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EFFLUENT CHARGES, INFORMATION GENERATION AND BARGAINING BEHAVIOR*

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The quality of the nation's water continues to deteriorate and there is growing dissatisfaction with the water pollution control strategy based on regulation and enforcement.[1] An alternative strategy, based on the use of effluent charges, has received increasing attention.[2] This alternative strategy would involve the following elements:

1. An ambient water quality standard would be established by the appropriate public agency through some crude evaluation of benefits and costs.
2. A charge would be levied upon waste discharged to the waterway based upon the quantity and strength of the effluent. The charge, derived from readily available information, would not be sufficiently high initially to induce the reduction in waste discharges necessary to achieve the established standard.
3. By monitoring water quality, the effect of the charge would be determined and if an adequate improvement were not achieved, the rate of the charge would be increased. This would be repeated until the standard were achieved.

Although the economic arguments for this strategy appear persuasive, no attempt has been made thus far to investigate human behavioral problems which might appear in the operation of such a system nor have studies been directed at evaluating the capability of such a system to achieve a set pollution standard at minimum cost.

This paper presents the results of an empirical study of the possible use of an effluent charge of the type proposed to determine whether a system of charges could be devised which would achieve specified standards at minimal cost. The paper also attempts to estimate the likely behavior of those who would be involved in the iterative process of establishing the level of charges. These analyses raise serious questions about both the technical efficiency and effectiveness of the proposed strategy and lead to the proposal of an alternative

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1. The Council on Environmental Quality, in its 1972 Annual Report to Congress, concluded that water pollution is increasing.

2. *See* A. Kneese & B. Bower, Water Quality Management: Technology, Economics, Institutions (1968); Freeman & Haveman, *Residuals Charges for Pollution Control: A Policy Evaluation,* 177 Sci. 322 (1972). For an analysis of some of the proposals that have been made for an effluent charge *see* A. Dorcey, Economics Incentives for Water Quality Improvement (1971). (Water Resources Center, University of Wisconsin).

strategy which appears to offer greater promise of both technical efficiency and effectiveness.

A CASE STUDY OF THE WISCONSIN RIVER

In a case study of water quality management on the Wisconsin River, the problem of information generation for the determination of water quality objectives and the design of implementation mechanisms was examined.[3] A model was developed for estimating the effect of changes in waste loads upon the quality of the river as indicated by the level of dissolved oxygen. The technology available for abating waste discharges and improving water quality was identified and the cost of applying it at various levels of intensity was estimated. These models were used to generate information about the nature of least cost systems for achieving various water quality standards. A number of effluent charge schemes were then assessed as possible mechanisms for implementing such systems and achieving ambient water quality standards.[4]

A. *The Wisconsin River*

In a 180 mile central section of the Wisconsin River from Rhinelander to Petenwell Dam, survey data indicated that the state ambient water quality standards were not being attained as a result of the waste emissions of industries and municipalities. Thirteen pulp and paper mills contributed more than 85% of the average B.O.D. load and the municipal contribution was concentrated among three of the more than eighty municipalities. Flow in this section was controlled by a number of power dams and the average flow of the Wisconsin River at the confluence with the Mississippi River was approximately 8,500 cubic feet per second with a peak flow of record of 80,800 cubic feet per second.

Ambient water quality standards were adopted by the State of Wisconsin for the Wisconsin River in 1968. Each stretch of the river was designated for a particular use and minimum ambient water quality standards were adopted for each use category. The regulatory authority, the Department of Resource Development, issued "orders" to waste dischargers which specified required levels of abate-

3. This study was reported in nine volumes by multiple authors under the general title Institutional Design for Water Quality Management: A Case Study of the Wisconsin River (1970). (Water Resources Center, University of Wisconsin).

4. Some conclusions of the case study are specific to the Wisconsin River but others have more general applicability. Since advocates of the effluent charge have generally argued for a regional approach to water quality management, a case study of a region would seem to be most appropriate. This implies a national strategy should be designed in the light of requirements of a regional strategy.

ment which were determined as necessary to achieve the water quality standards. A survey of the river in 1970 indicated that standards were not being met and that the main stem of the Wisconsin River was severely polluted in several sections from pulp and paper mill wastes. The regulation-enforcement strategy, as elsewhere, was not being effective in controlling water pollution.

