	Total Cost to the Firm (3 Plus 5)
	¢	¢	¢	¢	¢
1	2	3	4	5	6
0	0	0	5	25	25
1	1	1	5	20	21
2	3	4	5	15	19
3	4	8	5	10	18
4	6	14	5	5	19
5	8	22	5	0	22

extremely difficult to assess or separate the damages imposed upon a series of downstream firms by the waste discharged by a firm or firms upstream. Second, since the damage function is usually non-linear, the problem of delineation of offsite damage costs is extremely complex. Third, the measurement of damage costs associated with environmental quality in general and aesthetic and recreation considerations in particular, is a difficult and perhaps impossible task. In light of practical problems, especially the delineation and measurement of offsite damage costs, it may be necessary that "for the time being, at least, we will have to rely on less precise evaluation techniques in our water quality management programs."[17]

Stream Quality Standards and Effluent Charges

In view of the practical difficulties and operational problems associated with determining an optimum water quality standard at the present time, water quality levels cannot be established purely on economic grounds. Furthermore, in view of the urgent need to improve the water quality in the nation's watercourses, recent federal and state legislation has prompted the setting of water quality standards. These standards are and will presumably be "based on some, usually vague, consideration of damage costs vs. costs of quality improvement."[18] It is possible to establish a system of charges which can provide incentives for achieving given stream standards at the lowest cost.

Under the combined stream standards and charges approach, the problem of direct measurement of the damage function is avoided. In the simplest case, the charge would be set at a level so that the waste discharged by all firms would not violate the stream standard at critical points in the river. In order to determine the correct level of the charge, the agency responsible would need to know for each waste discharger along a waterway the costs of reducing waste discharges

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17. Kneese and Bower, op. cit., p. 129. For a detailed discussion of the measurement problems, see pp. 111-129.

18. Ibid., p. 131.

incrementally by the least-cost methods (whether treatment or process changes). With this information, the agency could calculate the level of charges necessary to induce waste dischargers to reduce loadings to a point that the standard would be achieved. It should be recognized that this would entail the collection and analysis of detailed information not currently available to water quality management agencies, and furthermore few such agencies have sufficient staffs to undertake this kind of an effort.

The effluent charge would probably not be uniform for an entire river basin. For example in the Delaware Estuary Study[19] two methods were analyzed: (1) Single Effluent Charge Solution (SECH), and (2) Zone Effluent Charge Solution (ZECH). Under the Single Effluent Charge Solution, each waste discharger in the estuary is charged the same price per unit of waste discharge, i.e. per pound of oxygen-demanding material. Under the Zonal Effluent Charge Solution, a uniform effluent charge is proposed within each of the three zones comprising the Delaware Estuary, but the charges vary from one zone to another. Both solutions attempt to identify a minimum charge (SECH or ZECH) which will induce sufficient reduction in waste discharge to achieve the standard.[20]

It may be noted here that each firm, as discussed earlier, will attempt to minimize its total costs (waste reduction cost plus charges) to be able to maximize its profits or to minimize its losses. In this manner, the waste reduction cost on the last unit of waste treated or withheld by each firm would be about the same and would approximate the effluent charge.

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19. Federal Water Pollution Control Administration, Report on the Effluent Charge Study (1966), mimeo; Edwin Johnson, "A Study in the Economics of Water Quality Management," Water Resources Research, Vol. 3, No. 2, (Second Quarter 1967); and Grant W. Schaumberg, Jr., Water Pollution Control in the Delaware Estuary (Harvard Water Program, May 1967), mimeo.

20. See Edwin Johnson, *op. cit.*

Economic and Other Implications of Effluent Charges

It is generally agreed that cost of waste treatment induced by an appropriate charge system will tend to approach the least-cost solution to achieve water quality goals. The Federal Water Pollution Control Administration staff after studying the Delaware Estuary Comprehensive Study arrived at a similar conclusion and recommended that effluent charges should be seriously considered as a method for attaining water quality improvement. Another study which considered various incentive programs while concluding that a system of effluent charges is not likely to result in the exact low cost solution pointed out that:

> Not reaching the low cost solution need not indicate that the solution obtained from effluent charges is less efficient than would result if a regulatory agency imposed uniform treatment levels...the fact that differences in ability to borrow, etc. cause the response to a given effluent charge to differ from the minimum cost solution is not an argument against effluent charges if the alternative is regulation. Indeed, this difference in response is an advantage over the uniform cut back solution.[21]

The Delaware Estuary Study represents one of the few attempts to compare the total treatment costs of achieving various levels of water quality through an effluent charge system versus an effluent standard approach requiring uniform treatment by all waste dischargers. The table reproduced below shows that at all levels of water quality, except the highest, either the single (SECH) or zone (ZECH) effluent charge is less costly than uniform treatment. The table also shows that the cost of the zone effluent charge is very close to the least cost solution.

