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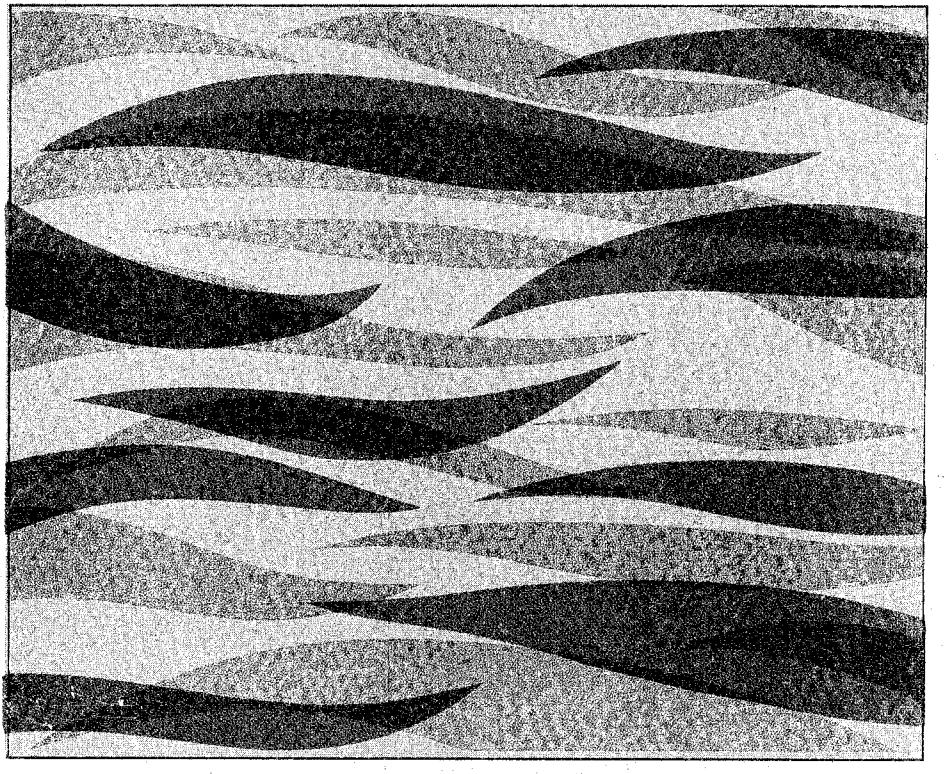

INSTITUTE OF WATER RESOURCES
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AN ECONOMIC EVALUATION OF CONNECTICUT WATER LAW: WATER RIGHTS, PUBLIC WATER SUPPLY AND POLLUTION CONTROL

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Most of the legal facts and interpretations were drawn from the work of my colleagues on the project, Theodore H. Focht, Associate Professor, The University of Connecticut School of Law, and Robert I. Reis, now Associate Professor, School of Law of the State University of New York at Buffalo.

Many of the basic principles on which the analysis is structured were liberally borrowed from the work of Dr. S. V. Ciriacy-Wantrup, Professor of Agricultural Economics, University of California, Berkeley.

While not directly involved with the research, my friend and colleague, Arthur W. Dewey, Professor of Agricultural Economics, University of Connecticut, provided much appreciated encouragement and response to many ideas.

R. L. L.

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I. THE WATER LAW SYSTEM – AN ECONOMIC PERSPECTIVE

The development and use of water resources in Connecticut occurs within a rather complex institutional framework. In the absence of a statutory definition of water rights the courts have relied on common law principles in defining property rights in water. Common-law water rights coexist with, and are limited by, numerous statutory laws pertaining to various aspects of water use.

In defining private rights to use water from a water course, Connecticut courts have relied on the riparian rights doctrine.[1] "Broadly stated, a riparian right has come to represent a property right arising from ownership of land adjoining a water course. It is inseparably annexed to the soil. A riparian right includes the right to make any reasonable use of water relating to riparian lands with due regard to the rights of upper and lower riparians in their use of the water."[2]

Much of the common law regarding riparian rights was developed in settling conflicts over rights to detain water for power production. From the early grist mills until the middle 1800's water power sites were the prime determinants of industrial location and growth. To encourage water power development the Connecticut General Assembly granted limited condemnation power to persons wishing to build a mill pond and ditch system.[3] These statutes also protected existing mills

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1 There have been two major legal studies of Connecticut water rights law.

Clyde O. Fisher, Jr., "Connecticut Law of Water Rights," Appendix A, of Water Resources of Connecticut, Report to the General Assembly, by the Water Resources Commission (a special commission created by Special Act No. 572, 1955, State of Connecticut, 1957, pp. A1-70).

Robert I. Reis, Connecticut Water Law: Judicial Allocation of Water Resources (Institute of Water Resources, University of Connecticut, Storrs, 1967, 215 pp.).

For convenience reference will be made only to Reis for information contained in both studies.

2 Reis, op. cit., p. 21.

3 These early grants of authority continue in the statutes. Connecticut General Statutes (Rev. 1958), Sec. 52-446 through 52-455.

and mill sites from condemnation. However, the scheduling of detentions and flow releases was left to the mill owners. Civil suits resulted when mill owners could not agree on the scheduling of releases.[1]

Currently conflicts exist along some rivers between recreational users and companies generating hydroelectric power.[2] Hydroelectric stations are usually operated only during hours of peak demand for electricity. Stream flow is detained and then released rapidly for a few hours per day. On weekends and holidays power demands are usually less than average; thus, little water is released if storage capacity is available. The resulting fluctuations in downstream flow limit recreational uses both directly and through intensification of pollution problems.

A diversion of stream flow for public water supply purposes does not qualify as a riparian use in Connecticut.[3] Public water supplies are developed under legislative grants of authority to purchase or condemn necessary water rights.[4] Injured riparian proprietors can demand compensation but cannot prevent a diversion for public water supply purposes.

New legislative restrictions on the development of public water supplies were established in 1967 by Public Act No. 792.[5] Any person, corporation, or municipality receiving authority to divert water from a river for public use by special act after January 1, 1967, must also obtain a permit from the Water Resources Commission. Public interest

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1 Numerous cases are cited by Reis, op. cit., pp. 36-43.

2 In fairness to the power companies recognition must be given to the considerable recreational use of power company reservoirs.

3 Reis, op. cit., p. 54.

4 The allocative aspects of these grants of authority will be discussed in several sections of this report. For a legal summary on the relationship between municipal water supplies and riparian rights see: Reis, op. cit., pp. 53-69.

5 "An Act Concerning Use of Water from Rivers for Public Consumption" (Connecticut Public Act No. 792, 1967 General Session). A reprint of the Act is provided in Appendix B of this report.

in other water uses must be considered in determining whether or not to issue a permit.[1]

Of the total water withdrawn in Connecticut, only a small percentage is lost through consumptive uses. Industries withdrawing large volumes for washing, processing, and cooling typically discharge waste water into the same stream. Interbasin diversions are primarily for public water supply. Thus, laws pertaining to pollution control and development of public water supplies have a direct and often dominant influence on the allocation and use of water resources. An economic evaluation of the "water law system" must, therefore, include the allocative aspects of these statutory laws in conjunction with water rights as traditionally defined.

A. Resource Allocation through Pollution Control Laws

No state legislature or court has clearly defined water rights with regard to quality. While there have been a number of successful civil suits to enjoin continued pollution and obtain compensation for damages, these actions to protect property rights have not been generally effective in controlling pollution. Legal uncertainties, the time and expense of litigation, and the diffusion of damages and sources of pollution appear to protect waste dischargers from civil suits.

Progress in water pollution control is being made through federal and state financial assistance and through state pollution control regulations based on police power — the authority of states to regulate the use of property in the interest of public safety and general welfare.[2] These regulations result in an administrative allocation of the use of water for waste disposal. From an economic point of view,

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1 Ibid., Section 2.

2 In Connecticut, The Water Resources Commission is responsible for water pollution control beyond that required to protect public health. The organization, powers and responsibilities of the Commission are defined in Section 25 of the Connecticut General Statutes (Rev. 1958). The powers of the Commission regarding pollution control were significantly strengthened by Public Act No. 57, "An Act Concerning the Elimination of Pollution of the Waters of the State" (Connecticut Public Act No. 57, 1967, General Session).

a permit to discharge liquid wastes can be very similar to a right to divert water.

B. Public Interest in Stream Flow

Legal differences exist between public and private water courses. A water course is public if it is either commercially navigable or affected by tidal ebb and flow. In Connecticut a public water course is legally characterized by state ownership of subaqueous lands and public rights of passage. In the case of a private or non-navigable water course the bed is privately owned, and within reasonable limits the stream flow may be diverted or detained.[1]

Expanding state and federal activities in water resource development and management appear to be reducing the practical significance of legal differences between public and private water courses. The federal government has built numerous flood control projects on non-navigable tributaries of navigable streams. Detentions of flood flow seldom involve important questions pertaining to water rights. However, plans to store water for low-flow augmentation introduce new issues.

1. Water quality management

Federal agencies involved in river basin and reservoir planning are now required to consider the inclusion of storage for regulation of stream flow to assist in water quality protection.[2] The value of such storage is included in determining the economic value of the entire project. If the benefits from the water quality control features are widespread the costs of such features are non-reimbursable.

Plans to regulate stream flow raise several questions pertaining to private water rights. Will detention from flows smaller than flood

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1 Reis, op. cit., p. 17.

2 Federal Water Pollution Control Act, Public Law 84-660, as amended by the Federal Water Pollution Control Act Amendments of 1961 - (PL 87-88), the Water Quality Act of 1965 - (PL 89-234), and the Clean Water Restoration Act of 1966 - (PL 89-753) and Oil Pollution Act 1924, as amended by the Clean Water Restoration Act of 1966 - (PL 89-753), compiled by Federal Water Pollution Control Administration, U. S. Department of Interior (U. S. Printing Office: 1967 0-243-126), Section 3 (b) of PL 84-660, p. 2.

stage interfere with established water rights? How can releases for water quality improvements be protected from downstream detention or diversion from the basin? The preceding questions will be considered in subsequent sections of this report. The issue was raised at this point to illustrate public interest in stream flow and water rights.

The Federal Water Quality Act of 1965 requires establishment of water quality standards for all interstate waters (including coastal waters).[1] Moreover, the discharge of waste into tributaries which reach interstate waters are subject to abatement under the Act.[2] The legislation also specifies that failure of a state to set acceptable standards and develop an acceptable plan for enforcement will result in direct action by the Secretary of the Interior.[3]

Previous to 1965 the Connecticut Water Resources Commission concentrated attention on control of individual waste discharges. Relatively little attention was given to the setting of instream quality standards (often referred to as stream classification). Since stream standards are of little direct value in reducing waste discharges, the federal emphasis on standards may be excessive. However, the standards do provide the basis for clear public statements regarding objectives and the future use of specific waters. Emphasis on standards also encourages state pollution control agencies to give increased attention to future stream flow and consequently to water rights and the development of public water supplies. Future detentions and diversions which reduce stream flow must be considered when setting quality standards and preparing plans for achieving the standards.

2. Recreational uses and scenic values

In addition to its owning the land under public waters, the State provides public boat launching facilities on coastal waters and on many inland lakes. The State Board of Fisheries and Game has purchased public access rights for fishing along numerous streams. These State

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1 Federal Water Pollution Control Act, op. cit., Sec. 10 and 13 (e) pp. 15 and 22.

2 Ibid., Sec. 10 (c) (5), pp. 16 and 17.

3 Ibid., Sec. 10 (c) (2), p. 15.

property rights have not been the basis of action to secure pollution abatement or to limit detentions or diversions of stream flow. However, the public use of these areas has surely been considered in establishing priorities in pollution control. Public recreational uses are recognized in Public Act No. 792, which instructs the Water Resources Commission to consult with the State Board of Fisheries and Game and to hold a public hearing in determining whether or not to grant a permit for diversion of river water for public water supply.

Detentions, diversions and waste discharges reduce scenic values and recreational uses on both public and private property. Are these non-commercial uses effectively represented in the existing decision process? If not, how can protection of environmental uses be strengthened? Can property rights be redefined to reflect the increasing concern over non-commercial uses? Can diversions and detentions be limited through regulations similar to existing pollution control laws? These questions extend beyond the scope of an economic analysis. Part of the results of this study will consist of the identification of specific questions for future legal research.

II. ECONOMIC CRITERIA

There are two basic elements to be considered in an economic evaluation of water law. First, the use of water resources depends to a large degree on the incidence of costs and benefits resulting from particular uses. To the extent possible, rights and regulations should structure the decision process in such a way that consideration is given to all costs and benefits associated with all potential water uses. The incidence of benefits and costs should provide economic incentives for research directed toward a reduction in consumptive use and waste creation, and toward improved waste treatment techniques. Second, rights and regulations should be sufficiently stable to encourage investment and yet provide for a reallocation of resource use through time. Both of these basic criteria must be considered for the entire water law system.

A. External Costs

Efficient utilization of water resources is possible only if all costs and benefits associated with each water use are considered in the decision process. The market mechanism fails to provide this coordination of benefits and costs if the actions of one decision unit (person, firm, or municipality) result in direct (non-market) transfers of costs or benefits to others.

Direct transfers of benefits are often referred to as "real external economies" or "technological external economies."[1] A process which results in benefits to downstream users will be conducted at less than the socially optimum rate if there is neither compensation from the beneficiaries nor some form of public subsidy. Practical examples exist but are not numerous. The discharge of plant nutrients could benefit downstream irrigators. However, the discharge of plant nutrients should be encouraged only if an increased contribution would result in a net of external benefits. Seasonal storage of stream flow for hydroelectric generation benefits downstream power stations. Since all parties can benefit from cooperation important external economies are often internalized through mergers or contracts. Public subsidy is needed only if the benefits are too diffused for private initiative.

In the case of real external diseconomies there is, unfortunately, no inherent tendency toward correction.[2] Water pollution has long been

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[1] Within the context of equilibrium theory, real external economies result in a less than optimum allocation of resources. Within the context of economic growth theory, particularly as applied to the less developed countries, dynamic external economies can stimulate economic growth. See: Tibor Scitovsky, "Two Concepts of External Economies," The Journal of Political Economy (Volume LXII, No. 2), April 1954, pp. 143-151.