B. The Nature of Least-Cost Systems for Achieving Ambient Standards

Table I illustrates the type of information that was developed in this study of the Wisconsin River and that might be an input to the water quality management process. The technologies which could be used to achieve water quality objectives might be combined in a number of ways and are described by the *type of system. Waste load* is the level of waste generation. *Risk level* is an estimate of the probability of the water quality objective not being attained based on the record of flow and temperature. *Constraint* refers to *a priori* requirements upon the technology that must be utilized in attaining the dissolved oxygen objective at least cost. Chart I shows the 2 and 5 milligram per liter dissolved oxygen standards adopted in the Wisconsin River. From this table, conclusions such as the following can be drawn.

a) A regulation requiring all waste sources to employ secondary treatment would be an inefficient system for attaining the dissolved oxygen objective (System A compared to System B). Secondary treatment is only necessary at a few municipal waste sources as the objective can be achieved more economically through secondary treatment of industrial wastes. (System D compared to System H).

b) As the risk of failing to achieve the dissolved oxygen is lowered, the cost of the system increases (compare systems F,E,D,C).

c) A regulation requiring a minimum of primary treatment by all industries in order to lower fiber discharge to the river will raise system costs by 14% (System G compared to System D).

d) If the turbines in the dams are vented to provide increased aeration, system treatment costs for achieving the dissolved oxygen objective can be lowered (System L compared to System D).

e) The lack of information about waste loads might be expensive as system costs are very sensitive to their variation (System D, J and K compared).

These conclusions illustrate a type of information that can be generated about the effects of different policies and programs. If information about the nature of least-cost systems is used in designing plans for achieving the standard, then the information can be used in making a decision between alternative ambient water quality standards.

TABLE 1

COSTS OF ALTERNATIVE WATER QUALITY MANAGEMENT SYSTEMS

Type of System	Waste Load	Risk Level	Constraint	Dissolved Oxygen Objective	Cost ($000)
A. Uniform Secondary Treatment	Average		All industries and municipalities secondary treatment		6,966
B. Unconstrained Waste Treatment System	Average	10%		2-5[1]	3,745
C. Constrained Waste Treatment System	Average	1%	50% municipal[2] removal	2-5	5,276
D. Constrained Waste Treatment System	Average	10%	50% municipal removal	2-5	4,467
E. Constrained Waste	Average	20%	50% municipal removal	2-5	3,930
F. Constrained Waste Treatment System	Average	50%	50% municipal removal	2-5	3,611
G. Constrained Waste Treatment System	Average	10%	50% municipal removal, 25% industrial	2-5	5,088
H. Constrained Waste Treatment System	Average	10%	90% municipal removal	2-5	4,830
I. Constrained Waste Treatment System	Average	10%	50% municipal	3-6	5,764
J. Constrained Waste Treatment System	Maximum	10%	50% municipal removal	2-5	5,783
K. Constrained Waste Treatment System	Minimum	10%	50% municipal removal	2-5	2,605
L. Turbine Aerating and Waste Treatment	Average	10%	50% municipal removal	2-5	4,120
M. Turbine + In-stream Aeration + Waste Treatment	Average	10%	50% municipal removal	2-5	3,208
N. Turbine + In-Stream Aeration + Waste Treatment	Average	10%	50% municipal removal, 25% industrial	2-5	4,116
O. Constrained Waste Treatment System	Average	10%	50% municipal removal	1-4	3,730

6 Institutional Design for Water Quality Management: A Case Study of the Wisconsin River (Water Resources Center, University of Wisconsin, Wisconsin, 1970).

1. Chart 1 shows the 2 and 5 milligrams per litre dissolved oxygen standards adopted in the Wisconsin River.

2. A constraint of primary treatment with chlorination of the effluent will remove approximately 50% of the B.O.D.

C. *Effluent Charges on the Wisconsin River*[5]

Once the type of plans that would be required to achieve ambient water quality standards were understood, the effluent charge mechanism was considered as the policy instrument for implementing these plans and achieving standards. An attempt was made to characterize the response function of each producer whose discharge behaviour would have to be controlled. This function was defined by the producer's perception of the alternatives to paying the charge and their costs. Three different effluent charge mechanisms were then considered as policy instruments for achieving the standard.