Cost of Treatment* in $\$10^6$ per year

Dissolved Oxygen Goal	Uniform Treatment	SECH	ZECH	Least Cost Solution
2	5.0	2.4	2.4	1.6
2-3	8.4	7.7	6.3	5.8
3	11.2	7.7	7.4	6.9
3-4	20.0	12.0	8.6	7.0
4	23.0	23.0	23.0	16.0

* Johnson, op. cit., p. 97.

21. ABT Associates, Inc., op. cit., p. 98.

On the basis of the Delaware Estuary Comprehensive Study, it can also be concluded that a charge level of 8 to 10 cents per pound of oxygen-demanding material discharged appears to produce relatively large increases in critical dissolved oxygen levels.[22] A charge at this level is not likely to cause major regional economic readjustments (such as the closing of industrial plants.)[23] In other words, the overall burden of charges is within the realm of economic feasibility and in general industry would be able to absorb such costs.

The question as to whether or not a system of effluent charges is equitable cannot be answered emphatically. If effluent charges are used to implement a stream water quality standard, the equity issues become considerably more complicated. However, it is believed that the charge method, in addition to being able to achieve the same goals of improving water quality as the conventional methods at lower costs, results in a more equitable distribution of costs among waste dischargers.[24]

Effluent charges as a means of improving water quality involve several difficulties.

The effluent charge method will probably increase administrative costs and management difficulties as compared to conventional methods of water quality improvement due to the amount of information that is needed concerning the costs of waste reduction by individual waste producers. The implementation of charges cannot be done on a trial and error or

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22. Federal Water Pollution Control Administration, Delaware Estuary Comprehensive Study cited in Kneese and Bower, op. cit., p. 160.

23. In the case of the Delaware study it was found that in all but a few cases the total cost (cost of treatment plus effluent charge) was less than 1 per cent of the value of output. In most cases it was much less. See Edwin Johnson, op. cit., Table 8. Other studies show roughly similar results. See for example: The Working Committee on Economic Incentives, op. cit., Tables V, VI, VII; and D. F. Bramhall and E. S. Mills, Future Water Supply and Demand (Maryland State Planning Department, April 1965).

24. Federal Water Pollution Control Administration, op. cit., cited in Kneese and Bower, op. cit., p. 161.

iterative basis. In order to avoid inefficient investment by firms in capital intensive equipment such as treatment facilities, the original charge levied must induce the proper amount of waste reduction. To do this, detailed waste reduction costs are necessary in advance of levying the charge. This type of information is difficult to obtain and will require more investigation.

If a direct regulatory program attempted to limit the discharge of individual waste producers so that the cost of the program approached the least-cost solution, it would require as much cost information as that needed to implement an effluent charge system. Even after the least-cost solution was implemented, the regulatory agency would not know for certain that their estimated costs of reduction for individual waste producers were correct since the amount of waste discharged was "ordered". Under an effluent charge system the amount of waste discharged by each waste producer would reflect their actual costs.

Effluent charges are opposed by two major pressure groups interested in pollution control--conservation and industry. The conservation groups are opposed to effluent charges because they think that the charges set would not be high enough to be effective and in this sense may become "license to pollute." The issue here is one of political judgement. If the charges are set to achieve, in fact, agreed upon standards, this argument has no validity. On the other hand, if only token charges are levied, the influence upon water quality could be negligible. The relevant substantive question is, are effluent charges efficient and can they be set high enough to be effective.

The position taken by industry is well described in one report:

> Under a system of regulation, the polluting industries have at most to pay for the cost of treatment they actually perform. With effluent charges, they have to pay both for the treatment they do and additional charges for the residual wastes which are not removed by the treatment. Thus even if the treatment itself is accomplished more efficiently, it is likely that the total costs to industry will be greater with effluent charges than with a regulatory system.[25]

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25. Ibid., p. 98.

The concern of industrial groups is understandable, but this must be viewed in light of the fact that effluent charges in all likelihood are more efficient in achieving water quality objectives because the total cost of treatment to maintain a given water quality with effluent charges may be substantially less than the cost of treatment required under uniform treatment system.