[2] A real technological external diseconomy must be distinguished from a "pecuniary external diseconomy," which is created when increased production by one firm results in an increase in the price of inputs for other firms. A pecuniary external diseconomy transfers income but does not circumvent the market or distort the allocation of resources. See: William J. Baumol, Welfare Economics and the Theory of the State with a New Introduction — Welfare and the State Revisited (Harvard University Press, Cambridge, Massachusetts, second edition, 1965, 212 pp.), p. 25.

a classic example of a real external diseconomy (external cost). Discharge of waste into a stream results in increased water treatment costs, losses in satisfaction for recreational users and nearby residents, and loss of opportunities for developing new uses. Unless the injured parties can procure compensation from the waste discharger the costs of the waste discharge are external to the waste discharger and to the entire market mechanism. There is no economic incentive to consider downstream costs when selecting plant locations and production processes or to treat wastes. External costs are also created by detentions and diversions of stream flow if downstream costs are incident on persons unable to procure compensation.

Altering the decision structure to eliminate external costs improves the efficiency of resource allocation, and in theory gainers could compensate losers in such a way that at least one individual would be better off and none worse off than before the change.[1] In practice all losers cannot be compensated. Altering the definition of property rights or expanding the scope of public regulation over the use of property will entail uncompensated losses for some individuals. Thus, policy decisions must include value judgments made through the political process in conjunction with economic and technical considerations.

1. Clarification of property rights

In some situations external costs can be eliminated or at least reduced through a more specific definition of individual property rights. Where rights to all potential uses can be quantitatively defined and exchanged through a market process there are no external costs. Where consumptive uses compete for limited supplies there are clear opportunities for rationing through the market.

There is little practical opportunity for reducing external costs from waste discharges through a definition of pollution rights. External costs would continue to exist even in the absence of potential

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[1] At least one gainer and no loser is the basic idea of the well known Pareto criterion for identifying an increase in welfare. For additional discussion of the Pareto criterion in relation to water policy see: S. V. Ciriacy-Wantrup, "Concepts Used as Economic Criteria for a System of Water Rights," Land Economics (Volume 32, No. 4), November 1956 (pp. 295-312), pp. 306-309.

recreational uses and scenic values. With several water uses along a stream, a cooperative hoarding of discharge rights to maintain or improve water quality would require individuals to support the cooperative effort in the face of an individual incentive to wait for others to hoard the rights for the benefit of all uses.

Opportunities for protecting recreational and scenic uses through the market process appear to be very limited. Except for commercial recreation enterprises these instream uses and values are dispersed over too many users for effective representation through private property rights.

Benefits and costs which cannot be effectively expressed in the market should be represented through some form of public control. However, a simple statement that all benefits and costs should be considered is not an adequate basis for a practical evaluation of existing water law. A norm, or at least a perspective on expectations, must be established. The nature of costs resulting from diminished quality and flow must be investigated. Practical methods of bringing existing external costs into the decision structure must be identified.

2. Role of optimization models

Detailed economic models have been developed in an attempt to define the conditions necessary for minimizing all costs associated with liquid waste disposal in a region (usually defined as a watershed). More specifically, the objective is to state the conditions necessary for minimizing the sum of abatement costs and damage costs. Within rather stringent assumptions this can be accomplished by reducing waste discharges (through treatment and industrial process alteration) up to the point where additional abatement would be more expensive than the value of the downstream damage avoided. Kneese has defined conditions under which this equalizing of marginal costs and benefits from abatement at each outfall could be accomplished through effluent charges, incentive payments, or direct regulation of discharges.[1]

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[1] Allen V. Kneese, The Economics of Regional Water Quality Management (published for Resources for the Future, Inc., by the Johns Hopkins Press, Baltimore, 1964, 215 pp.). These models and subsequent developments are summarized in Appendix A, Regional Water Quality Optimization Models of this report.

Under the incentive payments proposal, a public agency would stand ready to pay current and potential waste contributors to restrict waste discharges. The schedule of payments offered would be based on the incremental damage costs. The amount paid would be determined by the rate from the schedule times the amount of waste reduction in response to the payment. Estimating the reduction would be extremely difficult since there is no practical way of estimating the quantity of waste which would have been discharged in the absence of the payment system.[1]

An effluent charge system would be less complex, since the charge would be determined by the amount actually discharged, in conjunction with the incremental damage costs. While the conditions for an exact social optimum are stringent even in theory, an approximation could be achieved if the damage costs can be estimated.

In the effluent standard proposal, the controlling agency would have to estimate both the marginal costs of abatement for each waste contributor and the associated marginal damage costs. Since estimating abatement costs would be the less difficult of the two, implementation would depend on success in estimating damage costs.

The literature on regional water quality optimization models gives little or no attention to external costs resulting from diversions and detentions of flow. At least in theory the models can be easily expanded. An optimum set of diversion and detention charges or standards would be analogous to the respective effluent charges or standards. The key to implementation would be estimating the costs (including losses in satisfaction) resulting from incremental reductions in flow.

The costs of incremental waste discharges and reductions in flow could be reasonably well estimated in the case of a stream with a few commercial users and no significant potential for recreational uses. In this situation court proceedings could be utilized to protect property rights and thereby eliminate external costs. However, time and expense could probably be saved and efficiency of management improved through a regional agency. An agency coordinating a limited number of commercial uses could make rather direct application of the optimization models using either charges or standards.

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[1] For additional discussion of these difficulties see Appendix A.

For the State as a whole, or even for a sizeable river basin within the State, there is no conceivable means of estimating the costs of incremental waste discharges or reductions in flow. The effect on downstream users of discharging an additional unit of a particular waste at a point along a stream depends on flow, temperature, the amounts and locations of other waste discharge, and the condition of the streambed. Thus, the optimization models do not provide a workable pattern for State water resource policy and programs.

There are conceptual as well as practical limitations in attempting to develop public policy on the basis of an optimization model. Neither economics nor political science has produced a generally accepted formula or procedure for aggregating individual welfare functions into a social welfare function or objective.[1] Moreover, institutional structures are operational parts of the decision process when forming public policy. In a direct application of optimization techniques, institutional structures are entered as constraints along with known technology and resource availability.[2] Thus, direct applications are limited to private decisions and to public decisions related to specific operational activities.

In relation to State water resources policy, the models developed by Kneese are constructs. In a more general analysis Ciriacy-Wantrup has noted that the concept of maximizing the social satisfaction of whole groups is really a scientific fiction — a conscious deviation from reality to expedite understanding and explanation.[3] The optimization models are valuable in illustrating the nature and concept of external costs. In forming public water resources policy flexibility and security must be considered along with external costs.

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1 Charles E. Lindblom, "Policy Analysis," The American Economic Review (Vol. XLVIII No. 3), June 1958 (pp. 299-312), p. 308.

2 Optimization of some specific function under each of a variety of hypothetical institutional structures does not necessarily form a logical basis for developing general policies. The role of institutional structures and general public policies is to guide the making of specific decisions through time rather than to optimize some function at particular points in time. For additional discussion of the role of economic optimizing in relation to water resources policy see: S. V. Ciriacy-Wantrup, "Water Policy and Economic Optimizing: Some Conceptual Problems in Water Research," The American Economic Review (Vol. LVII No. 2), May 1967, pp. 179-189.

3 Ciriacy-Wantrup, "Concepts Used as Economic Criteria for a System of Water Rights," op. cit., pp. 309-310.

3. Public policies and programs

External costs can be roughly controlled through public protection of water quality and stream flow. However, individuals and organized groups are more concerned with the protection of particular water uses than with the setting of specific quality and flow objectives. General policy issues relate to uses and to means of protecting those uses. The public can usually express general values most clearly through a reaction to specific proposals. Therefore, potential methods of State control over the use of water resources will be summarized prior to a discussion of quality and flow objectives.

Methods of public control:

State control over water use can be exercised through regulation, cost-sharing, and charges. The first two approaches are presently being utilized in Connecticut. Effluent and diversion charges would not necessarily involve a radical change in policy.

State authority to regulate waste discharge is well established in Connecticut.[1] Legislation regarding preservation of minimum natural stream flow has been passed in several states. In Virginia and Arkansas stream flow provisions relate only to impoundments, while in Florida, Mississippi, and Iowa they also apply to direct withdrawals from streams.[2] Regulatory protection of stream flow is basically very similar to the regulation of waste discharges.

Cost-sharing includes grants, special tax considerations, and sales of water from public projects at low prices. While special tax considerations for pollution control are often referred to as "economic incentives," the term "cost-sharing" is more accurate. Grants and tax concessions reduce the cost of treatment, but they do not create an actual incentive to treat wastes. The role of cost-sharing is to lower resistance to the establishment and enforcement of more direct measures, such as regulation. Providing water from public storage facilities at low prices would reduce resistance to stream flow protection policies.

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[1] For a recent analysis of administrative procedures of the Connecticut Department of Health and the Water Resources Commission see: Theodore H. Focht, "Connecticut's Administrative Control of Water Pollution--The Fluid Administrative Process," Report No. 8, Institute of Water Resources, The University of Connecticut, April 1969.

[2] Harold H. Ellis, "Relationships between Water and Other Property Rights and Small Watershed Developments in the Eastern States," Economics of Watershed Planning ed., by G. S. Tolley and F. E. Riggs (Iowa State University Press, Ames, Iowa, 1961), (pp. 262-275), p. 270.

In theory, a system of charges could be rather simple where the objective is to achieve and maintain specified flow and quality standards. Once target classifications had been set for each section of a stream, the maximum acceptable rate of diversion and of discharge of each type of waste could be established. Per-unit charges for flow reduction and for each critical waste could then be set for each stream section. Charges could be started at a relatively low level and increased through time until diversions and waste discharges were reduced to the rates consistent with target classifications. Charges could also be used to supplement a program primarily dependent on regulatory procedures.

Quality and flow objectives:

A definition of specific quality and flow objectives is needed to link public desires for particular water uses to public policies. An organized research and planning program is needed to provide this connecting link. Detailed study is essential in identifying the flow and quality conditions required to assure the availability of desired water uses. Policies and programs to protect water quality and stream flow must be coordinated with policies pertaining to water supply, flood control, power generation, recreational use of lakes and reservoirs, and some aspects of land use planning. Public values expressed through reactions to previous proposals can be projected into the planning process. Meanwhile, research and planning programs should continually provide the public with information about trends in water use and about projections of future conditions likely to occur under alternative policies.

In setting long range objectives, care must be taken to preserve opportunities for future development. In the absence of effective planning an opportunity for future development can be lost with little public attention or knowledge.

Ciriacy-Wantrup has suggested that the process of setting water quality objectives can be greatly simplified through use of minimum standards stable over time for most streams.[1] He suggests that the basic minimum standard be one that maintains a healthy habitat for fish life with allowance for uncertainty, particularly with regard to the

[1] S. V. Ciriacy-Wantrup, "Water Quality, A Problem for the Economists," Journal of Farm Economics (Vol. XLIII, No. 5), December 1961, (pp. 1133-1146), p. 1142-4.

cumulative effect of some pollutants. General recognition of a minimum standard would not preclude setting a higher or lower standard for some streams. The general minimum standard could be used as the base point for evaluating alternatives.

The concept of a minimum standard can be applied to stream flow in two ways: preservation of natural flow below a specified minimum for non-depleting uses, and maintenance of a minimum flow through releases from impoundments. In the case of preserving natural flow a basic rule for the entire state with criteria for deviations would seem feasible. Detailed study involving numerous physical, economic, and social considerations would, of course, be needed in setting the general standard and in defining criteria for deviations. In establishing a flow preservation program water users would have to be given sufficient notice to allow time for construction of storage facilities or procurement of supplemental supplies.

Since maintenance of a particular flow would normally require either publicly owned impoundments or public purchases from privately owned storage, a general standard for the entire state would be useful only in rather long range planning. Opportunities for low flow augmentation will probably have to be evaluated on an individual basis.

Two types of flow standards could be applied jointly. In formulating policy both standards could be jointly stated in terms of natural flow patterns. For example, the instantaneous minimum flow could be maintained at all times up to the lowest average monthly flow expected to occur once in ten years while natural flows could be protected up to the lowest average monthly flow expected to occur once in five years.

4. Incentives for research

There is no direct incentive for a firm to develop new techniques for reducing costs external to the decision unit. Where regulatory standards are determined by available technology there is an incentive to discourage research which might result in higher standards and increased expenditures to reduce external costs. Research directed toward the mitigation of external costs is dependent upon: (a) fortuitous correlations between external and internal costs; (b) third party expectations of new markets; or (c) public support.

There seems to be at least some correlation between external and internal costs for all water uses involving diversions and detentions of stream flow. Pumping, treatment, and distribution costs encourage some

economy in water use. Low operating cost for existing hydroelectric stations has not discouraged research on alternative methods of supplying capacity for peak loads. Expanding demands for electricity and lack of sites for new on-stream peaking capacity have been effective in encouraging research on the use of pumped storage and gas turbines.

Much of the research directed toward improving techniques for treating sewage and industrial wastes has been sponsored by public agencies and by firms expecting to increase sales of equipment and supplies. Treatment problems of most municipalities are sufficiently similar to utilize the results of a general research effort. However, the firms discharging industrial wastes are often in the best position to develop techniques for limiting waste creation and for specialized waste treatment. Thus, incentives for research by the discharger are essential for long-run progress in industrial waste control.

B. Security and Flexibility

Ciriacy-Wantrup has carefully developed the concepts of security and flexibility as economic criteria for evaluating alternative systems of water rights.[1] While his analysis was focused on withdrawal uses, the basic concepts can also be applied to recreation, environmental quality, and waste disposal. Since withdrawal uses in Connecticut are often more competitive with in-stream uses than with other withdrawal uses, the criteria must be stated in terms applicable to the entire water law system.

For a water "right" to be secure there must be assurance that sufficient water of acceptable quality will be available and the use will not be prohibited either by a conflicting property claim or by a change in public regulations. The possibility that use will be curtailed by a decrease in flow or quality will be referred to as "physical uncertainty."[2] The possibility that use will be restricted by a court

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1 Ciriacy-Wantrup, "Concepts Used as Economic Criteria for a System of Water Rights," op. cit.