Figures 1 and 2 characterize the response functions for industries and municipalities respectively. In the case of the pulp and paper industry it was concluded that the perception of the alternatives to paying the charge was dominated by the alternative treatment plants that might be installed. The five discrete points reflect the available primary and secondary treatment technologies. Thus there is a point on the response function which represents the average cost of a primary treatment plant which removes 25% of the B.O.D. load and similarly there are points for secondary treatment technologies removing 70%, 80%, 85% and 90% of the B.O.D. load respectively. Average costs were calculated from total annual costs after applicable fiscal policies had been taken into account. It was found that the average cost exhibited relatively small variation about the average cost of treatment for both primary and secondary processes. This was found for each of the six different mill processes for which treatment costs were developed. In the case of the municipalities, treatment was perceived as the only alternative to paying the charge. The four discrete points reflect the technologies of primary treatment removing 25% of the B.O.D. load, primary treatment with chlorination of the effluent, removing 50% and two secondary treatment processes removing 85% and 90% of the B.O.D. load respectively. Average costs were calculated from total annual costs on the assumption that a grant would be received. It was found that average costs fell until the 85% removal level was reached but rose slightly for the 90% removal level for each municipality in the study.

If the response functions are characterized by discreteness and incremental costs which do not rise then the effluent charge mechanism cannot be used to induce all levels of treatment that might enter into a least-cost system. In the case of the pulp and paper mills, if average costs of treatment are perceived to be almost constant, then a charge can either induce no treatment or the highest level of treatment. A charge equal to the average cost will have an

5. For a more detailed account of the argument that follows, *see* Dorcey, *supra* note 2.

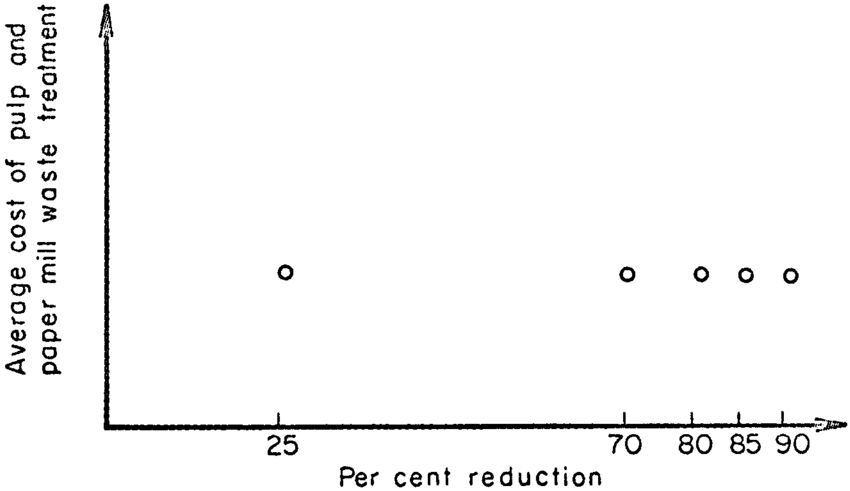

FIGURE 1.

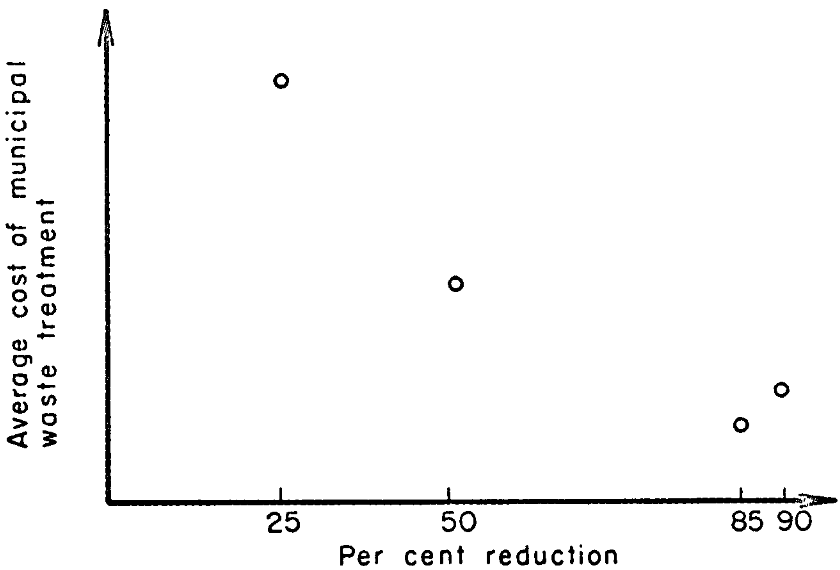

FIGURE 2.