The Delaware River Study's empirical analysis showed that for a dissolved oxygen goal of 3-4 mg/l, the total cost to waste dischargers (treatment costs plus charges) under an effluent charge scheme was substantially less than the total treatment costs alone under a uniform treatment program. However, for lower dissolved oxygen goals, the opposite was true.[26]

Up to this point in the report, we have only been concerned with decentralized treatment, i.e. the waste treatment or reduction of individual waste producers. The next chapter examines the effect that regional joint facilities have on water quality management programs. A discussion of regional joint facilities has been included because it is believed that these facilities can achieve scale economies in abatement facilities which are impossible to obtain using only decentralized methods. It is possible that the resulting scale economies could further increase the efficiency of water quality programs and help to reduce the total outlays required of waste dischargers in achieving desirable water quality levels. Here the question arises as to whether effluent charges might be utilized to raise revenues to finance joint facilities.

Summary

A number of economists have advocated the levying of effluent charges as an effective device for inducing economically efficient behavior on the part of waste dischargers. Under an effluent or emission charge system, charges are assessed against each firm on the basis of its waste discharge.

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26. Johnson, op. cit., p. 300.

Different firms and municipalities are faced with widely different costs of waste reduction or treatment. If uniform treatment is required as a means of improving water quality, some plants may be required to incur very high abatement costs for a relatively small improvement in stream quality. For all the firms taken together on a particular stretch of a river, it would be economically more efficient to require that each plant treat its waste to a point where the waste reduction cost to each one of them for the last unit of waste withheld or removed is the same. A system of effluent charges makes this possible so that for any given amount of waste reduction, the total costs are lower than uniform treatment, by increasing the level of treatment for the low cost firm and decreasing it for the high cost firm.

Effluent charges are based on the quantity of waste discharged and the amount of damages caused by such discharges. Once a charge is placed on the effluent discharged by a firm, it will attempt to minimize its losses. Such a system is likely to result in efficient pollution abatement. The measurement of the "damage cost function" raises some serious practical problems. However, it is possible to establish a system of charges which can provide incentives for achieving a given stream standard in an economically efficient manner.

An appropriate system of effluent charges has several advantages: 1) it will tend to approach the least-cost solution to achieve water quality goals, 2) the overall burden of charges is likely to be such that they would be within the realm of economic feasibility. Such a system has one major difficulty. It would probably increase administrative costs over the conventional methods of water quality improvement. However, if a system of regulation is designed to achieve a minimum cost solution, the administrative cost would be no lower than under a system of effluent charges.

CHAPTER V

REGIONAL SYSTEMS

Introduction

An effluent charge approach for achieving desirable water quality, as discussed in the preceding chapter, provides and distributes costs among waste dischargers so that the total waste treatment expenditures in any given basin tend to approach the least cost solution. One issue that arises is the possible redistribution of resources from waste dischargers to a state or regional agency. The purpose of this chapter is to examine whether this transfer of resources could be used to finance regional or joint waste treatment facilities and whether a charge system designed to induce an efficient pattern of waste treatment would be consistent with a set of charges designed to finance joint facilities.

Regional facilities in conjunction with a system of effluent or user charges offers several advantages:

1. Joint facilities for waste treatment including flow augmentation, stream aeration, etc., could provide scale economies and reduce the cost of water quality management relative to decentralized treatment methods by individual waste producers.
2. A system of regional facilities could raise the quality of treatment operation because these plants would be able to support expert technical services relative to decentralized treatment systems.
3. Service charges to finance regional systems would provide incentives (similar to effluent charges) for the firm to engage in process changes to lower its waste load, since lowering waste loads would mean lower service charges.

The concept of financing joint facilities through a system of charges is quite similar to the method used by municipalities for financing sewage collection and treatment facilities. Therefore, an examination of municipal sewage service charges is useful in providing a background of experience for a regional water quality management system based on a combination of effluent charges and joint facilities.

Municipal Sewer Service Charges

The most common method of supporting municipal sewage systems is through the implementation of a user charge which is basically a charge or payment paid by an individual or firm for this public service. Johnson states that the term user charge "implies a utility function, and consequently, a more or less close relationship between the payment required and the cost of providing the service. In addition, economic efficiency and equity would be more fully served if the charge paid by users of the system reflected the costs which his use imposes on the system."[1]

Present Charge System

There are three basic types of user charges that are available to local municipalities for financing sewer service costs. The first type is a flat or uniform rate for the service performed. This type is the simplest and least costly to establish from an administrative point of view since no metering of water is required.