2 In this study physical uncertainty includes the possibility that use will be curtailed by either natural variations in flow or lawful increases in use by others. Ciriacy-Wantrup used a more detailed classification. In his analysis physical uncertainty referred only to the possibility of loss of use due to natural variations in flow. The possibility that use would be curtailed by lawful increases in use by others was referred to as "tenure uncertainty." Ibid., p. 297.

injunction or an order from a public health officer or the Water Resources Commission will be referred to as "rule uncertainty." The two types of uncertainty can be closely related. For example, for riparian industries a strengthening of water pollution control regulations could increase rule uncertainty regarding waste discharges and decrease physical uncertainty with regard to water supply.

Security against both types of uncertainty is a basic objective for any water law system. There is no need to elaborate on the importance of a dependable water supply for public distribution, irrigation, and industrial use. Security with regard to future flow and quality is also needed in planning conservation areas and developing facilities for recreational uses. The need for security with regard to waste disposal is not clearly recognized in existing water rights law.[1] Yet the privilege of discharging wastes is just as valuable as that of diverting a water supply.[2] The possibility of a shift to extremely rigid pollution control laws could discourage investment. On the other hand, the possibility of a substantial relaxing of pollution control standards could also discourage investment by creating uncertainty about future water supplies.

Security must be balanced with flexibility. A water law system must provide flexibility to accommodate shifts in water use in response to changing technology, expanding urbanization, and growing public interest in conservation and outdoor recreation. Shifts in use can be provided for through changing public regulations, altering the definition of reasonable use under the riparian rights doctrine, and transferring property rights. Transfers of water rights include sales, condemnation for public use, and loss of rights through prescription.[3]

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1 Reis, op. cit., pp. 49-51 and 70-74.

2 Consider, for example, a riparian industrial use involving no loss of volume. An order prohibiting any future discharge of waste into the stream would be equivalent to an order to cease diverting the supply if no alternative place for disposal was available. A shift to complete recirculation would be the only way to continue the operation. If other streams could be used for water supply and waste disposal the costs of shifting the waste discharge might be greater than developing a new water supply.

3 Reis discussed additional ways in which rights may be lost and distinguishes between loss of the right to use water and loss of the right itself. Of the methods of transfer listed above only a sale would involve a loss of the right itself according to Reis, op. cit., pp. 77.

A joint use of security and flexibility as economic criteria involves a major element of logical polarity; however, the objective is not limited to a simple compromising of the two criteria. Institutional changes can sometimes create new opportunities for development with little or no threat to established uses. For example, the Connecticut statutes granting limited condemnation power to persons wishing to build a mill pond and ditch system provide protection for owners of established mills and mill sites and protected other property owners by requiring compensation of one and one-half times the assessed value of damages.[1] A similar addition of flexibility might be achieved through legislation permitting dischargers of heated water and some types of industrial wastes to cooperatively supply low-flow augmentation in lieu of cooling or treatment.

III. EVALUATION AND RECOMMENDATIONS

A. Public Water Supplies

Connecticut courts have consistently held that a diversion of stream flow for public water supply purposes is not a riparian use.[2] Public water supplies have been developed under statutes granting powers of eminent domain. The purity of public water supplies is protected by several specific statutes and the general powers of the State Department of Health. Relationships between public water supply and other uses have been determined by the interpretation and application of these statutes in conjunction with common law principles.

1. Condemnation powers

The Connecticut general statutes provide that municipalities or corporations authorized to provide a public water supply may, with just compensation, take and use lands, waters, and rights in land and water within the authorized service area.[3] Exercise of eminent domain is limited by a general requirement that the taking must be deemed necessary by the Superior Court. Prior to 1967 the general statutes gave comdemnation power free of any requirement to maintain a minimum flow downstream from water supply reservoirs.

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1 Connecticut General Statutes (Rev. 1958), Sec. 52-446 through 455.

2 Reis, op. cit., p. 54.

3 Connecticut General Statutes (Rev. 1958), Sec. 25-42.

Many municipal water departments and privately owned water companies have been created through special acts of the General Assembly. Some special acts provide explicit protection for existing water companies. This protection is provided by a statement prohibiting the purchase or condemnation of certain streams or lakes or by a general statement that the sources of developed public water supplies shall not be diminished.

Condemnation powers needed to develop a supply outside of the authorized service area can be secured only through a special act. The supplies of established water companies are usually protected either explicitly or by limiting the area from which the newly-created water company can develop a supply.[1] Among numerous special acts reviewed only two provide protection for a water use other than another public water supply.

Greenwich Water Company:

The special act authorizing the Greenwich Water Company to develop public water supplies from the Mianus River provides specific protection for the New York, New Haven and Hartford Railroad Company.[2] The authority of the Water Company is subject to the right of the railroad company to take water up to specified quantities for use at its power generating plant at Cos Cob. The railroad was permitted to expand diversions within the limits of a schedule of amounts which increased periodically until January 1, 1942, when the maximum of five million gallons per day was reached.

Use by the railroad never reached 5,000,000 gallons per day and has declined to a current use of 300,000 to 400,000 gallons per day.[3] The

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1 The term "water company" will be used to refer to either a privately owned water company or a municipal water department except when modified by the word "private."

2 Special Act No. 408, "An Act Establishing the Rights of the Greenwich Water Company and the New York, New Haven and Hartford Railroad Company in the Waters of the Mianus River," 1927 session of the General Assembly of Connecticut, approved June 6, 1927.

3 Source: Telephone conversation with Mr. Carl H. Swanson, Chief Engineer, Cos Cob Power Plant, New York, New Haven and Hartford Railroad Company, December 9, 1968.

Water Company provides a minimum flow of approximately one million gallons per day to the reservoir owned by the railroad.[1]

From presently developed sources the Water Company could not supply five million gallons per day to the railroad in addition to other commitments. However, there are no plans for increasing the capacity of the power plant at Cos Cob.[2] Thus, the rights of the railroad do not appear to be a serious threat to the Water Company.

Metropolitan District Commission:

Plans by the Metropolitan District Commission (often referred to as "MDC") to construct Hogback Reservoir on the West Branch of the Farmington River aroused considerable concern over possible loss of recreational uses and scenic values. A local interest group secured protection for these uses through an agreement and through the special act granting condemnation powers to "MDC".[3]

Allied Connecticut Towns, Inc., a non-profit Corporation, was formed on December 10, 1948. Several of the persons forming the corporation owned land abutting the Farmington River downstream from the proposed Hogback Reservoir. A nominal acreage of riparian land was transferred to the corporation. Nevertheless, the objective was to protect scenic and recreational uses throughout the watershed, and the bargaining power of the corporation was based on political strength rather than property rights.

Allied Connecticut Towns, Inc., agreed not to assert its common law rights in exchange for rights defined in an agreement with "MDC".[4] Among other conditions "MDC" agreed to:

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1 Source: Telephone conversation with Mr. James Cypher, Assistant Manager, Greenwich Water Company, October 14, 1968.

2 A rebuilding and expansion of the plant might not result in additional water use from the reservoir. Brackish water is available for cooling. The existing plant recovers only 5 to 10 percent of the water in steam passing through the turbines. Ibid.

3 Several legal documents regarding riparian rights and the operation of the Metropolitan District Commission are reprinted in Appendix C of Water Resources Planning Study of the Farmington Valley, by Paul Bock, Edwin E. Pyatt, and John A. DeFilippi (The Travelers Research Center, Inc., Hartford, Connecticut), February 1965.

4 "Riparian Agreement Made April 18, 1949, Between the Allied Connecticut Towns, Inc., and the Metropolitan District Commission," Water Resources Planning Study..., op. cit, Appendix C, pp. 345-350.

1. not build a dam in specified areas for a period of 75 years;
2. permit boating and fishing on Hogback Reservoir and permit hunting and fishing in all the watershed of the Hogback Reservoir owned by the "MDC", subject to regulations promulgated by a commission provided for in the agreement;[1]
3. maintain through Hogback dam a minimum flow of 50 c.f.s. at all times;
4. allow free passage through Hogback of natural flows up to 150 c.f.s. exclusive of any water discharged from the Otis Reservoir watershed;
5. have the contract ratified in the special act granting "MDC" condemnation powers needed to build Hogback Reservoir.

The contract was subsequently ratified in a special act which also restated most of the conditions to which "MDC" had agreed.[2]

Having reviewed two exceptions in some detail, attention must be returned to the usual pattern. Other public water supplies are the only uses usually protected by restrictions on condemnation power. Thus, riparian owners are informed that they can demand payment for property rights lost but cannot prevent the development of public water supplies.

2. Compensation requirements

Upstream uses threatening the purity of public water supplies can be stopped without compensation under statutes protecting the purity of public water supplies.[3] Reis cites several cases in which these statutes have been enforced.[4]

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1 Water is diverted from Hogback to Barkhamstead Reservoir which is not open to any recreational use.

2 Special Act No. 444--"An Act Increasing the Powers of the Metropolitan District, Respecting Water," General Assembly, State of Connecticut, 1949.

The requirement that natural flows up to 150 c.f.s. be passed through the Reservoir was removed from Special Act No. 444 by Special Act No. 141, "An Act Concerning the Powers of the Metropolitan District Respecting Water," General Assembly, State of Connecticut, 1963. However, the natural flow requirement is still in the agreement with Allied Connecticut Towns, Inc.

3 Connecticut General Statutes (Rev. 1958), Sec. 25-38 and 39, and Supplement 1965, Sec. 43.

4 Reis, op. cit., pp. 64-69.

Condemnation of an upstream use to preserve flow for public water supply would require compensation. However, water companies bear little risk of incurring this type of expense in the foreseeable future. There is very limited potential for expanded irrigation in the hills and narrow valleys typical of public water supply watersheds in Connecticut. Industries evaporating large quantities of water generally have sufficient waste discharge to proscribe their acceptability in a protected watershed.

Compensation to downstream riparian owners generally has been limited to those with an established commercial use of the stream. Agreement to release specified flows in exchange for riparian claims to natural flow have been used in coming to terms with riparians currently using water for power or for industrial processing. Rights at established mill sites no longer in operation have been cleared through purchasing riparian land and selling the land, less all claims to water rights, back to the previous owner.

No case has been found of actual compensation to downstream riparian owners for losses in recreational uses or scenic values resulting from diminished flow. In the case of Adams vs. Greenwich Water Company numerous riparian proprietors along the Mianus River brought action to enjoin diversion from the river.[1] The court refused to enjoin the diversion but "issued an injunction designed to force the defendant into either: (1) ceasing to withdraw water from the Mianus River; or (2) properly initiating an action to purchase the right to continue the diversion of water from the river by eminent domain."[2] The water company did initiate eminent domain proceedings, but there was no actual compensation.[3] Some flow was maintained, and apparently the riparian owners were not interested in collecting nominal damages for losses in recreational and scenic values.

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1 Source: Telephone conversation with Mr. James Cypher, Assistant Manager, Greenwich Water Company, October 14, 1968.

2 Reis, op. cit., pp. 60-63.

3 Source: Telephone conversation with Mr. Cypher, op. cit.

3. Public Act No. 792

New legislative restrictions on the development of public water supplies were established in 1967.[1] Any person, corporation, or municipality receiving authority to divert water from a river for public use by special act after January 1, 1967, must also obtain a permit from the Water Resources Commission. Public interest in other water uses must be considered in determining whether or not to issue a permit. The Water Resources Commission is specifically instructed to consult with other appropriate State agencies, including the State Department of Health and State Board of Fisheries and Game, and to hold a public hearing.[2]

In its present form the Act is of limited significance to either water companies or parties wishing to make other water uses. Most municipalities and large privately owned water companies have extensive authority to develop additional supplies under special acts passed prior to January 1, 1967. Most of the recent special acts create water companies to serve small suburban areas. These acts only authorize the development of supplies from ground water, which is not covered by Public Act 792. There had been no application for a permit as of July 3, 1969.

4. Status of public water supplies

Lack of riparian status for public water supplies has not impaired the development of supplies by municipalities and privately owned water companies.

A narrow view of the riparian doctrine would indicate that water companies may be subject to many future civil suits for either flow releases or compensation. However, most downstream riparian proprietors probably have lost the power to exercise riparian rights through prescription.[3] The fact that a diversion for public water supply is never a riparian use has probably been to the advantage of water companies in securing prescriptive rights. In practice public water supplies are well protected against both rule and fact uncertainties.

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1 "An Act Concerning Use of Water from Rivers for Public Consumption" (Connecticut Public Act No. 792, 1967, General Session).

2 Ibid., Sec. 2.

3 Reis, op. cit., pp. 82-87.

B. Water Rights

An economic evaluation of existing water rights law must include consideration of both current problems and characteristics of the system which might result in future problems. While the immediate objective is the identification of potential improvements in the definition of water rights, attention must also be given to the possibility of solutions based on other approaches. Institutional modifications outside the realm of water rights will be further developed in subsequent sections.

The first step in searching for an economically superior definition of water rights is the identification of the dominant economic features of the existing system. The riparian rights doctrine is primarily characterized by a preference for use on or associated with land contiguous to the water course and by the coequal nature of the right. Riparian owners are correlative cosharers in a right to make reasonable uses of the water with no fixed quantity of water assured to any riparian owner. In theory, new uses compete on an equal basis with established uses. In practice, a determination of relative reasonableness usually involves some preference for established uses in competition with a new use.[1]

There has been no modern definition of ground water rights in Connecticut. A decision in 1850 was based on an English concept of absolute ownership of percolating ground water.[2] While it seems safe to assume that the principle of absolute ownership would be abandoned in a future case, there is little basis for presupposing the particular concept most likely to be employed. Meanwhile, the absence of law is effectively very similar to the principle of absolute ownership.

The appropriation doctrine, widely used in the western states, has several features which contrast sharply with the basic principles of the riparian doctrine.[3] Under the appropriation doctrine there is no

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1 This tendency to protect the established user can be seen in several of the cases cited by Reis, op. cit., pp. 24-44. For additional information see: J. H. Beuscher, "Appropriation Water Law Elements in Riparian Doctrine States," Buffalo Law Review (Vol. 10, No. 3), Summer 1961, pp. 448-455.