8 Institutional Design for Water Quality Management: A Case Study of the Wisconsin River (Water Resources Center, University of Wisconsin, Madison 1970).

indeterminate effect. In the case of municipalities, any charge below the average cost of 85% removal will induce no treatment. Any charge greater than the average cost of 85% removal but less than the average increase in the total cost of removal between 85% and 90% will induce 85% removal. Any charge above this will induce 90% removal. No charge can induce only 25% or 50% removal. Thus for a typical municipality where the average cost of 85% removal is 8 cents per pound and of 90% removal is 10 cents per pound, a charge greater than 8 cents per pound but less than 44 cents per pound will induce 85% removal and greater than 44 cents per pound will induce 85% removal and greater than 44 cents per pound will induce 90% removal. These characteristics of the response function and the consequent reaction to the effluent charge have important implications for the use of this mechanism in achieving ambient quality standards.

Table 2 illustrates the use of an effluent charge for implementing a least-cost system; in this case, System B of Table 1. This system would achieve the 2-5 standards, with a 10% risk of failure, by requiring seven of the pulp and paper mills to treat their wastes at an annual cost of $3.7 million to the system. Since the characteristics of the response function do not allow all levels of treatment to be induced, the charge was used to induce treatment at least sufficient to achieve the 2-5 standard with a 10% risk of failure and a system cost which most closely approximated the least-cost system. Table 2 shows the charges that were necessary, the treatment level induced and the total system cost. It can be seen that the effluent charge would induce a system costing $4.8 million per annum as opposed to the least-cost system of $3.7 million per annum.

The use of a zoned effluent charge was also considered and the results are summarized in Table 3. In each zone the effluent charge

Table 2

River Mile	Source	Charge Cents/lb.	%	Charge Induced Cost ($1,000.00)	%	Least Cost ($1,000's)
349.4	Aspen	3	90	671	85	637
322.1	Dogwood	8	90	926	25	281
278.2	Fir	4	90	301	25	103
265.2	Gum	3	90	671	80	621
211.7	Poplar	3	90	429	80	391
205.6	Sycamore	2	85	849	85	849
201.9	Teak	8	90	926	85	863
				4773		3745

Source: Economic Incentives for Water Quality Improvement (Water Resources Center, University of Wisconsin, Madison, Mimeo, 1971).

Table 3

Charge	1	2	3	4	5	6	7	8	9	10	
Standards Met	N	N	N	N	N	N	N	Y	Y	Y	*Zone 1*
349.4 Aspen	0	0	90	90	90	90	90	90	90	90	Charge
348.6 Rhinelander City	0	0	0	0	0	0	0	85	90	90	8 cents/lb
327.5 Birch	0	0	0	0	0	0	0	0	0	0	cost = $1.775
323.4 Cypress	0	0	0	0	0	0	0	0	0	0	million
322.1 Dogwood	0	0	0	0	0	0	0	90	90	90	
319.9 Tomahawk City	0	0	0	0	0	0	0	0	0	0	
292.5 Elm	0	0	0	0	0	0	0	0	0	0	
291.4 Merrill City	0	0	0	0	0	0	85	90	90	90	
Standards Met	N	N	N	Y	Y	Y	Y	Y	Y	Y	*Zone 2*
278.2 Fir	0	0	0	90	90	90	90	90	90	90	Charge
278.0 Brokaw	0	0	0	0	0	0	0	0	0	0	4 cents/lb
271.3 Wausau	0	0	0	0	0	0	0	85	85	90	cost - $1.072
265.2 Gum	0	0	90	90	90	90	90	90	90	90	million
264.9 Rothschild City	0	0	0	0	0	0	85	90	90	90	
256.0 Hemlock	0	0	0	0	90	90	90	90	90	90	Charge
255.7 Mosinee	0	0	0	0	0	0	0	85	85	90	8 cents/lb
230.5 Juniper	0	0	0	0	0	0	0	0	0	0	cost = $2.038
229.3 Steven Points City	0	0	0	85	90	90	90	90	90	90	million
226.9 Lemon	0	0	0	0	0	0	90	90	90	90	
226.5 Maple	0	0	0	0	0	0	0	0	0	0	
Standards Met	N	N	N	N	N	N	N	Y	Y	Y	*Zone 3*
214.3 Oak	0	0	0	0	0	0	90	90	90	90	Charge
213.9 Biron	0	0	0	0	0	0	0	0	0	0	8 cents/lb
211.9 Poplar	0	0	90	90	90	90	90	90	90	90	cost = $3.121
208.3 Wisconsin Rapids City	0	0	0	0	85	90	90	90	90	90	million
205.6 Sycamore	0	85	85	85	85	85	85	85	85	85	
205.1 Port Edwards	0	0	0	0	0	0	0	85	85	85	
201.9 Teak	0	0	0	0	0	0	0	90	90	90	
200.9 Nekoosa City	0	0	0	0	0	0	0	0	0	90	