The charges are generally determined by setting a rate sufficient to produce the required amount of revenue to pay for the service. The charge to individuals may be based on dwelling units, the size of the water connection, the type of property, or the number and type of fixtures in each dwelling unit.

About 30 per cent of Wisconsin municipalities use a uniform charge system and most base their rates on dwelling units for residences, and the type of property (i.e. hotel, restaurant, etc.) for commercial establishments.[2] These municipalities typically have populations of less

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1. Edward Johnson, "User Charges," (unpublished draft, 1968), p. 1.

2. All references to the application of types of sewer service charges in this paper were obtained from: Wisconsin State Board of Health, "Summary of Sewer Service Charges in Wisconsin," Madison, 1963.

than 2,000 people.

Approximately 60 per cent of the industrial rates charged by municipalities also fall under this category. These charges have been negotiated with the industry based on their individual waste load. The disadvantage of a fixed rate to industry is that once the rate is set for a particular industry, there is no longer any incentive for that industry to make more efficient use of its water intake or reduce the strength of the wastes it discharges into the sewer system.

The second category of charges is based on the quantity of water used by the consumer. This may take the form of a charge per 1000 gallons of water consumed, a fixed percentage of the water bill (usually in conjunction with a municipally-owned water system), or a flat charge plus a percentage of the water bill.

About 70 per cent of the municipalities in Wisconsin use this method of financing for the residential and commercial categories, and most employ a charge based on a fixed percentage of the water bill. If the charge is to be considered as a surrogate measure of the municipality's actual cost of waste treatment, it must be assumed that the quantity of water discharged is directly proportional to the cost of providing the service. In other words, it must be assumed that the strength of the wastes discharged is similar. For residential users, this is a fair assumption and, it might be added, an administratively necessary assumption.

About 35 per cent of the industrial rates in Wisconsin municipalities are based on the quantity of water consumed and in most of these municipalities the industrial rate is equivalent to the residential rate. There is no question of a fair distribution of costs between industrial and residential users if it can be assumed that industrial wastes have the same strength, and therefore the same treatment costs, as residential waste. Even if the waste strengths are different, it can be argued that the volume of industrial waste is usually quite large requiring larger treatment facilities (with resulting scale economies) which allow lower unit costs of treatment. However, most rate structures are based on a declining scale (i.e. the charge is less for the second 10,000 gallons than for the first) which effectively lowers the total charge to industrial users.

In the final method, user charges are based on both the amount of water consumed and the strength of the sewage discharged. This method is used only for the industrial users in only four Wisconsin municipalities.

Recommended Procedures for Establishing Charges

Probably the most thorough quest for an appropriate charge system for local municipalities has been conducted by the joint committee of the American Society of Civil Engineers and the Municipal Law Section of the American Bar Association.[3] They have based their procedure for establishing a rate structure on the following premise:

> The needed total annual revenue of a water or sewage works shall be contributed by users and nonusers (or by users and properties) for whose use, need, and benefit the facilities of the works are provided approximately in proportion to the cost of providing the use and benefits of the works.[4]

This statement implies two things. First, the total cost of the provision of the service should be entirely financed by those using the service and those properties that benefit from the service. This aspect of a self-financing system (i.e. the total charges paid for the operation, maintenance, and retirement of capital necessary for the project) is generally followed by all Wisconsin municipalities. Second, the distribution of costs among users should be in proportion to the actual costs of providing the service to those users.

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3. Joint Committee Report, "Recommended Procedures for Establishing Fair Rates and Rate Structures," Ohio Law Journal, Vol. 12, No. 151, (1951), pp. 226-255.

4. Ibid., p. 226, continued next page.

To this end, the Joint Committee has developed a two-part procedure for distributing the costs of a sewage project to users. The first part pertains to the allocation of the costs of the collection system and treatment facilities between users and properties.

It can be stated that users -- those households and firms that are connected to the sewage system -- do not use the entire capacity of the collection system. In the design of the collection system, the capacity has been increased to allow for infiltration, storm water, and future growth. Therefore, the Joint Committee has recommended that users be charged only for the actual capacity necessary to transport their wastes. Infiltration and storm water capacity would be charged to all properties by an ad valorem tax, and the allowance for future growth would be charged to vacant or undeveloped property also by an ad valorem tax. The percentage of the capacity attributed to users and properties would be applied to the total cost of the collection system to determine the charge or tax rate.