2 Reis, op. cit., pp. 158-159.

3 Wells A. Hutchins and Harry A. Steele, "Basic Water Rights Doctrines and Their Implications for River Basin Development," Law and Contemporary Problems (Vol. XXII, No. 2), Spring 1957, pp. 276-300.

preference for use on land adjoining the water course. A water right is acquired through use. An appropriative right is for a particular quantity of water per unit of time and often relates to a specific time, rate, place, and method of diversion. In times of shortage senior rights have priority over junior rights.

Originally, appropriative rights were acquired simply through diversion and beneficial use. Each of the states recognizing the appropriation doctrine now has a statutory procedure for acquiring rights. The procedures usually involve an application to a state agency, a permit to initiate a new diversion, and a license or certificate after a beneficial use has been established. In some states the statutes specify an order of preferences based on the proposed use. These preferences usually relate only to conflicting applications pending before the state administrator at the same time. In some states municipalities can file claims for future use which can be reserved without current use.

The contrast between the riparian doctrine and the appropriative doctrine provides a convenient and challenging basis for comparative analysis. The relative merits of the two systems have been evaluated in several studies.[1] This analysis will be focused on features particularly relevant in Connecticut. On the other hand, consideration will be given to concepts not closely associated with either of these established doctrines.

1. Locational preferences

The strong preference for riparian uses is the most obvious inflexibility of the riparian doctrine. However, both legal interpretations and geographical factors must be considered in assessing the practical importance of limitations resulting from the preference for riparian uses.

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[1] For a collection of papers see: The Law of Water Allocation in the Eastern States, Papers and Proceedings of a Symposium held in Washington, D.C., October 1956, sponsored by the Conservation Foundation, edited by David Haber and Stephen W. Bergen (The Ronald Press Company, New York), 1958.

Papers focused on a comparative analysis include: Charles M. Haar and Barbara Gordon, "Legislative Change of Water Law in Massachusetts -- A Case Study of the Consequences of Introducing a Prior Appropriation System," pp. 1-48.

Clyde O. Fisher, Jr., "Western Experience and Eastern Appropriation Proposals," pp. 75-154.

S. V. Ciriacy-Wantrup, "Concepts Used as Economic Criteria for a System of Water Rights," pp. 531-564 (also in Land Economics, op. cit.).

Non-riparian uses have been allowed subject to the actual needs of riparians.

> Despite statements which may be found in the cases to the effect that any diversions by a non-riparian is unlawful, as a matter of practical construction the Connecticut courts have generally required a showing of injury by the complaining riparian proprietor before awarding either compensatory damages or an injunction to prevent future withdrawals. Therefore, rather than being "unlawful" and prohibited under any circumstances, the withdrawal of water by a non-riparian, or by a riparian for use on non-riparian lands, is under the practical construction of the courts a temporarily permissive withdrawal until a riparian can show damages.[1]

Some additional flexibility can be achieved through conveyance. "A riparian may convey his 'right' to the use of water to a non-riparian."[2] However, a conveyance is only a grant of permission. The grantee does not gain riparian status. A new use by an uncommitted riparian would have priority over an established non-riparian use. Physical uncertainty for the non-riparian can be eliminated only through procuring a release from all upstream riparians. A release from all downstream riparians would be necessary to avoid rule uncertainty. In most situations a non-riparian without condemnation power has little opportunity to obtain completely secure rights to the use of water through purchasing releases.

A non-riparian can gain rights to the use of water through prescription against downstream riparians. In Connecticut fifteen years of continuous use adverse to a riparian's right with no legal action by the riparian can result in a prescriptive right even if the riparian was not physically short of water for uses made during the period.[3] However, the possibility of gaining a prescriptive right after fifteen years is a weak basis for investment unless an alternative water supply is available.

Several geographical factors indicate that the uncertain status of non-riparian uses has not been a major obstruction to economic development in Connecticut. Most of the better agricultural land is in the river valleys where much of the land is riparian and where ground water resources are generally sufficient for supplemental irrigation. Moreover, much of the riparian land is not irrigated. There is no shortage

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1 Reis, op. cit., p. 44.

2 Ibid., p. 46.

3 Ibid., pp. 82-87.

of riparian sites for industry. Establishment of a large water-using industry away from the water course would require expenditure for rights-of-way and construction of conveyance facilities. Industries using small or moderate amounts of water can select a location either with a public water supply or with adequate ground water resources.

The locational inflexibility of the riparian doctrine probably creates some inconvenience and should be removed in the course of a major revision of water rights law. Of its own accord the economic consequences of the existing preference for riparian uses do not merit the effort of a basic redefinition of water rights in Connecticut.

2. Common law protection against pollution

Private property rights can be effective in providing protection against pollution only to the extent that the loss resulting from a particular source of waste can be clearly identified. Unfortunately, the identification of loss from individual sources is almost impossible where waters receive wastes from numerous outfalls. The potential role of civil suits in pollution control is further limited by the dispersion of damages among many existing and prospective water users. General progress in pollution control is dependent upon financial assistance to municipalities and regulatory action. However, these more direct public activities can be supplemented through private suits provided rights are sufficiently well defined.

In 1858 a Connecticut court ruled that a landowner depositing waste on his land was not liable for pollution of a neighbor's well if the wastes were washed into the ground and commingled with subterraneous streams or currents before entering the well.[1] The court went on to note that the liability would be created if the wastes were washed along the surface and into the well or if they soaked into the ground and entered the well without mingling with the underground streams or currents supplying the well.

A more recent case involved the pollution of a well by gasoline of a type stored in an underground tank across the street from the plaintiff's well.[2] The plaintiff was awarded the full cost of drilling and

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1 Reis, op. cit., pp. 159-163.

2 Arthur J. Blais, et al., The Callahan Oil Company, Court of Common Pleas, Windham County, File No. 922 (18 Conn. Suppl.), case completed and filed October 21, 1952.

equipping a new well on another part of his property. The court noted that the liability of the defendant did not depend in any way on proven negligence. In this case the court did not attempt to distinguish between pollution of percolating water and pollution of water in underground streams.

The right of a riparian proprietor to compensation for damages resulting from waste discharges by a municipality was clearly established in four decisions between 1892 and 1904.[1] Claimed riparian and prescriptive rights to pollute were both denied. Similar claims of pollution rights by a private riparian were denied in 1910.[2]

One Connecticut decision could be interpreted as upholding the right of a riparian to cause injurious pollution at least within a particular situation.[3] The plaintiff, a dye producer, brought suit to enjoin the defendant from continuing to discharge metallic wastes into a stream formerly used as a water supply by the plaintiff. The dye producer claimed that declining water quality had forced the company to purchase water from other sources. As summarized by Reis "The court held that since the defendant had done everything within its power to treat the water before it was returned to the stream its discharge was a reasonable use under the circumstances."[4] In analyzing the case Reis notes that several factors bearing in the decision should be considered:

> First, the defendant was engaged in war production during a period of emergency. Second, there had been an increase in both manufacturing and urban population density along the stream--both invariably contributing to the overall quality of the water. Finally, the plaintiff had not been totally deprived of water for the production and manufacture of supplies, but was able to secure water from the Stamford Water Company;...[5]

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1 One exception during this period allowed a city in a particular situation to acquire a right to pollute based upon the silence of a riparian proprietor. Reis, op. cit., pp. 70-74.

2 Ibid., p. 50.

3 Stamford Extract Manufacturing Company v. Stamford Rolling Mills Co., 101 Connecticut 310; 125 At 1.623 (1924) as cited by Reis, op. cit., pp. 50-51.

4 Reis, op. cit., p. 51.

5 Ibid.

An injunction against the defendant would have created an unnecessary hardship and would have resulted in an inefficient allocation of resources. However, an award of damages equal to the additional cost of purchasing water would have been consistent with established principles of equity and would have encouraged the defendant to continually seek more effective methods of reducing the amount of waste discharged.

The extent to which initiation of private suits against waste dischargers has been discouraged by the decision in "Stamford Extract Manufacturing Company v. Stamford Rolling Mills Company" is open to speculation. The special circumstances of the case, the later ruling on damages from ground water pollution, and increased public concern over pollution, limit the probable influence of the decision on the results of a future case. Legal research is needed to determine the extent to which riparians have been influenced by the decision. Either substantial evidence that the decision is discouraging action by riparians, or a future decision excusing injurious pollution on the grounds of treatment by known techniques would create a clear need for legislation defining the rights of riparians to protection against damages from waste discharges.

3. Consumptive use

Limitations of the riparian doctrine in efficiently allocating and reallocating water among consumptive uses have been well established.[1] With competing consumptive uses there would be little security in a coequal right unless established uses were protected to the point of little flexibility. Allocation would depend on a judicial determination of the reasonable use of each riparian in relation to the total supply. With competition among consumptive users there would be little opportunity for achieving a reallocation through market transfers. Purchase of a release from one riparian would not protect the grantee from increased

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[1] Ciriacy-Wantrup, "Concepts Used as Economic Criteria for a System of Water Rights," op. cit.

Jack Hirshleifer, James C. DeHaven, and Jerome W. Milliman, Water Supply: Economics, Technology, and Policy (The University of Chicago Press, 1963), pp 231-245.

Frank J. Trelease, "A Model State Water Code for River Basin Development," Law and Contemporary Problems (Vol. XXII, No. 2), Spring 1957, pp. 301-322

use by other riparians. With keen competition for the available supply the court would have to periodically reevaluate established uses in relation to each other and to proposed new uses. Flexibility would be achieved only through uncertainty.

In establishing a perspective on the likelihood of serious water rights problems associated with consumptive use in Connecticut a distinction must be made between water purchased from public purveyors and water withdrawn on the basis of riparian rights. A diversion for public water supply is not a riparian use, and the entire amount diverted is lost for at least a substantial length of the stream regardless of the eventual use. A distinction between the two sources does not mean that attention can be limited to consumptive loss from water diverted by riparian users. Many industrial firms use water from both company owned systems and public water supplies. Some firms discharge waste water both to sewers and directly to natural waters.

A complete survey of industrial water use is made by the United States Bureau of the Census at five-year intervals. Data in Table 1 is the most recent available. Net loss plus discharge to public sewers amounted to 22 billion gallons in 1964. Purchases of 28 billion gallons from public water purveyors do not indicate an augmentation of natural fresh waters since an unknown amount of originally fresh water was discharged into brackish waters.

Data on sources of water for agricultural irrigation in 1960 are the most recent available. The United States Bureau of the Census survey of 1960 irrigation practices included only farms reporting irrigation in the 1959 Census of Agriculture.[1] Of the 173 farms reporting irrigation, 117 farms reported ownership of a total of 241 constructed reservoirs.[2] Unfortunately, there is no data on the size of reservoirs or on the acreage irrigated from stored water. Data on the source of water, summarized in Table 2, cannot be related to the use of reservoirs.

The acreage of farmland irrigated in Connecticut varies widely from year to year in response to weather conditions. Acreage irrigated in agricultural census years is reported in Table 3. Under Connecticut

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1 U. S. Bureau of the Census, "U. S. Census of Agriculture: 1959, Volume V, Part 2, Irrigation in Humid Areas" (U. S. Printing Office, Washington, D. C., 1960), p. X.

2 Ibid., p. 13.

TABLE 1

Fresh Water Intake and Discharge
by Industry in Connecticut -- 1964[a]

(billion gallons per year)

Water Intake		
From company water systems		49
surface 42		
ground 7		
From public water systems		28
	Total intake	77
Water Discharge		
Public sewer		15
Surface water		54
Subsurface systems		1
	Total discharge	70
	Water loss	7

[a] U. S. Bureau of the Census, "Census of Manufacturers, 1963, Volume 1, Summary and Subject Statistics," (U. S. Printing Office, Washington, D. C., 1966), pp. 10-96 and 10-97, except for corrections based on information from William R. Gray, Industry Division, U. S. Bureau of the Census, U. S. Department of Commerce. The large consumptive use indicated by the published data result from an error in compiling data on water discharged by industries in the chemicals and allied products group. Industries in this group discharged 28 billion gallons to surface water rather than nine billion as reported. The data in Table 1 are adjusted to correct this error. The data were also adjusted to exclude brackish water from discharges. It was assumed that all of the 68 billion gallons of brackish water, reported on page 10-96, was discharged to surface water.

TABLE 2

Acreage of Connecticut Farmland Irrigated
by Source of Water -- 1960[a]

Source	Acres
Wells	218
Natural streams and rivers	2,516
Springs and seepage	979
Farm runoff	124
Natural lakes and ponds	325
Drainage ditches	7
Municipal water systems	224
Total	4,393

[a] "U. S. Census of Agriculture: 1959, Volume V, Part 2, Irrigation in Humid Areas," op. cit., p. 12. Note: The survey of 1960 irrigation practices included only farms reporting irrigation in the 1959 Census of Agriculture.

TABLE 3

Acreage of Farmland Irrigated in Connecticut[a]

Year	1,000 Acres
1939	1
1944	*
1949	8
1954	12
1959	5
1964	14

* less than 500 acres

[a] U. S. Department of Agriculture, "Agricultural Statistics, 1969" (U. S. Government Printing Office, Washington, D. C., 1969), p. 431.

climatic conditions most farmers have chosen to invest in irrigation equipment only for use on crops of relatively high economic value.

The small amount of consumptive use in Connecticut is not a completely sufficient basis for concluding that there would be no advantage in shifting toward a system more adapted to allocating water among competing consumptive uses. At least to some extent, the small amount of consumptive use could be the result of uncertainty about water rights. Absence of frequent litigation does not prove that use is not restricted by fear of litigation. Fortunately, a hypothesis that use is restricted substantially by uncertainty can be tested against observations on the pattern of water use. If there were substantial fear of litigation, industries with relatively high percentages of consumptive loss could be expected to use public water supplies to a greater extent than industries with little consumptive use. This pattern is not reflected in data on industrial water use in Connecticut.[1] Available data indicate that acreage of farmland irrigated has varied with the need for supplemental irrigation rather than with the supply of water. Of the years for which data are available the most extensive irrigation occurred in 1964, a year of severe drought by Connecticut standards.[2] These water use patterns are not consistent with the hypothesis that consumptive uses are restricted by fear of litigation.