Standards Met: Y = Yes N = No

Economic Incentives for Water Quality Improvement (Water Resources Center, University of Wisconsin, Madison, Mimeo 1971).

would be the same for all waste sources, reactions to this would differ to the extent that response functions within the zone differed. The river was divided into three zones reflecting three major sags in the dissolved oxygen profile that resulted from the distribution of waste loads and assimilative capacity. It was found that a charge of 4 cents per pound of B.O.D. in one zone and 8 cents per pound in the other two zones was necessary to achieve the 2-5 standards. This resulted in an annual system cost of $5.5 million as opposed to $3.7 million for the least-cost system. The idea of setting one effluent charge for the whole river is equivalent to defining only one zone. It was found that a charge of 8 cents per pound would be required to meet the 2-5 standards and that this would raise the annual cost to the system to $6.4 million.

If it is assumed that an effluent charge can be set and levied at any level and that it can be raised at any time, then the 2-5 standards could be attained by raising the charge until the standard is attained. However, such a strategy would involve a cost at least as great as that of the zoned effluent charge. For the inefficiency to be left at this minimal level, it would have to be assumed that all investment induced by the lower charge levels was compatible with the investment induced by the ultimate charge. It must therefore be concluded that such a strategy would involve a substantial inefficiency cost.

D. Case Study Implications

The data on which this case study is based indicate that either a single effluent charge or a zoned effluent charge system would be an inefficient way of achieving the standards adopted by the State of Wisconsin. It might be argued that if the costs of means of reducing waste loadings besides waste treatment were available the findings of the study would have been quite different. This contention can neither be proved or disproved. The significant point is that on the basis of substantial data it is evident that conditions can exist under which an effluent charge system will not by itself induce specified water quality standards at least cost. Much depends on the response functions of the individual dischargers and their relative positions along the particular river.

This should in no way be taken to mean that common property resources should not be priced. There are many ways in which a price might be associated with the use of the assimilative and carriage capacity of watercourses but what is being suggested here is that it is doubtful whether these prices should be used as the prime mechanism for controlling the behaviour of waste producers.

AN ASSESSMENT OF THE BEHAVIOURAL RESPONSE TO THE ESTABLISHMENT OF CHARGES THROUGH AN ITERATIVE PROCESS

Let us assume that the proposed strategy is in fact technically capable of achieving a specified standard at least cost. Would those involved respond to make the process effective? The answer to this question depends upon how those who levy the charge react to the influences under which they operate. There is no empirical basis for demonstrating what the response will be. However, experience with the regulation of pollution provides an insight into the kind of interactions that would take place. Drawing upon experience with pollution control, an assessment is made of the probable results of the iterative process. The analysis is based upon the following assumptions:

1. The charges must be established by a public agency because the legislative process would not be flexible enough to apply the iterative approach.
2. The waste dischargers would know that the initial set of charges will be subject to change if the standards were not achieved through the initial action.[6]

There are several factors that will determine how those involved in the iterative process are likely to respond under these assumptions.

First, experience with regulation demonstrates that the process of establishing charge levels will be a bargaining process.[7] It is inconceivable that a public agency could establish charge levels without negotiating with those having an interest in the level of the charges. Matthew Holden points out that a number of factors will influence the nature of these negotiations including:

—The social values and myths associated with the problem and

—The extent to which the regulatory agency and the regulated party must have continuous relations in future or may have one time relations only.

Second, the waste dischargers will be able to devote more time and effort to negotiating with the agency over the level of the charge than

6. For examples of analyses suggesting an iterative approach to setting the effluent charge and which start from these assumptions *see* Hass, *Optimal Taxing for the Abatement of Water Pollution*, 6 Water Resources Research (Apr. 1970); Haimes, Kaplan & Husar, *A Multilevel Approach to Determining Optimal Taxation for the Abatement of Water Pollution*, 8 Water Resources Research (Aug. 1972).

7. Holden examined pollution control as an example of regulatory decision-making and argued that, pollution control agencies like other regulatory agencies, "tend to engage in some loose interchange (bargaining) with regulated parties until they find a settlement which is tolerable to them all." M. Holden, Jr. Pollution Control As a Bargaining Process: An Essay on Regulatory Decision-Making (Cornell Univ., Water Resources Center Publication No. 9, 1966).

those interested in upgrading water quality in the river. Again the literature on regulation and interest group behaviour substantiates this conclusion.

Third, the waste dischargers and associated interests will have a strong motivation (a) to keep the charge as low as possible and (b) to gain a commitment that increases in the charge should be delayed as long as practicable.