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4. cont. It may be pointed out that the quantity-quality formula for assessing user charges, as recommended by the Joint Committee Report, is based on the <u>average</u> costs of the joint facility for processing wastes. An average-cost pricing system insures only that the total cost of capital, depreciation, operation and maintenance will be fully recovered by the user charges. An average-cost pricing system will not, in general, achieve a least-cost solution.

To achieve maximum efficiency the user prices charged to individual waste producers should be based on the marginal cost (or incremental cost of production) of achieving improved water quality by the joint facility. In theory, the reason that a marginal-cost pricing scheme is efficient is that it results in a system where the additional cost of the last unit of waste reduced by each individual waste producer is equal to the cost of the last unit of waste processed by the joint facility.

However, marginal-cost pricing does not insure that the full costs of the joint facility will be recovered by user charges. If the marginal cost is less than the average cost, as would be characterized by a facility with increasing returns to scale, the returns from user charges would be less than the cost of the joint facility. The regional agency would then be operating at a deficit. On the other hand, if the marginal cost is greater than the average cost, this pricing scheme would generate a surplus. There is no pricing scheme which will maximize efficiency and achieve full-cost recovery unless the marginal cost by chance is equal to the average cost.

The same type of procedure could be used to determine the proportion of the costs that should be paid by users and properties for the treatment facilities. Each component of the treatment facility would be analyzed separately and the cost would be proportioned between users and properties based on the operating and capital costs of processing raw sewage, storm water and infiltration, and the capital costs of future capacity.

Once a proportion of the total cost of the treatment facility has been attributed to users, the second part of the procedure would be to distribute these costs to each user or group of users. The charge to each user would be based on the estimated cost of treating that user's individual waste discharge. For instance, the waste discharged into the sewage collection system by individual households and firms would be measured by:

1. the quantity of waste liquid discharged, based on water meter readings;
2. the strength of the discharge liquid based on the number of pounds of suspended solids (or BOD);
3. the chlorine demand of the discharge liquid;
4. other measures if other materials were discharged by users which proved to be difficult or costly to process (e.g. grease).

The municipality would then determine the average costs of treating each 1000 gallons of liquid, 100 pounds of suspended solids (or BOD), and 100 pounds of chlorine demand.[5]

The strength of the waste discharge for residential dwellings and most commercial establishments can be assumed to be relatively uniform. Therefore only the quantity of water used, as measured by a water meter,

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5. For an example of specific formulas and the rationale behind them see: N. S. Bubbis, "Industrial Waste Control in Metropolitan Winnipeg," Journal of the Water Pollution Control Federation, Vol. 35, No. 11 (1963), p. 1413; Joseph J. Olcliffe, "Sewer Service Charges and Surcharges," Journal of the Water Pollution Control Federation, Vol. 35, No. 5 (1963), p. 613.

would be needed to estimate their rate. In other words, only a single cost multiplier would be needed to compute the rate per 1000 gallons consumed which would include the cost of treating suspended solids and chlorine demand.

However, for industries and some commercial establishments, such as commercial laundries, the strength of waste discharged may vary widely; therefore the actual municipal costs of treating these wastes will also vary. For these firms, a charge based on quantity of water used plus a charge based on the discharge strength are both necessary.

The quantity-quality formula recommended in the Joint Committee Report assumes that such a system would be more efficient than uniform charges for all wastes. Basically, the assumption of increased efficiency defined in this case as a lower total amount of expenditures for waste treatment by both the municipality and private firms implies two things. First, the basis for determining charges in municipalities should be similar to the average unit cost pricing method previously described. Second, it is assumed that industrial firms with large amounts of waste will seek the least expensive method of disposing of these wastes to maximize its profits. It can also be assumed that in most instances the firm will have a choice of either discharging its wastes into the municipal sewage collection system or to some extent reducing the amount of wastes it discharges by in-plant process changes (e.g. recirculating water, etc.).[6] If the sewage service charge is low, the firm will discharge more wastes and change internal processes only slightly to reduce its wastes. However, if the sewage service charge is high, the firm will attempt to reduce its wastes by internal process changes until the unit cost of reducing its wastes are equal to the cost of paying for the service charge to the municipality.

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6. For a discussion of reducing wastes through in-plant changes see: R. F. Rocheleau and E. F. Taylor, "An Industrial Approach to Pollution Abatement," Journal of the Water Pollution Control Federation, Vol. 36, No. 10 (1964).