Questions pertaining to the adequacy of water supplies and uncertainty about water rights were included in a 1957 survey of irrigation practices in Connecticut.[3] The survey included 167 farmers practicing irrigation in 1957, which had an extremely dry growing season. Thirteen farmers considered that their water use had been restricted by competing uses.[4] Of the 167 farmers 22 had investigated legal rights to water; five reported past, current, or expected challenge of water rights;

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1 U. S. Bureau of the Census, "Census of Manufacturers, 1963, Volume 1, Summary and Subject Statistics," op. cit., pp. 10-96 and 10-97.

2 Byron E. Janes and Joseph J. Brumbach, "The 1964 Agricultural Drought in Connecticut" (Agricultural Experiment Station Bulletin 390, June 1965, University of Connecticut), 22 pp.

3 Horace L. Puterbaugh and Marvin W. Kottke, "Technical and Economic Characteristics of Irrigation on Connecticut Farms" (Agricultural Experiment Station Bulletin 340, March 1959, University of Connecticut), 42 pp.

4 Ibid., p. 15.

sixteen had a verbal agreement with others using water from the same source; and two had a written agreement.[1] The results of the survey do not indicate a major concern about uncertainty of water rights.

Foreseeable consumptive use in Connecticut is not sufficient to merit adoption of a water rights system focused primarily on water allocation. Common-law water rights can be supplemented with stream flow protection and ground water management policies without a complete redefinition of water rights. Moreover, such policies can include diversions and extractions for public water supply as well as withdrawals based on private property rights.

A substantial increase in demand for consumptive use would increase the need for more effective use of market processes in water allocation. More direct use of a pricing system would not necessarily involve a shift toward appropriative rights. An efficient allocation could be encouraged through fees on withdrawals from natural sources with the funds used to augment available supplies through storage and ground water recharge. Such activities could be administered through regional authorities or districts.

4. Recreational and environmental uses

Uncertainty about property rights and dispersion of losses among numerous property owners have limited the ability of riparians to protect recreational uses and environmental values. The limitations of civil suits in providing protection against pollution from multiple sources are compounded when damage is dispersed among many noncommercial users. Even in the rather simple situation of a substantial reduction in flow by a single party the downstream losses in recreational and scenic values have taken the form of external costs.

The generally unrestricted powers of municipalities and privately owned water companies to develop supplies leave riparians little opportunity to protect in-stream uses. Since riparian owners can collect only nominal damages for recreational and scenic losses resulting from diversions for public water supply, there is no way for riparian owners to create an economic incentive for water companies to provide flow releases for these purposes. Moreover, rights to even nominal damages from established diversions probably have been lost through prescription in most cases.

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[1] Ibid.

Wide fluctuations in flow and extremely low flows result from peak load generation at hydroelectric stations. Data in Tables 4 and 5 are from a gaging station 0.4 miles downstream from the Farmington River Power Company dam. Both days of extremely low flow (Table 4) were Sundays when power demands are relatively small.

Under Connecticut law, detentions for power production are clearly dominant over recreational and scenic uses. When water power even on small streams was vital to the economy, maximum power during normal working hours was the primary objective. In an exhaustive review of case law in Connecticut, Reis found no case where riparians even attempted to protect recreational uses against detentions.[1] Considering the usual definition of prescriptive rights there seems to be little chance for increasing demands for recreational uses to be reflected through claims based on riparian rights.

Interesting methods of protecting environmental uses have been developed in some western states. While an appropriative right is based on diversion and use, most states recognizing appropriative rights authorize the responsible administrative agency to deny applications contrary to the public interest. By statute Oregon has excluded from appropriation the water of some streams to preserve fish life and scenic attractions. Some states allow administrative agencies to withdraw water from availability for appropriation for a variety of purposes, including preservation of scenic values and in-stream uses.[2] These approaches operate through control over the initiation of new uses. Water use in Connecticut has already developed to the point where public controls exempting established uses would be of limited significance.

5. Status of water rights

This analysis has produced no economic basis for recommending the adoption of a system of quantitatively defined water rights in Connecticut. Major opportunities for controlling external costs and

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[1] In one case a riparian owner was able to limit diversions from a pond for power to the extent that the bottom not be exposed in such a manner as to create offensive sights and odors, Reis, op. cit., p. 43.

[2] For two somewhat contrasting perspectives on the effectiveness of these methods of protecting environmental uses see: Fisher, "Western Experience and Eastern Appropriation Proposals," op. cit., pp. 129-132; and Trelease, "A Model State Water Code for River Basin Development," op. cit., pp. 317-318.

TABLE 4

Flow in the Farmington River at
Rainbow, Connecticut -- September 1967[a]

Date	Ave. Discharge c.f.s.	Date	Ave. Discharge c.f.s
1	395	16	110
2	262	17	189
3	127	18	253
4	145	19	323
5	252	20	199
6	269	21	256
7	445	22	158
8	242	23	166
9	203	24	22 (Sunday)
10	24 (Sunday)	25	204
11	267	26	66
12	186	27	295
13	131	28	281
14	142	29	493
15	147	30	436

[a] U. S. Geological Survey, Water Resources Division, U. S. Department of the Interior, "Water Resources Data for Connecticut--1967" (Hartford, Connecticut, 1968), p. 53.

TABLE 5

Flow Pattern of the Farmington River at
Rainbow, Connecticut -- September 30, 1967[a]

Time	Discharge c.f.s.	Time	Discharge c.f.s.
2 a.m.	24	2 p.m.	180
4 a.m.	23	4 p.m.	24
6 a.m.	23	6 p.m.	21
8 a.m.	23	8 p.m.	21
10 a.m.	1,990	10 p.m.	20
12 m.	1,960	12 p.m.	20

[a] Unpublished records of the U. S. Department of the Interior, Geological Survey, Water Resources Division, Hartford, Connecticut.

physical uncertainties from waste discharges and diminutions of flow are in the area of public regulation rather than property rights. There is no indication that expanded regulation would create rule uncertainty in excess of that which would be created by a redefinition of property rights. With regulatory protection of flow and quality, an evolving concept of reasonable use (expanded to include ground water extractions) should be a sufficient basis for settling specific conflicts over private water rights.

C. Stream Flow and Ground Water Management

Several elements of public interest in stream flow protection and management have been established. Riparian owners have little practical opportunity to protect in-stream uses from detentions and depleting diversions. Many environmental uses are related to public recreation areas including numerous streams on which the State has procured public access rights for recreational fishing. Effective water quality management requires coordinated control over stream flow and waste discharges.

To date there has been little need for public management of ground water withdrawals in Connecticut. There has been no long-run decline in ground water levels. There are opportunities for expanded use of ground water resources in many parts of the state; however, the current trend toward relatively greater use of ground water could be accelerated by stream flow protection policies. With increasing use of ground water new forms of public policy will be needed for effective use of underground storage without excessive impact on low stream flow conditions.

Public policies in water resources management involve a complex interweaving of regulation and direct public activities. In developing general economic criteria for evaluating water law there was a clear distinction between protection of natural flows below a specified level through regulation, and low-flow augmentation at public expense. There are exceptions to this pairing of function and method. Prior to 1963 the Metropolitan District Commission was required to both release a minimum flow of 50 c.f.s. at all times and pass natural flows up to 150 c.f.s. . Looking to the future, the political feasibility of regulatory protection of low natural flows may be enhanced by the construction of multiple purpose reservoirs with capacity for storage from high flows for both low-flow augmentation and sales to downstream users. Thus, the relationship of riparian rights to the operation of State- and federally-owned

reservoirs will be considered prior to the development of recommendations pertaining to regulatory protection of low natural flows.

1. Public storage for flow management

State authority needed to facilitate state and federal low-flow augmentation activities has been identified by Kendall in a study sponsored by the New England Interstate Water Pollution Control Commission.[1] Based on an extensive analysis Kendall made the following recommendations:

> For purposes of stream flow regulation and augmentation, as contemplated in this study, no great modification of the riparian doctrine is needed. It is submitted that statutes enacted to effect the following principles would provide sufficient basis for stream flow regulation and augmentation:
>
> 1. No action shall be brought to recover damages or to enjoin an upstream storage or diversion of stream flow, unless actual harm is done to the plaintiff's riparian estate.
>
> 2. The Water Resources Commission, or similar state agency, shall be empowered to order releases of water in reasonable quantities from storage facilities for stream flow augmentation. Reasonable compensation for the value of the released waters shall be paid to the proprietor of the facility.
>
> 3. The Water Resources Commission, or similar state agency, shall be empowered to participate in regional planning and the operation of multiple-purpose water storage facilities, and to order the transfer of water between watersheds and river basins in the public interest, and to engage in interstate transfers.
>
> 4. The Water Resources Commission, or similar state agency, shall be empowered to detain, divert and store for public purposes, water flowing in watercourses within the state, upon payment of reasonable compensation for property or interests actually harmed thereby. Thereafter, title to waters so stored shall be in the public and such title shall be retained when the waters are released for stream flow augmentation, for transfer to another storage facility, or for other public purposes. No proprietor of a flow regulation structure shall detain public waters being transferred by order of the Water Resources Commission.[2]

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[1] Kendall, James H., "Water Law: Streamflow Rights in New England and New York State" (published by New England Interstate Water Pollution Control Commission, Boston, Massachusetts), November 1967 (47 pp.)

[2] Ibid., p. 31.

These recommendations are consistent with the previously discussed economic criteria. However, a broader range of flexibility in water management could be assured by expanding these recommendations to specifically authorize the sale of publicly stored water for private use. This authorization would permit greater flexibility in water use and would facilitate regulatory protection of low natural flows.

Many of the economic decisions pertaining to low-flow augmentation are in the area of benefit-cost analysis.[1] The benefits and costs of providing storage capacity for low-flow augmentation and for other uses such as flood control, water supply and recreation must be evaluated in relation to available reservoir sites. However, many of the benefits associated with recreational uses and environmental protection cannot be readily measured through market values. In some situations monetary values of non-market uses can be estimated indirectly on the basis of the lowest cost of achieving the same objective by other projects or procedures. Assuming that the lowest cost alternative is considered, the validity of the process depends on the acceptability of the original objective. The key decisions in estimating benefits through the alternative cost method are very similar to those in setting objectives for regulatory protection of flow and quality.

2. Stream flow objectives

The process of setting objectives for a stream flow protection policy should include: a determination of the cost of protecting various flow levels, an identification of the flows needed for particular uses, and a determination of the economic and social evaluation of the potential uses. Public reaction to specific proposals can provide a rough

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[1] Some new approaches in benefit-cost analysis have been recently suggested. The central recommendation is to begin an analysis with explicit recognition of multiple social objectives such as economic efficiency, regional economic stimulation, and income redistribution. Particular project alternatives can then be evaluated in relation to each objective. The final decision would involve a weighting of the objectives through the political process. For information on this approach see: Robert J. Kalter, et al., "Criteria for Federal Evaluation of Resource Investments" (Water Resources and Marine Sciences Center, Cornell University), August 1969, 11 pp.

For an extensive bibliography on earlier studies see: Hinote, Herbert, "Benefit-Cost Analysis for Water Resource Projects: A Selected Annotated Bibliography (revised edition)" (Center for Business and Economic Research, University of Tennessee, Knoxville, Tennessee), June 1969.

index of social values. Some perspective on the process of objective formulation and on the range of possible objectives can be gained from a brief review of some existing flow objectives and current planning activities.

In setting water quality standards for Connecticut the Water Resources Commission gave specific recognition to the impact of low flow conditions on stream quality. "The minimum average daily flow for seven consecutive days that can be expected to occur once in ten years shall be the minimum flow to which the standards apply."[1] This limit is based on actual flow. Thus, an increase in depleting diversions from a stream would require either a reduction in the maximum permissible discharge of waste or a lowering of the stream classification.

Minimum flow objectives for the main stem of the Connecticut River have been proposed by the Connecticut River Basin Coordinating Committee:[2]

> Adequate minimum flows are essential to the ultimate achievement of the goals of the anadromous fishery program. Preliminary analysis of natural flows in the Connecticut Basin streams indicates that, from a fishery viewpoint, the instantaneous minimum flow release at main stem dams along the Connecticut River should be 0.25 cubic feet per second for each square mile of drainage area upstream from the dam in question.
>
> The coordinating Committee for the Comprehensive Study recognizes this need for adequate minimum flows and has recommended that a minimum instantaneous release of 0.20 csm (cubic feet per second per square mile) be maintained at five existing main stem power dams with the remaining flows to be provided by releases from new and existing tributary reservoirs.[3]

The reservation of minimum flows is a major element of state water policy in Iowa. Under legislation passed in 1957 the Iowa Natural Resources Council has the power and duty to plan and regulate (within

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1 "Water Quality Standards," State of Connecticut, Water Resources Commission, Hartford, Connecticut, 1968 (30 pp. + maps), p. 5.

2 This committee is composed of representatives from six Federal agencies, the four basin states, and the New England River Basins Commission.

3 "Comprehensive Water and Related Land Resources Investigation -- Connecticut River Basin -- Information for Public Hearings," Connecticut River Basin Coordinating Committee, Waltham, Massachusetts, January 1970 (81 pp.), p. 42.

limits) the use of water.[1] Except for specified unregulated uses, a permit must be obtained for withdrawing water from any natural source. The Council is required to limit permits to protect the "established average minimum flow" for each water course.[2] The statute also instructs the Council to establish the average minimum flow (protected flow) on the basis of average minimum daily flows in preceding years and the minimum flow needed to protect the public interest. After extensive study and consultations the Council adopted a general policy of setting the protected flow for each stream at the level equaled or exceeded 84 per cent of the time between April and September in past years determined to be most representative of normal conditions. In applying the 84 per cent standard, adjustments were made to account for particular characteristics and uses of each stream.[3]

Much of the information needed for setting flow objectives in Connecticut should become available through a current planning project. In 1967 the General Assembly instructed the Water Resources Commission, the State Department of Health, the State Board of Fisheries and Game, and the Connecticut Development Commission to jointly prepare a state-wide, long range plan for the management of the water resources.[4] The Act authorized bond sales of $1,500,000 to finance the planning project. While the Act does not refer directly to stream flow objectives, there is clear instruction to consider all water uses, including recreation. Thus, some form of recommendations pertaining to flow preservation and maintenance can be expected. These recommendations could serve as the basis for legislative policy. More specific operating objectives could be set by the agency made responsible for administration.