Fourth, the public agency does not know at what level to set the charge in order to induce sufficient abatement to achieve the standard.

In this negotiating environment it is only reasonable to expect (a) that initial charges would be much lower than necessary to achieve substantial upgrading in water quality and (b) that increases in the charges would be delayed as long as possible. This conclusion is based on the expectation that the waste dischargers would press for this and the public agency knowing that it will be having continuous relations with the waste dischargers would want to be reasonable. One should expect the waste dischargers and associated interests to marshall information about the adverse effects upon them and the regional economy if high charges are imposed and contend that they must be assured of no immediate changes in the level of charges because they need time to amortize the investment called for by the initial level of charges. It is not significant that these arguments may not be valid. What is significant is that since the public agency is not informed about what the effects of a given level of charges will be it would be in a weak position to oppose the industry's contention.

There is one possible countervailing influence and this is the "social values and myths associated with the problem." It is conceivable that in view of the influence of the prevailing concern about environmental quality the public agency might be motivated to be "tough" with the waste dischargers. Yet, experience with public regulation in general indicates that periods in which regulatory agencies are "tough" upon the regulated are temporary phenomena.

Thus, one is led to the conclusion that unless something is done to re-structure the bargaining arrangement effluent charges are unlikely to achieve desired standards within a reasonable length of time. For it to be otherwise is to expect the public agency to respond in a manner quite contrary to the long record of regulatory agency behaviour.

The reservations about the effluent charge based upon an iterative process because of doubts about the efficiency of the likely results together with the prospect that administration of the charge would not be effective underscore the desirability of examining alternative strategies.

AN ALTERNATIVE STRATEGY: COMBINING REGULATION AND COST-SHARING

An improved strategy should be capable of achieving a standard at least cost, of distributing these costs in accord with some accepted concept of equity and of controlling effectively the behaviour of waste producers.

In the case of the Wisconsin River it was concluded that a strategy combining regulation and cost-sharing might go a long way toward meeting these criteria.[8] This strategy is designed to perform three critical functions:

1. Implement a management plan for achieving standards at least cost.
2. Distribute the costs of the management plan in accord with some accepted concept of equity.
3. Structure negotiations between the agency, waste dischargers and other parties so that the beneficial results of bargaining will be generated, an acceptable concept of equity formulated and management plans effectively implemented.

The study of the Wisconsin River indicated that considerable information could be developed without prohibitive cost.[9] This information would be sufficient to provide a management agency with a basis for initiating negotiations with a more reasoned approach. It was concluded from this that the difficulty and cost of generating information did not clearly outweigh the potential benefits from improved management. This implies that a more effective strategy should be based on improved generation and utilization of information.

This strategy assumes that information can be generated about the nature of least cost plans for achieving standards.[10] Indeed, it reflects the judgment that a water quality standard is really only meaningful if accompanied by a plan for achieving it and the specification of the means for monitoring and enforcing it. Hence a strategy for achieving

8. This again reflects the judgement that a national strategy should be designed in the light of the requirements of a regional strategy. Further that requirements are likely to vary considerably between regions. For an approach that is similar in many respects *see* Roberts, *Organizing Water Pollution Control: The Scope and Structure of River Basin Authorities,* 19 Pub. Policy 75 (1971).

9. The study of the Wisconsin River cost a quarter-million dollars over a three-year period.

10. The analysis in this paper has focused on the use of an effluent charge for achieving *adopted* standards since much of the discussion of the strategy has been in this limited context. *See e.g.,* Freeman & Haveman, *supra* note 2, at 324. A fuller analysis of strategies for pollution control must include consideration of how water quality objectives should be determined. If information can be generated about the nature of least cost plans for achieving water quality objectives then this *must also be considered in determining what water quality standards are to be adopted.* The strategy being suggested here assumes standards are set on the basis of such information.

an adopted standard becomes the strategy for implementing the management plan.

Unless the costs and benefits of the management plan are distributed equitably it is likely that the implementation of a least cost plan will be opposed. A least cost plan is likely to require different levels of treatment at each waste source because of different costs of abatement and relative positions on the stream. Such a distribution of costs is unlikely to be considered equitable and hence the least-cost plan would be opposed unless there is some redistribution. Present fiscal policies have substantial effect on the distribution of the costs of waste abatement by industries and municipalities.[11] Such distributional effects must be considered explicitly if the likelihood of a strategy being effective is to be increased.