The experience of the Greater Winnipeg Sanitary District (Canada) is one illustration to show the extent of reduction of industrial waste discharge once a sewage surcharge is implemented.[7] Winnipeg has a number of large food processing plants which produce high strength wastes. One of the main problems was with the meat packing plants which discharged large quantities of paunch manure, grease, pigs' toenails, etc., which resulted in the clogging of sewers and pumps. Legal ordinances were passed prohibiting the discharge of these materials into the sewer system. However, these ordinances proved only partially effective and had no effect at all on the strength of the processing wastes discharged.

Finally, it was decided to review the schedules of sewage charges. A new schedule of charges was determined which reflected the actual costs of treating different types of wastes such as suspended solids and grease. Since the charges have been initiated, there has been a substantial reduction in both the quantity and strength of the wastes discharged. In the first two years, the total payment due to the surcharge was $100,000. However, as firms initiated more in-plant changes to reduce their wastes, the total payment dropped to $80,000 in the third and fourth years even though the number of firms paying the charge had doubled and the unit cost of treatment to the Authority had increased substantially.

A second example is cited by Kneese and Bower.[8] The town of Otsego, Michigan had a waste treatment plant that was designed to handle about 500 pounds of BOD per day in 1983. Yet one firm alone was contributing as much as 1500 pounds per day in 1965. After the initiation of a surcharge, the firm's monthly BOD load dropped from 27,000 pounds to 15,000

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7. Bubbis, op. cit., pp. 1403-1413; see also A. Penman, "Wastewater System for the Metropolitan Corporation of Greater Winnipeg," Journal of the Water Pollution Control Federation, Vol. 39, No. 3 (1967), pp. 373-383.

8. Allen V. Kneese and Blair T. Bower, Managing Water Quality: Economics, Technology, Institutions, (Baltimore: The Johns Hopkins Press, 1968), p. 168, citing Smalla, R. D. "One Way to Control Industrial Wastes," Water and Wastes Engineering, Vol. 4, No. 3, (1967), p. 75.

pounds within three monthly billing periods.

Proposed Waste Acceptance Service in Maryland

It is possible to expand the use of sewage sanitary districts beyond the confines of municipal or metropolitan boundaries. This is the idea behind the State of Maryland's investigation into the feasibility of a Waste Acceptance Service (WAS).[9] Basically, the WAS would be a statewide sanitary district which could organize subdistricts to accommodate regional needs and river basin programs.

WAS would be responsible for accepting wastes from all municipalities and industries in all parts of the state since it would not allow any polluter to discharge wastes into state waterways without its permission. WAS could construct, own and operate the major treatment facilities and trunk sewers, but would not infringe on local autonomy. Local municipalities would still be responsible for their local collection system and would set all the policies for its use including sewage charges to local customers and sewer extensions. However, the local communities would be relieved of the burden of making sure their wastes did not violate the standards of stream quality. The treatment of wastes and responsibility of stream quality would rest with the state.

This framework for pollution control offers flexibility in the design of treatment facilities. WAS would decide whether to treat waste at the source or transport the wastes through trunk sewer lines for treatment in joint facilities which could achieve lower unit costs of waste processing due to scale economies. WAS would also have the flexibility to make use of other types of joint facilities such as dams for flow augmentation or instream aeration devices.

Financing

The WAS framework for pollution control also offers flexibility in

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9. Andrew Heubeck, et. al., "Program for Water-Pollution Control in Maryland," Journal of the Sanitary Engineering Division, April 1968.

financing. Basically, the relationship between the state and municipalities or individual industries would be similar to the relationship between a municipal waste disposal agency and its local customers. Maryland plans to employ a user charge to municipalities and individual industries using a quantity-quality formula based on the volume, strength and treatability of the wastes WAS accepts.[10] A user charge system based on a quantity-quality formula should lead to a relatively efficient regional method of pollution abatement. It should be noted that this formula could be set so that user charges allowed WAS to be fully self-financing or could be lowered to provide different amounts of subsidies to municipalities and industry. The financing of trunk sewers to transport wastes to joint facilities could be accomplished in the same manner as the joint committee recommended for local sewer collection systems. Each user would be charged according to the percentage of the capacity used to transport that user's waste. The cost of future capacity requirements could either be absorbed by the state or passed on to municipalities and industries.

The WAS approach could take advantage of the Clean Water Restoration Act of 1966. Under this program, federal grants up to 55 per cent of the cost of treatment facilities would be available, and since WAS would be responsible for the construction of treatment facilities, industries which are now excluded could in effect take advantage of this federal subsidy. However, this would lead to inefficient allocation of resources (See Chapter III).