3. Implementation and administration

The Water Resources Commission appears to be the appropriate agency to implement and administer a stream flow and ground water protection

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1 Hines, N. William, "A Decade of Experience under the Iowa Water Permit System -- Part One," Natural Resources Journal (Vol. 7, No. 4), October 1967, pp. 499-554.

2 Ibid., p. 538.

3 Ibid., p. 541.

4 "An Act Concerning Long Range Water Resources Planning" (Connecticut Public Act No. 477, 1967, General Session).

policy. Specific flow objectives should be closely related to water quality objectives and to potential public and private uses. Moreover, the Commission has extensive data on industrial water use and sources of supply as well as waste discharges.

Implementation of a comprehensive water management program would require authority to regulate both new and existing detentions and diversions of stream flow and ground water extractions. Regulatory authority could be created through a statutory definition of public interest analogous to that in the statutes which authorize the Water Resources Commission to regulate the discharge of wastes to natural waters.[1] Regulatory authority should cover both public water purveyors and parties developing supplies on the basis of private rights. Regulation to protect a defined public interest would not involve a redefinition of water rights. Regulations would take effect through limiting the exercise of both property rights and condemnation powers.

Administration of a regulatory program would involve some form of permit system. Detentions, diversions, and extractions below some established minimum could be exempted from regulation for administrative convenience and economy.[2] Water use intensity varies regionally and through time; thus, there would be practical advantage in allowing the responsible administrative agency some discretion in specifying the maximum use to be exempt from regulation. Since the program would be new and there would be an immediate need to consider all major uses, permits should be required for established as well as new uses. Permits to established users should include a schedule for accomplishing steps necessary in adjusting operations to allow free passage of the protected flow or to reduce ground water extractions from an overdrawn area. In establishing schedules, time should be allowed for constructing storage facilities, developing alternative sources of power, or developing alternative sources of water as the case may be. This scheduling could be similar to that currently in use for orders to abate existing sources of water pollution. Administrative procedures regarding the term of

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1 (Connecticut Public Act No. 57) op. cit., Section 1.

2 The permit system implementing the Iowa stream flow protection policy exempts from regulation uses of less than 5,000 gallons per day. Hines, op. cit., p. 508.

permits and provisions for hearings and appeals could also be similar to those for discharge permits and pollution abatement orders.[1]

As envisioned in this report the objective of the permit system would be to protect specified stream flows. This protection should be provided with a minimum of involvement in the process of allocation among depleting users. The Iowa permit system has been carefully designed to avoid involvement in this allocative process. However, success in avoiding the allocation issue stems, at least in part, from the fact that uses within municipal corporations at the time of the legislation are exempt from regulation. With this exemption, irrigation was the only major depleting use immediately subject to regulation. Among the regulated uses there are no priorities based on the date of initial use, the date of the permit, or the type of use.

Administration of the Iowa system involves the definition of an equivalent protected flow at each point of withdrawal in relation to the protected flow at a downstream gaging station. A summation flow rule has been developed for protecting stream sections with more than one consumptive user. Under the summation flow rule the cutoff point for each consumptive user is the equivalent protected flow plus the sum of all other permitted consumptive uses from a particular stream section. The Commissioner allows use below the summation flow level only if all users along a stream section enter into a sharing agreement which assures preservation of the protected flow.[2] The formation of sharing agreements is left entirely to the permit holders. If one user should attempt to hold out for a particularly large share of the difference between the summation flow level and the protected level the other users could presumably force a settlement on the basis of riparian rights. Since the permit system relates to both detentions and direct withdrawals for immediate use, the sharing agreement could include the timing of detentions and of withdrawals for off-stream storage.

The use of cutoff points does not imply an actual rationing of water. Sufficient notice to allow time for construction of storage facilities or development of alternative supplies is a basic element of the proposal for Connecticut. Protected flows, summation flow levels,

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1 (Connecticut Public Act No. 57) op. cit., Sections 7-17.

2 Hines, op. cit., pp. 542-544.

sharing agreements, and cutoff points would become fundamental considerations in planning storage requirements. Expanded opportunities to purchase stored water from state or federally owned reservoirs could facilitate implementation of a stream flow protection policy.

A permit from the Water Resources Commission should be required prior to drilling of a well with anticipated capacity as great as the rate of extraction covered by use permits.[1] While there are opportunities for increased ground water withdrawals in many parts of the State, the location of high-capacity wells should be carefully selected in order to utilize underground storage without excessive impact on low stream flow conditions. Increasing demands for water and declining availability of sites for surface storage can be expected to generate a growing need for more effective management of natural underground storage capacity. Beyond planned well location, management could be intensified through coordinated timing of withdrawals from different parts of a basin and from the streams associated with the basin.

Other potential ground water management practices include artificial recharge with cooling water or with local or imported surface supplies when available in quantities beyond immediate needs. Ground water replenishment districts with authority to assess ground water extractions to finance replenishment activities are making substantial contributions toward effective water resources management in California. If the need arises similar districts could be formed in Connecticut.[2] A combination of ground water replenishment and assessments on extractions would both augment natural supplies and encourage users to seek alternative sources. Thus, actual rationing could be on an economic basis with permits providing an element of coordination.

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[1] This permit could be either in addition to or in place of permits currently required to collect geological information and regulate the well drilling industry. "An Act Concerning the Conservation of Underground Water Resources, and the Protection of the Public Health and Safety by the Creation of a State Well Drilling Board to Implement Well Drilling Practices" (Connecticut Public Act No. 659, 1967, General Session).

[2] It should be noted, however, that the formation of ground water replenishment districts in California involved considerable controversy and delay. Some of the California experience should be helpful in Connecticut. See: Robert L. Leonard, "Integrated Management of Ground and Surface Water in Relation to Water Importation: The Experience of Los Angeles County" (Giannini Foundation Research Report No. 279, University of California, Berkeley), October 1964.

Even after allowing time for construction of storage facilities and procurement of alternative supplies an absolute rule against any infringement of protected stream flows could create extreme hardships. Moreover, an absolute rule probably would not be enforced. In the event of an actual shortage public water supplies and other economically valuable uses are not likely to be substantially curtailed in order to maintain stream flow. Practical enforcement powers should strongly encourage the development of storage facilities prior to actual shortages. This encouragement could be provided through a predetermined system of fines for infringements of protected flows. Of course, the penalties would have to be sufficiently high to make compliance more economical than the fine. Penalties should apply to all infringements without exception.

4. Impact on water users

In considering the impact of a flow protection policy on water users it should be noted that restrictions on diversions and detentions would be increased only to the extent that the protected flow exceeded obligations based on riparian rights. Thus, the impact would vary inversely with the extent of existing obligations. The necessity of actual adjustments in water use or supply would also vary with the relationship of use to supply. A minor restraint on water management policies would be the only impact on users with supplies in excess of actual use. Less fortunate parties could modify use or expand supplies in a variety of ways. Basic approaches could include: reductions in use; re-regulation of flow; and development of supplemental supplies. Choice of method could be left to the individual user.

Reductions in use would probably be the primary method of adjustment for uses of low economic value. As many farmers do not irrigate forage crops from available water supplies, there would presumably be little investment for supplemental supplies by those currently irrigating these crops. Potential power production at some of the smaller hydroelectric stations would not warrant investment in afterbays to re-regulate fluctuations in flow.[1] At some of these small stations passing the protected

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[1] Of the fifteen hydroelectric stations in Connecticut, six have a generating capacity of 800 kilowatts or less. Source: Fifty-sixth Annual Report of the Public Utilities Commission, State of Connecticut (Hartford, 1968), p. 93.

flow at all times would probably result in either operation only during seasons of relatively high stream flow or a complete cessation of operation. Manufacturers detaining flow nights and weekends for use during working hours could reduce detention requirements through increased recirculation, which would have the external effect of a reduction in use.

Re-regulation of flow would likely be the most economical approach for detentions of substantial volume. Afterbays should be as near the point of use as practical. Acquisition of needed land and rights-of-way for developing the most appropriate sites could be difficult in the absence of condemnation powers. This authority could be created through an amendment to the existing statutes which provide a form of condemnation power for parties wishing to develop a mill site.[1]

Many users requiring supplemental supplies would qualify for assistance under one or more of the numerous federal programs related to water supply. Both the Corps of Engineers and the Soil Conservation Service are authorized to provide storage capacities for water supplies in multiple-purpose projects. Participants in these projects benefit from the economies of size in construction and from low interest charges. No interest is charged on the cost of water supply storage until the supply is first used provided the interest-free period does not exceed ten years.[2] The Soil Conservation Service offers technical assistance without charge to farmers planning to expand water supplies. The Agricultural Stabilization and Conservation Service of the United States Department of Agriculture pays 50 per cent of construction costs for farm ponds provided the primary purpose is not to bring additional land into production through irrigation.[3] Both loans and grants for water

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1 Connecticut General Statutes (Rev. 1958), Sec. 52-446 through 455.

2 For additional information on the authority of the Corps of Engineers to enter into water supply contracts see: "Water Supply Act of 1958, Title III of Public Law 85-500," July 3, 1958 (85th Congress, 2nd Session). The Soil Conservation Service has similar authority to develop water supplies on watersheds up to 250,000 acres in size. See: "Multiple-Purpose Watershed Projects Under Public Law 566," Soil Conservation Service, U.S. Department of Agriculture (PA-575), May 1963, 13 pp.

3 Agricultural Stabilization and Conservation Service, U.S. Department of Agriculture, "Agricultural Conservation Program, Connecticut Handbook for 1968" (ACP - 1968 - Conn.), March 1968, p. 13.

supply are also available under numerous federal programs not specifically oriented toward the development of water supplies.[1]

A stream flow protection policy would create some rule uncertainty for the regulated users during the establishment of flow objectives and sharing agreements. However, once these policies were established future adjustments to share with new users would be on the basis of riparian rights. With an established system rule uncertainty for the regulated users and physical uncertainty for all users could be held to a low level through maintenance of rather stable flow protection objectives. While a particular level of flow protection is subject to debate, at least some regulatory limit on diversions and detentions appears to be clearly justified.

D. Pollution Control

Pollution control efforts by both the Federal Water Pollution Control Administration and the Water Resources Commission are composed of three basic parts, determination of water quality objectives, financial assistance, and regulatory activities. The relationships among these activities are somewhat less direct than might be presupposed. The regulation of individual waste discharges are usually based on treatment standards rather than stream quality objectives. Neither federal nor State regulatory powers are dependent upon the existence of the cost-sharing programs. However, compliance with regulatory orders is necessary for receipt of financial assistance.

1. Quality objectives

Criteria for setting water quality objectives or standards, and the role of such standards, have been the subject of considerable debate since passage of the Federal Water Pollution Control Act of 1965.[2] The Act requires that quality standards be set for all interstate waters (including coastal waters), and that standards and plans for implementation

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1 Office of Economic Opportunity, "Catalog of Federal Domestic Assistance" (Information Center of OEO), January 1969, 610 pp.

2 Federal Water Pollution Control Act, op. cit., Sec. 10.

and enforcement be filed with the Secretary of the Interior.[1] Failure by a state to comply with the requirements of the Act results in authority for direct action by the Secretary. Moreover, the Secretary is responsible for determining if standards comply with the following criteria:

> Standards of quality established pursuant to this subsection shall be such as to protect the public health or welfare, enhance the quality of water and serve the purposes of this Act. In establishing such standards the Secretary, the Hearing Board, or the appropriate State authority shall take into consideration their use and value for public water supplies, propagation of fish and wildlife, recreational purposes, and agricultural, industrial, and other legitimate uses.[2]

Except for an emphasis on enhancement of water quality, the Act gives little guidance in setting the quality objective for a particular stream.

Additional criteria for establishing water quality standards were provided by the Federal Water Pollution Control Administration.[3] Unfortunately, the two most specific criteria have been of little assistance in achieving the overall objectives. The guidelines as revised in 1967 specify that no standards providing for less than existing water quality will be acceptable.[4] A strict enforcement of this requirement would have, more or less, closed large areas of some states to any urban or industrial development. Strong reaction against this absolute rule of no degradation resulted in a progressive softening of the requirement. On February 8, 1968, the Secretary of the Interior agreed that a lowering of quality would be permitted if justified to both the state involved and the Department of the Interior.[5] The requirement of federal approval for

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1 When the Act was passed in 1965, the Secretary of Health, Education and Welfare was responsible for administration. Authority and responsibility under the Act was shifted to the Secretary of the Interior on May 10, 1966. Source: "Reorganization Plan No. 2 of 1966," Appendix A, Federal Water Pollution Control Act, op. cit., p. 1.

2 Federal Water Pollution Control Act, op. cit., Sec. 10(c)(3), p. 16.

3 Federal Water Pollution Control Administration, U. S. Department of the Interior, "Guidelines for Establishing Water Quality Standards for Interstate Waters" (originally issued May 1966, revised January 1967).

4 Ibid., item number 1, under Policy Guidelines (pages not numbered).

5 Rocky Mountain Mineral Law Newsletter, Water Law, Special Pollution Control Issue, Vol 11, No. 7, October 1968. (The Water Law Newsletter is compiled and edited by the Water Law Center, University of Wyoming and published by the Rocky Mountain Mineral Law Foundation, University of Colorado, Boulder), p. 2.

each lowering of quality met strong opposition from many states and from the United States Chamber of Commerce.[1] The Rocky Mountain Mineral Law Newsletter reports that "state water quality standards have been approved which contain statements that high quality waters will not be lowered in quality unless such change is justified to the state pollution control agency alone. Federal concurrence is not required."[2] The unrealistic standard of no lowering of quality in the earlier guidelines may have been a major factor in arousing opposition to federal control over degradation.

The other specific requirement in the guidelines issued by the Federal Water Pollution Control Administration prohibited use of a stream for the principal purpose of waste disposal. "No standard of water quality will be approved which provides for the use of any stream or portion thereof for the sole or principal purpose of transporting wastes."[3] Even with improved treatment, waste disposal will continue to be the principal use of at least sections of some streams. A more realistic perspective would be helpful in planning the location of future outfalls and in setting standards to protect public health and prevent nuisances in neighborhoods near the stream sections receiving large quantities of waste.