Institutional arrangements for implementing the strategy can be structured such that the negotiations between the management agency, the polluter and other interested parties enhance rather than frustrate the achievement of water quality objectives.[12] If the management agency strategically utilizes information that it is able to generate,[13] then more information and an improved understanding can be developed through negotiations with waste dischargers and others affected. In this way understanding of the physical and value effects of different water quality standards and of the various different management plans that might be employed to achieve each will be improved. If the plan to be implemented and the distribution of the costs and benefits of implementation, reflect the results of bargaining between the affected parties, then the likelihood of the strategy being effective is greatly increased.

Table 4 illustrates how such a strategy might be structured in a specific situation with an example of its application to the Wisconsin River.

When this initial analysis has been completed, the following information would be communicated to each waste producer:

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11. The maximum extent of subsidization might be as high as 55% and 63% of the annual cost of treatment for industries and municipalities. These subsidies are in the form of either foregone tax payments or grants. For an analysis of the distributional effects of fiscal policies *see* A. Dorcey, *supra* note 2, at 14-28.

12. Roland McKean has developed the analogy of bargaining as "The unseen hand in government." He argues that bargaining, like the price mechanism, produces some very desirable results, "The right kind of bargaining process can make special interests and parochial viewpoints, which one might think would produce chaotic decisions, lead to an orderly and sensible pattern of choices. If well designed, the unseen hand can go a long way toward turning private vice into public virtue in the government as well as in the private sector." *See* R. McKean, Public Spending 22 (1968).

13. The information generated in the Wisconsin study is illustrative of what might be generated.

Table 4

River Mile Point	Source	1000 # 5-day BOD/day 1	Proportion of Generated Load per cent 2	Generated Load Abated per cent 3	Discharge 1000 #5 day BOD/day 4	Annual cost of System 1000s $ 5	Cost Redistributed 1000s $ 6	Charge or Payment 7
349.4	Aspen (I)	49	14.0	80	10.6	621	738.6	−117.6
348.6	Rhinelander (M)	2.7	.8	50	1.3	97.5	42.2	+ 55.3
327.5	Birch (MI)	.1	.1	0	.1	0	5.3	− 5.3
323.4	Cypress (MI)	.3	.1	0	.3	0	5.3	− 5.3
322.1	Dogwood (I)	20.3	5.9	70	6.1	806.5	311.2	+495.3
319.9	Tomahawk (MM)	.4	.1	50	.2	23.6	5.3	+ 18.3
292.5	Elm (MI)	.5	.2	0	.5	0	10.6	− 10.6
291.4	Merrill (M)	1.5	.4	50	.7	55.6	21.1	+ 34.5
278.2	Fir (I)	15	4.4	25	11.2	103	232.1	−129.1
278.0	Brokaw (MM)	.1	.1	50	.1	8.5	5.3	+ 3.2
271.3	Wausau (M)	6.7	1.9	50	3.3	270.6	100.2	+170.4
265.2	Gun (I)	49	14.2	85	7.3	637	749.2	−112.2
264.9	Rothschild (MM)	.8	.2	50	.4	31.0	10.6	+ 20.4
256.0	Hemlock (I)	12	3.5	0	12.0	0	184.7	−184.7
255.7	Mosinee (MM)	.2	.1	50	.1	9.9	5.3	+ 4.6
230.9	Juniper (MI)	.9	.3	0	.3	0	15.8	− 15.8
229.3	Stevens Point (M)	5.0	1.5	50	2.5	100.4	79.1	+ 21.3
226.9	Lemon (I)	4.0	1.2	0	4.0	0	63.3	− 63.3
226.5	Maple (MI)	1.2	.3	0	1.2	0	15.8	− 15.8
214.3	Oak (I)	4.0	1.1	85	.6	175.0	58.0	+117.0
213.9	Biron (MM)	.1	.1	50	.1	7.2	5.3	1.9
211.7	Poplar (I)	27	7.8	80	5.4	391	411.5	− 20.5
208.3	Wisconsin Rapids (M)	7.7	2.2	50	3.8	173.8	116.1	+ 57.7
205.6	Sycamore (I)	75	21.8	85	11.2	849.0	1150.1	−301.1
205.1	Port Edwards (MM)	.4	.1	50	.2	19.2	5.3	+ 13.9
201.9	Teak (I)	60	17.4	85	9.0	863.0	918.0	− 55.0
200.9	Nekoosa (MM)	.6	.2	50	.3	33.2	10.6	+ 22.6
TOTALS		344.5	100		92.8	5276.0	5276.0	

I = Industrial MI = Minor Industrial M = Municipality MM = Minor Municipality

Economic Incentives for Water Quality Improvement (Water Resources Center, University of Wisconsin, Madison, Mimeo 1971).