The Size of Joint Facilities

The size and cost of the joint facilities will depend on the amount of waste reduction that is achieved by individual waste producers. If this anticipated waste reduction is underestimated in the design stage of the joint facilities, it will result in larger joint facilities than are necessary and higher user charges. This in turn will result in a desire by municipalities and industries to reduce their waste load even further. The assumption here is that up to some level of waste reduction, it is less

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10. Ibid., p. 290.

expensive for industry to reduce its wastes by good housekeeping techniques and in-plant process changes than to have that proportion of its wastes processed by the joint facilities. However, after this level of reduction is reached, it becomes less expensive for the industry to pay a user charge to have its wastes treated by joint facilities due to anticipated scale economies.

If the anticipated waste reduction by individual waste producers is overestimated it will result in smaller joint facilities than are necessary to achieve the desired water quality objective. The only alternatives would be to increase the size or number of joint facilities or to raise the user charge to induce even higher reductions by individual waste dischargers. The second alternative would not achieve as efficient a system as the first.

The amount of regional facilities constructed then must seek an equilibrium point which takes into account its own anticipated costs, the costs to various waste producers for processing different amounts of their own waste, and the total amount of wastes that must be reduced or processed to meet the water quality objective. This, of course, would necessitate some information about industrial waste reduction costs.

A regional system employing user charges for financing joint facilities is not limited to facilities that actually process the users' wastes such as treatment plants. Joint facilities could include, but would not be limited to, dams for low-flow augmentation, instream and turbine reaeration devices to increase the dissolved oxygen level of streams, transport of wastes through pipelines to make better use of the natural assimilative capacity of the streams, specialized use of streams, and combinations of these.

Summary

A water quality management program based on effluent charges and joint facilities is conceptionally analogous to a system of municipal sewage service charges. Charges may be based on either average or marginal cost pricing schemes. User charges based on average costs will insure full-cost recovery, but will not necessarily achieve maximum efficiency. User charges based on marginal costs will approach a least-cost system, but may result with a deficit or surplus of funds.

A regional management program employing user charges based on marginal costs to finance joint facilities will always be more efficient in achieving any water quality level than an effluent charge system alone. While the same statement cannot be made for a regional program employing user charges based on average costs in all cases, in general it is probably true.

A combination program can offer some flexibility in financing. The entire cost of joint facilities could be supported by charges to waste dischargers or various amounts of state subsidies could be provided. Further the state or regional agency and industry could take full advantage of any available federal subsidies.

Finally, a combination program offers flexibility in the choice of the type of administrative agency. This program could be administered by the state, as in the Maryland example; by an industrial-municipal organization, as in the Ruhr Valley; or by a regional agency or special district.

CHAPTER VI

SUMMARY

In 1965, the State of Wisconsin enacted important legislation to strengthen its capabilities to deal systematically with the problems of water quality management. One of the provisions of this legislation was a request for a study of "effluent charges" as a system of incentives towards achieving desirable levels of water quality for the State. The present study, sponsored by the Division of Environmental Protection, Department of Natural Resources, reflects the preliminary findings of this effort.

The characteristics of water resources and economic features of waste discharge are such that public intervention is necessary to realize overall objectives of water quality management programs. The recognition that Common Law is an inadequate tool for dealing with the adverse effects of waste discharged to waterways has led to a search for some other forms of public regulation. A number of regulatory devices have been employed by public agencies in different states and include: order system, water quality standards, stream standards, effluent standards, and permit system. The direct regulatory programs based on stream standards as the sole criterion for determining the amount of waste reduction for individual waste producers as well as the effluent standards which require uniform treatment are unlikely to satisfy both the efficient resource allocation and equitable distribution of costs requirements. The permit and order systems do provide flexibility but it would be difficult to establish criteria for program design that provide an equitable distribution of costs and maximize the efficiency of the system. In order to meet efficiency and equity criteria, the public agencies require a great deal more information than is presently available.

It is generally agreed that regulatory measures and enforcement procedures by themselves may not be entirely satisfactory and some form of incentive programs may be necessary to provide the "carrot" and the "stick" required to achieve public policy objectives for water quality management. Since effluent charges are but one type of incentive, it was felt that the scope of the study be broadened to include other forms of economic incentives as well. Sewage charges have some similarities with effluent charges and these have also been briefly reviewed in this report.