Despite the emphasis on stream standards based on potential water use, much of the actual guidance in setting stream standards seems to have come from the guidelines relating directly to treatment levels.

> No standard will be approved which allows any wastes amenable to treatment or control to be discharged into any interstate water without treatment or control regardless of the water quality criteria and water use or uses adopted. Further, no standard will be approved which does not require all wastes, prior to discharge to any interstate water, to receive the best practicable treatment or control unless it can be demonstrated that a lesser degree of treatment or control will be provided for water quality commensurate with proposed present and future water uses.[4]

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1 Ibid.

2 Ibid.

3 "Guidelines for Establishing Water Quality Standards for Interstate Waters," op cit., item number 3 under Policy Guidelines.

4 Ibid., item number 8 under Policy Guidelines.

In a somewhat indirect manner, practicable treatment generally has been defined as secondary treatment (approximately 85 per cent removal of decomposable organic matter and suspended solids) for municipal sewage and a comparable level of treatment for industrial wastes.[1]

Since the states are required to meet both stream and treatment standards, and the latter are the more specific, the federal policy encourages the states to set target classifications according to quality conditions expected to result from secondary treatment of waste flows anticipated in the near future. Quality objectives set for Connecticut waters appear to have been largely determined by this procedure with some modification to account for projected uses.[2] The statewide, long range plan for the management of water resources of Connecticut should soon provide guidance for modifying quality objectives.

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1 At a Senate Hearing, James W. Quigley, Commissioner, Federal Water Pollution Control Administration, made the following statement in response to a question as to whether or not the Department of the Interior had developed specific minimum standards against which state standards would be measured:

> Senator, as I understand your question, we have not drafted a set of minimum standards. The Secretary, in his prepared statement, referred to the National Technical Advisory Committee on Water Quality Criteria. The Committee's membership is made up of the finest experts in their respective fields. The Committee's Interim Report commends specific water quality requirements for various water uses, to guide the Secretary and to guide us in making our decisions on the standards submitted by the States.
>
> I think I made the point earlier in answering the chairman's question that to date the same ten states that we have approved have all provided for a minimum secondary treatment in municipal wastes and roughly its equivalent for industrial wastes.
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> Now, I am not going to sit here and tell you that in all of the submissions of the remaining 40 states that we will send to the Secretary, in every instance secondary treatment will be required. It may not be achieved in some instances; but, as a general proposition we are trying to achieve this where we can, when we can.

Water Pollution - 1967 (Part 2). Hearings before the Subcommittee on Air and Water Pollution of the Committee on Public Works, United States Senate, 90th Congress, August 9 and 10, 1967, p. 548.

2 "Water Quality Standards," State of Connecticut, op. cit.

2. Cost-sharing programs

Since passage of Public Act No. 57 in 1967, Connecticut has provided grants to municipalities for 30 per cent of the cost of constructing pollution abatement facilities.[1] The state grant program qualifies Connecticut communities for the maximum federal grant of 50 per cent plus an additional ten per cent of the amount of the federal grants for municipalities participating in regional planning.[2] Thus, most communities can qualify for grants of 85 per cent of the costs of constructing treatment plants and interceptor lines.

In order to avoid delays due to a shortage of federal funds, the Secretary of the Interior has been authorized to enter into contracts with states and municipalities to pay the federal grant over a period of up to 30 years. Payments under these contracts are for the same items that would be covered under a grant from current funds; however, the contract does not include interest on obligations issued by the contracting party.[3] Prefinancing by the State will mean that the State will pay the interest. Nevertheless, Connecticut has maintained an active grant program. The $150,000,000 bond authorization in Public Act No. 57 was increased to $250,000,000 in 1969.[4]

Substantial assistance in treating industrial waste is available only to those industries discharging into a municipal sewage system. The federal investment tax credit law and the several Connecticut tax concessions provide some assistance for industrial waste treatment. The federal investment tax credit law allows firms to deduct from corporate income tax an amount equal to seven per cent of the capital costs of buildings and equipment. Investment for air and water pollution control have been exempted from temporary suspensions of the tax credit law.[5]

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1 (Connecticut Public Act No. 57) op. cit, Section 18.

2 Federal Water Pollution Control Act as amended by the Water Quality Improvement Act of 1968 (9th Congress, 2nd Session), Section 8 (b) (7) and 8 (9).

3 Ibid., Sections 8 (e) and 8 (f).

4 "An Act Increasing the Bond Issue for Water Pollution Control" (Connecticut Public Act No. 384, 1969 General Session).

5 Analysis of the effectiveness of tax credits and other types of tax concessions see: Mantel, Howard N., et al., Industrial Incentives for Water Pollution Abatement (a report prepared by the Institute of Public Administration, for the Public Health Service, Washington, U. S. Government Printing Office), February 1965, 95 pp.

Connecticut allows a credit against the Corporation Business Tax of an amount equal to the product of the tax rate and the capital cost of water pollution control facilities.[1] These tax credit laws assist only those firms with taxable net income.

Connecticut taxes utilities and unincorporated businesses on the basis of gross income. Tax credits on these businesses assist economically marginal as well as profitable firms.[2] Buildings and equipment acquired after July 1, 1965, for treating industrial wastes are exempt from local property taxation.[3] Equipment, supplies, and materials used in treating industrial wastes are exempt from State sales tax.[4]

These financial assistance programs provide no direct incentive to abate pollution. Cost-sharing is effective only when accompanied by more direct measures such as regulation or effluent charges.

3. Regulatory powers and procedures

Responsibility for water pollution control is shared by the Water Resources Commission and the State Department of Health. With an obligation to protect public health, the Department of Health is primarily concerned with the purity of public water supplies, the safe operation of sewage treatment plants, the purity of shellfish, and the safety of public swimming areas. Immediate protection of public health often involves a restriction of use rather than abatement of pollution. The objectives and activities of the Department of Health are complementary to the more comprehensive water quality protection and improvement program of the Water Resources Commission. In evaluating the administrative process, Focht concluded that the staffs of the two agencies have benerally maintained an excellent working relationship.[5]

The regulatory powers of the Water Resources Commission were expanded by Public Act No. 57. Since May 1, 1967, the Commission may

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1 (Connecticut Public Act No. 57), op. cit., Section 29.

2 Ibid., Sections 30-32.

3 Ibid., Section 27.

4 Ibid., Section 28 and "An Act Concerning the Sales Tax Exemption of Water Pollution Control Consumables" (Connecticut Public Act No. 188, 1969 General Session).

5 Focht, op. cit., p. 27.

issue abatement orders without a formal hearing.[1] Thus, hearings are necessary only when requested by the alleged polluter. The Commission is no longer required to specify a waste treatment method.[2] As Focht puts it, "Since May 1, 1967, the alleged polluter has the burden of establishing that the order directing the abatement of pollution should be revised and modified. This has substantially strengthened the hand of the Commission in dealing with the problem of water pollution in this State."[3]

Public Act No. 57 authorized the court to impose a fine of not more than $1,000 for each knowing violation of any provision of the Act.[4] Each day's continuance of a violation was declared to be a separate and distinct offense. However, the actual threat of substantial fines was reduced in 1969 by legislation exempting from penalty violations during the time when either a hearing or an appeal is pending.[5] Considering the large investments often required to abate pollution and the fact that orders can now be issued without a hearing, unwarranted uncertainty could have been created by making dischargers subject to fines for activities during the course of hearing procedures. But the move to reduce uncertainty for alleged polluters may prove excessive. Exempting from penalty violations continuing during the entire course of appeals may result in the use of appeal procedures as delaying tactics. The incentive to appeal just to postpone the expense of abatement could be reduced by modifying the statutes to permit fines for violations continued during the course of appeals.

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1 Ibid.

2 Prior to May 1, 1967, the Commission was required to specify one or more systems for abating the pollution and to allow the discharger to choose among available systems. Orders could not require treatment involving unreasonable or inequitable cost. Sources: Connecticut General Statutes (Rev. 1958), Sections 25-1 through 25-24.

3 Focht, op. cit., p. 27.

4 (Connecticut Public Act No. 57) op. cit., Section 17.

5 "An Act Concerning the Forfeitures for Violations of the Water Pollution Control Statutes" (Connecticut Public Act No. 486, 1969 General Session).

4. Economic incentives

Lack of economic incentives for waste control and treatment is probably the most serious limitation of the existing pollution control procedures. Industries and municipalities have no incentive to propose plans for treatment beyond the minimum necessary to obtain a permit. The fact that the Water Resources Commission is no longer required to suggest a treatment method does not mean that the Commission can now rely on waste dischargers for information about pollution control techniques. Only when there is strong opposition to a proposed discharge can the regulated parties be expected to inform the Commission about new and more effective abatement techniques which are also more expensive. Since control of industrial waste should start with process selection, effective abatement through a regulatory process requires that the Commission staff keep abreast of current technology in manufacturing processes. A major administrative effort is also required to check on operating policies pertaining to waste control, spillage, clean-up procedures, and waste treatment.

With little or no incentive to reduce waste discharges beyond levels required by standards based on known techniques, waste contributors have little incentive to conduct or support research on pollution abatement. Treatment problems of most municipalities are sufficiently similar to utilize the results of a general research effort by universities, government agencies and firms engaged in the manufacture of sewage treatment supplies and equipment. But control and treatment of many industrial wastes require more specialized research. The Water Resources Commission recognized the need for research on industrial waste treatment and has sponsored research at Wesleyan and Yale Universities.[1] Research under these contracts has pioneered the development of a number of industrial waste treatment processes. Research efforts could be stimulated through advance notice of higher control requirements and through direct economic incentives.

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[1] Merwin E. Hupfer, "Forty Years of Water Pollution Control in Connecticut," a paper presented at the 81st Annual Meeting, Connecticut Society of Civil Engineers, Inc. (Cheshire, Connecticut, April 22, 1965), (23 pages), p. 9.

Advance announcement of higher standards:

Research by both waste dischargers and firms producing pollution control equipment and supplies could be encouraged through advance announcement of more rigorous standards. In order to maintain credibility, requirements should be realistic and enforcement schedules should be maintained. Completely unrealistic standards could be avoided by setting the future requirements just within the limits of current technology. Industrial and research firms would then have an incentive to seek more economical methods of compliance. Meanwhile, more basic research at universities and other publicly-supported agencies and institutions should generate the basis for higher standards by making more effective control technically possible. An expectation of rising standards appears to be the key to encouraging research through a requlatory program.

Sewage service charges:

An inquiry to several members of the Water Resources Commission staff about sewage service charges in Connecticut revealed only two examples of charges based on content of industrial waste. The Town of Wallingford operates an industrial waste treatment plant in conjunction with the sewage treatment plant. Four establishments are served by industrial sewers which receive no sanitary wastes. The four users pay all operating costs including a reserve for replacement of equipment and facilities. The cost of chemicals is allocated according to an analysis by an engineering firm. Subsequent testing for reapportionment is to be at the expense of the user requesting the review. Costs other than for chemicals are allocated in proportion to the volume of waste discharged.[1] The City of New Haven charges one large textile dyeing plant for one half of the chlorine cost attributable to the firm's waste water. Chlorine cost is estimated on the basis of the decrease in chlorine demand when the plant shuts down annually for a two week vacation period.[2]

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1 Source: Letter and attached data from Vincent A. Maseia, Superintendent, Department of Public Utilities, Water and Sewer Division, Town of Wallingford, Connecticut, November 14, 1969.

2 Source: Telephone conversation: Edgar B. Vinal, City Engineer, City of New Haven, Connecticut, October 16, 1969.

Sewer use ordinances usually limit the concentration of numerous materials. Unfortunately, these requirements can often be met more economically by dilution than through control or treatment. In many municipalities the incentive to dilute rather than treat is reduced somewhat by sewage service charges based on the volume of water used. However, a reasonably efficient combination of industrial waste control, pretreatment at the source, and final treatment at the municipal plant can be expected only if charges are based on the volume and content from each major source.

Basically similar principles and procedures for setting sewage service charges have been recommended in several reports. The most comprehensive study was made by a joint committee representing eight national organizations.[1]

The "Joint Committee" report recommends that both capital and operating costs be divided between current users and property owners. The capital and maintenance costs of capacity for future growth, infiltration, and storm waters in the case of combined sewers are assigned to property owners. Benefit assessments and property taxation are the recommended methods of financing the property-related costs. The report recommends that costs resulting from use be allocated among users according to the cost of providing service to each user or group of users. The cost allocation process involves estimating per unit costs for volume, suspended solids, biochemical oxygen demand (BOD), chlorine demand, and other characteristics having an impact on costs of current use. The unit costs can be applied directly for major industrial dischargers. For sources not large enough to merit individual analysis the costs associated with quality characteristics can be incorporated into a charge per unit of volume through the use of average concentrations for various types of users.

An extensive range of methods and formulas was illustrated as the result of a survey of industrial waste disposal charges by the American

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[1] Committees of the American Society of Civil Engineers and the Section of Municipal Law of the American Bar Association and Representatives of American Water Works Association, National Association of Railroad and Utilities Commissioners, Municipal Finance Officers Association, Federation of Sewage Works Associations, American Public Works Association, an Investment Bankers Association of America, "Fundamental Considerations in Rates and Rate Structures for Water and Sewage Works," Ohio State Law Journal, Volume 12, No. 2 (Spring 1951), pp. 151-276.