1. Column 1 gives organic waste loads generated by each source in thousands of pounds of BOD.
2. Column 2 gives the proportion of organic load in the region which is generated at each source.
3. System C from Table 1 is assumed to be the least cost system being implemented.
4. Column 4 gives the waste loads that would be discharged after implementing System C.
5. Column 5 gives the estimate of the annual cost, before taxes and grants, incurred by each source if System C is implemented and the total cost for System C.
6. Here the total cost of System C is redistributed among all waste sources in proportion to their percentage contribution to the total waste load as shown in column 2.
7. In Column 7 we have the transfer of costs that would be required for each waste source to bear the total cost burden that is allocated in column 6.

a. Its estimated raw waste load (from column 1).

b. Allowable discharge, which might be called the "poundage order" (from column 4).

c. Technical alternatives and their costs utilized in the least cost analysis (from column 5).

The waste producer would then be asked to answer the following questions:

a. Do you agree with these estimates? If not, show why not.

b. Is there any way in which you could achieve this poundage order more efficiently? If so, give details necessary to include the alternatives in the least cost analysis.

There would be an incentive to respond to these two questions with accuracy. A monitoring system would be implemented as part of the strategy and would soon check on the polluter's response to its estimated raw waste load. A requirement of an annual audit of waste abatement activities would check on the "poundage order" and waste producer's cost at the end of the year.

The information feedback to the regional agency would be used to rework the analysis of Columns 1 through 7. The cost minimization solution derived from this would be implemented through the issuance of a poundage order, which would be a fixed term lease for the use of a designated amount of assimilative capacity. Thus over time the agency would control directly the supply of assimilative capacity using the regulatory device of a poundage order. Depending on the criterion adopted for sharing costs a price would be associated with the supply of assimilative capacity.

This outline is only intended to be suggestive of how an improved strategy might be designed for water quality management in the Wisconsin River.[14] Regulation is utilized to implement directly the management plans necessary for achieving adopted standards. Cost-sharing is considered explicitly to increase the political acceptability of the management plan. Further, the resource is priced to reflect its scarcity value. A strategy structured along these lines appears to offer hope of more effective water quality management in the Wisconsin River. In other regions an improved strategy would have to be designed to perform these same three critical functions. However, the specifics of the strategy might well differ between different regions.[15] A national strategy would therefore be designed to

14. Some of the problems of designing and implementing this strategy are discussed in Dorcey, *supra* note 2. Explicit attention is given to the structure of incentives in such a strategy, the dynamics of managing assimilative capacity in the short and long run and the dichotomy between short and long-run efficiency.

15. An actual example of an approach which is similar in some respects is the strategy

encourage and facilitate the performance of these three critical functions in the regions.

CONCLUSIONS

This paper has sought to assess whether an effluent charge strategy is likely to produce the expected improvement in water pollution control. The results of an empirical study indicate that an effluent charge can be a highly inefficient means of achieving ambient water quality standards. Past experience in pollution control indicates that an iterative approach to implementation of an effluent charge strategy will result in a bargaining situation. When these behavioural characteristics are considered it seems unlikely that the strategy will be as effective as some analysts have suggested.[16] It must therefore be concluded that the effluent charge strategy will not necessarily be more effective than the present strategy. The results of the empirical study and the analysis of the behavioural characteristics of pollution control suggest that a more effective strategy might include a management plan for efficient achievement of standards, cost sharing to increase political acceptability of such plans and structured bargaining among all affected parties.

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employed in the Ruhr. The Ruhr strategy combines regulation and cost-sharing and is not an example of an effluent charge as often claimed. In this case regulation takes the form of compulsory membership in the basin organization that builds and operates treatment facilities, and cost-sharing for these operations is through user charges based on weighted average costs. *See* A. Kneese & B. Bower, *supra* note 2, at 237-53.

16. *See* Baumol & Oates, *The Use of Standards and Prices for Protection of the Environment*, 73 Swedish J. Econ. 45 (1971) for a particularly optimistic statement which does not recognize the importance of these behavioural characteristics:

> [T]he information needed for iterative adjustments in tax rates would be easy to obtain: if the initial taxes did not reduce the pollution of the river sufficiently to satisfy the present acceptability standards, one would simply raise the tax rates. Experience would soon permit the authorities to estimate the tax levels appropriate for the achievement of a target reduction in pollution.