This report is based primarily on the review of technical articles, policy statements, case studies, and other readily available material on economic incentives to achieve desirable water quality levels.

In recent years, many bills have been introduced into both Houses of the Congress to provide assistance or incentives to stimulate private pollution control investment and to encourage compliance with the pollution abatement standards under the law. Some states have already enacted similar legislation and a number of them are considering such proposals. Incentives may be either positive or negative; there can be rewards for good performance or penalties for unacceptable behavior. Positive incentives include outright subsidies or grants to firms or to government agencies, loans, and tax rebates for construction of waste treatment facilities. The negative incentives consist of charges or taxation levied upon those who discharge waste into waterways. In addition, charges may be levied to finance joint or regional waste treatment facilities.

Under the current tax structure, the Federal Government extends significant aid to industry in respect to pollution abatement costs. The present value to the firm of the federal tax savings for pollution control spending may be around 33 per cent of the capital outlays and 48 per cent of the maintenance and operating expenditures. The additional tax incentives that have been under consideration by the Congress and the state governments would further reduce the net capital costs to the firms whereas the net costs for maintenance and operating expenditures would remain unchanged.

It must be pointed out that inspite of the substantial tax savings to industrial firms for pollution abatement expenditures, such expenditures still result in a net loss to firms who undertake them. In view of this fact, it is doubtful that additional tax incentives can influence firms to undertake large pollution control expenditures.

Besides the limited effectiveness of tax incentives to induce further pollution abatement, there are additional deficiencies. First, the impact of tax incentives is such that it may lead to inefficient allocation of resources. This is because the proposed tax incentives are aimed at providing additional subsidies only for depreciable capital outlays and not for maintenance and operating expenditures. Second, almost all proposals for providing additional tax incentives for pollution abatement tend to discourage production process changes since tax write offs are not applicable to such investments. Third, tax incentives may introduce an element of inequity because different firms face different effective tax rates so that the net present value of tax benefits would be greater for those firms who face higher tax rates than for smaller firms whose effective tax rates may be lower.

Review of other fiscal (including tax) incentives suggests that across-the-board fiscal incentives or subsidies to inductry are difficult to justify on economic efficiency and/or equity grounds. These incentives are unlikely to have any major impact on industries' behavior towards waste treatment. Of all the alternative positive incentive schemes considered in the report, loans and grants seem to be preferable to tax incentives.

An effluent charge may be considered as a negative incentive since it is aimed at inducing polluters to reduce their waste loadings by placing a tax or charge on the quantity and quality of waste discharged into waterways. To maximize the efficiency of an effluent charge system, the charges would vary over different reaches of the river and during different times of the year depending upon the stream flow conditions.

An effluent charge system has a number of advantages and disadvantages associated with it. First, the available evidence and this analysis strongly suggest that an effluent charge system would be more effective than tax incentives and other subsidies in influencing industrial firms to undertake larger pollution abatement efforts. Second, in theory at least, a properly designed system of charges will induce adoption of the least costly pattern of waste reduction measures to achieve specified water quality goals. Third, if it is assumed that pollution abatement costs should be proportional to the amount of waste discharged, a properly designed charge system results in a more equitable distribution of costs among waste dischargers than other methods of waste management.

A major shortcoming of an effluent charge system stems from the practical difficulty of determining what is the proper charge to be placed on waste discharges to streams. To develop a most efficient charge, accurate information is needed that reflects the actual cost of waste discharge reduction by firms. This type of cost data is not readily available at the present time. Another problem raised by the effluent charge system relates to the firm with a low or negligible margin of profit. Would a system of charges force such firms out of business and if so, what would be the economic consequences to the region and state? The Delaware Estuary Study concluded that a system of charges would not cause any major economic readjustments in that region. It is not clear what the effect would be upon Wisconsin firms.

Regional or joint facilities in combination with a system of effluent or user charges may provide substantial scale economies for waste treatment facilities. At the same time, an appropriately designed system of charges affords the advantages associated with effluent charges by providing incentives for the firms to engage in process changes as well as install internal treatment facilities to reduce its waste loads in order to minimize their total waste reduction and treatment costs. A combined system also offers some flexibility in financing as well as choice of administrative agency to manage the program.

This report does not presume to answer in a definitive way what the effects would be of alternative kinds of positive and negative economic incentives. The problems have been defined and the available technical literature has been summarized and analyzed. Much further work remains to be done to provide a solid basis for policy decisions in this area.

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