Public Works Association. The survey, which included all cities in the United States with a population of 5,000 or more, resulted in replies from 256 cities levying some form of charge for industrial waste. The charges were based on quality and quantity in 32 cities. In all cases except one the general approach was to combine a regular charge with a surcharge for wastes exceeding limits defined for "normal sewage." Five-day BOD at 20° C., suspended solids, hydrogen ion concentration (pH), and chlorine demand were the major constituents on which surcharges were based.[1]

Conventional cost accounting procedures are of limited use in setting charges for wastes which impede the treatment process even when present in small amounts. While the concentrations of toxic wastes are usually limited by ordinance, these materials should also be considered in establishing charges. Operating efficiency can be reduced even by small concentrations. Moreover, metal wastes become concentrated in digesters and trickling filters.[2]

Assessments for toxic wastes are levied by regional water management associations in Germany. These regional agencies are responsible for land drainage, water supply, and stream flow regulation, as well as pollution control. The perspective of the multiple-purpose agencies in the Ruhr area is more oriented toward the condition of the stream and the costs of the entire system than toward the operation and cost of a particular treatment plant. Moreover, use of in-stream oxidation lakes and conversion of the Emscher into a concrete-lined waste channel with subsequent treatment of the entire dry weather flow have eliminated any clear definition of sewer, treatment plant, stream and lake. The charges levied in the Ruhr area combine many of the features normally associated with both effluent charges and sewer charges. Viewing the stream and the treatment plant as an integrated unit has facilitated the use of a dilution factor in setting charges for toxic wastes. The charge is based on the cost of providing dilution water required to protect fish.[3]

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1 Public Works Engineers, "Industrial Waste Disposal Charges in Cities Over 5,000 Population," American Public Works Association, Special Report No. 18-S (January 1955), pp. 1-70.

2 Masselli, Joseph W., et al., "The Effect of Industrial Wastes on Sewage Treatment" (1965), A Report for New England Interstate Water Pollution Control Commission (39 pages), p. 20.

3 Kneese, op. cit., pp. 176-179.

Another approach is to combine into a single index the effect of organic and toxic wastes. The index is a form of population-equivalent BOD. The conversion of toxic wastes to an equivalent BOD is accomplished through measuring the extent to which the rate of decomposition of organic material is reduced by the toxic wastes. The impact of toxic materials on treatment costs can then be estimated on the basis of the reduced rate of response to treatment processes.[1]

Many sewage treatment plants in Connecticut receive at least some wastes detrimental to biological treatment processes.[2] Research is needed to assist municipalities in identifying the costs of receiving and treating all significant waste components.

Monitoring of volume and content of major sources of industrial wastes could be done in several ways. The volume of flow could be measured periodically, metered, continuously measured and recorded, or estimated from data on plant capacity, type of process and the rate of water use. Waste content could be determined through periodic analysis, continuous recording of some characteristics, estimates from engineering data on the production and treatment processes, or some combination of these approaches. While a system of charges tends to focus attention on monitoring requirements, effective monitoring is equally essential for a rigorous enforcement of quality and flow regulations.

Effluent charges:

Effluent charges would provide the most direct economic incentive to limit waste discharges into natural waters. In considering the potential role of charges, a distinction should be made between a system of charges to supplement regulatory control and a system of charges to limit waste discharges without dependence on a regulatory program. The latter approach must be further subdivided into charges based on estimated downstream damages and charges set to achieve specified quality objectives.

Difficulties in attempting to estimate the economic value of downstream costs and losses in satisfaction from particular waste discharges

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1 Ibid.

2 "Waste Water Disposal by Connecticut Industries: Inventory as of January 1, 1961: Compiled for Basic Data Files of the Connecticut Water Resources Commission," U.S. Department of Health, Education, and Welfare, Public Health Service, Division of Water Supply and Pollution Control (Washington, D.C. 1964), 287 pp.

are discussed in Part II of this report. Moreover, restricting public control to a pricing mechanism would create uncertainty about future water quality and would create price uncertainty for waste dischargers. There appears to be no practical way of implementing a pricing system closely related to the perfectly competitive economic model.

Only one of the above limitations would apply to a system of charges set to achieve particular quality objectives. Even with stable objectives there would be serious economic uncertainty for waste dischargers. For example, consider a situation where three or four industries were discharging the same type of wastes to a section of a stream. Expansions in production and in waste discharge by an economically strong firm could force weaker firms entirely out of business. Conceivably the strong firm might temporarily increase discharges for the purpose of driving out the other firms. Pricing alone does not appear to be a feasible method of controlling waste dischargers.

None of the above limitations would apply to the use of effluent charges in combination with regulation. The two approaches would be complementary in several ways. A regulatory process tends to focus on treatment efforts and inputs. Charges would focus directly on results. Regulation is needed to assure compliance with minimum standards. Charges would provide a continuous economic incentive to reduce discharges.

Unfortunately, much of the public discussion about effluent charges seems to be based on the assumption that charges would be substituted for regulation. This assumption appears to have been created and promoted by trade associations opposed to the possible use of effluent charges. As originally introduced, Senate Bill 2987 contained a provision directing River Basin Commissions to consider the possible use of effluent charges.[1] The Bill contained no indication that charges would be in lieu of regulation. Yet opponents based part of their attack on an implicit assumption that regulations would be abandoned. Consider for example the following statement:

> There are a number of specific objections that should be made to provisions in S. 2987. We will discuss some of the more important of them in the comments that follow:

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[1] Senate Bill 2987, 89th Congress, 2nd session, a bill entitled "Clean River Restoration Act of 1966," Section 104 (b).

> 1. Section 104 (B) directs planning agencies to consider the possibility of effluent charges. If by an effluent charge is meant the equivalent of a sewer charge--a fee for service paid to an agency providing waste treatment, there can be no objection. But we have serious reservations about this if it could be interpreted to mean a charge imposed against a plant according to composition of its effluent. For one thing, we believe an equitable system for assessing such charges would be exceedingly difficult to devise. This obstacle alone would be enough to suggest that effluent charges of this type should not receive any endorsement. We further feel that it would be out of keeping with the goal of this legislation to say to a business firm or municipality: "If you want to pour pollutants into the river, you can pay a fee for this right." The aim should be to conserve our waters -- not to charge for polluting them.[1]

Industrial groups using the "license fee to pollute" theme appear to have had some success in winning the sympathy of conservationists.[2] Emphasis by economists on detailed economic models may have indirectly contributed to the idea that effluent charges would be a substitute for regulation. A substantial effort may be required to correct this misconception.

An effluent charge could be either a service charge or a tax depending on the relationship to the use of the funds collected and the associated regulatory policies. Assessments on waste discharges to pay the cost of augmenting low stream flows would clearly be service charges if the permitted discharges were related to the flow management program. The rate for each type of waste could be based directly on the cost of providing the required dilution. A charge not related to the financing of projects to increase the waste-assimilative capacity of receiving waters and subsequently to permitted dischargers would be a tax. The general level of an effluent tax could be set through the legislative process in the same manner as existing taxes. The relative rates for various types of waste could be in proportion to dilution ratios needed to protect aquatic life and to permit specified uses by man.

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[1] Statement of P. N. Gammelgard, Director of American Petroleum Institute's Committee on Air and Water Conservation, Water Pollution Control 1966. Hearings before the Subcommittee on Air and Water Pollution of the Committee on Public Works, U. S. Senate, Second Session on S. 2987 et al. (April 19, 20, 26, 27, 28 and May 5, 10, 11, 12, 1966), May 12, 1966, p. 545.

[2] Joseph W. Sullivan, "Cleaning Up Dirty Water: Big Spending on Waste Purification Pushed by Key Lawmakers Bucking Administration," The Wall Street Journal, Thursday, June 23, 1966, p. 28.

Opportunities for widespread use of effluent charges directly related to service provided appear to be limited by two factors. First, the federal government already allows costs allocated to flow regulation for quality protection to be classified as non-reimbursable. Second, little information is available on the feasibility of in-stream treatment techniques such as areation and mechanical removal of algae.

A nationwide system of effluent taxes would probably be the most effective way of economically encouraging long run progress in waste control and treatment. With immediate abatement objectives left primarily to the regulatory process, the charge rates could be more-or-less uniform for all regions. Charges at the same level for all points of disposal would focus attention on control, treatment, and research. In order to maintain this focus on abatement and research, exceptions to the principle of uniformity should be limited to obvious situations such as the discharge of salt into the open oceans. Uniformity would, also, minimize opposition stemming from defense of the existing competitive position of firms in the same industry.

An effluent charge system should not allow exemptions for the concentration or quantity of wastes remaining after some definition of "reasonable" treatment. Exemptions of this type would eliminate the incentive to develop more effective ways of reducing waste discharges since the technical advancement would decrease the exemption.

Monitoring requirements for effluent charges would be basically the same as those for a rigorous enforcement of regulatory standards.

IV. SUMMARY

There will be an economic need for a basic redefinition of water rights in Connecticut only if there is either a substantial increase in consumptive use or an eventual shortage of riparian sites for industries requiring large volumes of water.

Lack of riparian status for public water supplies has not impaired the development of supplies by municipalities and privately owned water companies. The General Assembly has been extremely liberal in granting condemnation powers for such purposes. Compensation generally has been limited to riparians with an established commercial use of the stream.

Riparian rights have not been effective in protecting recreational uses and environmental values against losses resulting from waste

discharges or reductions in flow. Detentions and diversions can create external costs in much the same way as waste discharges. Public interest in protecting stream flow is not essentially different from public interest in controlling water pollution. Empowering the Water Resources Commission to regulate detentions and diversions would not necessarily create serious uncertainty for water users.

Present pollution control laws and practices do not include effective economic incentives. More extensive use of sewage service charges based on flow and content could be helpful in the case of industries discharging to municipal sewers. Effluent charges combined with existing regulatory programs could provide the needed economic incentive without creating serious uncertainty for either water users or waste dischargers.

APPENDIX A

REGIONAL WATER QUALITY OPTIMIZATION MODELS

Models developed by Kneese illustrate the conceptual basis for minimizing costs associated with liquid waste disposal in a region.[1] The optimization models are first developed under the assumption "... that there are no efficient quality control measures that cannot be realized at the individual waste outfall or water supply intake."[2] This assumption is useful in focusing attention on the maldistribution of resources which results from external costs. The models are then modified to include situations where economies can be realized by collective treatment, low-flow augmentation, or stream reaeration. Under the second set of assumptions the responsible regional authority must have power to plan, finance, construct and operate facilities.

Kneese analyzes three forms of public intervention, which under his assumptions could cause all external costs to be reflected in waste disposal decisions. The systems are: effluent charges, incentive payments, and direct regulations.[3] All three systems are dependent upon schedules of estimated downstream costs associated with various levels of waste discharge at each possible outfall location under varying stream flow conditions. In each case the objective is to minimize the sum of the damage costs and the treatment costs.

Charges model

The effluent charges system can be readily presented only if we assume that the damage costs are a linear function of the amount of a pollutant discharged and that the marginal costs of abatement rise as the abatement level is increased. With linear damage functions the incremental damage per unit of discharge will be equal to the average

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1 Allen V. Kneese, The Economics of Regional Water Quality Management (published for Resources for the Future, Inc., by the Johns Hopkins Press, Baltimore, 1964), pp. 54-85.

2 Ibid., p. 121.

3 Charges based on downstream costs had previously been suggested by Edward F. Renshaw, "Economics of Pollution Control," Sewage and Industrial Wastes, Volume 30, No. 5, May 1958, pp. 680-688.

damage per unit of discharge and will not vary with the amount discharged. Moreover, the damage resulting from a particular discharge will not be influenced by the amount of the pollutant from other sources. Thus, for each waste contributor the regional agency can set the charge per unit of pollutant equal to the associated damage costs. Each waste contributor can then reduce waste discharges to the point where an additional unit of abatement would be more expensive than the corresponding effluent charge. The marginal costs of tolerating waste discharges will be equated to the marginal costs of reducing waste discharges, and the sum of both types of costs will be minimized.

Economists have generally held that a misallocation of resources due to external costs can be avoided through the use of charges without compensating the damaged parties. Kneese concurs with this conclusion if there are no opportunities for direct negotiation between individual waste dischargers and those damaged by the discharge.[1] Whipple has noted that lack of compensation could force financially marginal firms to suspend operations.[2] This type of forced closing could create real external diseconomies. If so, the value of these "secondary" external costs would have to be included in the effluent charges for an efficient allocation of resources without compensation to damaged parties.

A similar problem exists if the levying of an effluent charge results in the closing of an industry which had been creating real external net economies. The external diseconomies of closing a plant in a community with few opportunities for alternative employment are just as real as the external diseconomies from waste discharges. However, the purpose of a model is to focus on a set of relationships. All of the relationsnips in the economy cannot be considered at once. Thus, we will proceed to review and analyze regional water quality models under the assumption that all other resources, goods and services are being efficiently allocated and will be efficiently reallocated in response to a change in water policy.

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1 Kneese, op. cit., pp. 56-62.

2 William Whipple, Jr., Economic Basis for Water Resource Analysis (Water Resources Research Institute, Rutgers, The State University, New Brunswick, New Jersey, June 1968, 116 pp.), pp. 95-98.

If the damage costs are not a linear function of the quantity of a particular waste discharged, it is possible to define an incremental damage function for one discharger only by holding constant the rate of discharge by others. Thus, the schedule of effluent charges for each discharger depends on the schedule of charges and corresponding marginal costs of abatement for the other dischargers. A theoretical solution to this dynamic problem has been developed through the use of excess demand functions.[1] Unfortunately, the standards defined would become and remain optimum only when the economy reaches and maintains a steady state of growth.[2]

Payments model

In an optimization model based on payments, a regional agency would stand ready to pay all potential waste contributors to restrict waste discharges. The schedule of payments offered to each potential waste contributor would be based on the incremental damage costs associated with the potential discharge.[3]

A major debate has arisen over whether or not a payment model can be theoretically symmetrical to a charges model.[4] The two approaches are basically very different with regard to the information needed by an implementing agency. With a charges system the regional authority would levy the assessment on each unit of waste discharged. With a payments system the total payment to a potential waste contributor would depend upon the amount which would have been discharged in the absence of the payment less the amount actually discharged. Estimating the amount that would be discharged in the absence of the payment would

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1 Gardner, Brown, Jr., and Brian Mar, "Dynamic Economic Efficiency of Water Quality Standards or Charges," Water Resources Research, Volume 4, No. 6, December 1968, pp. 1153-1159.

2 Ibid., p. 1159.

3 Kneese, op. cit., pp. 56-62.

4 For additional information on this question and reference to several recent journal articles see: Allen V. Kneese and Blair T. Bower, Managing Water Quality: Economics, Technology, Institutions (published for Resources for the Future, Inc., by the Johns Hopkins Press, Baltimore, 1968, 328 pp.), pp. 101-109.

become increasingly complex as cost and revenue functions shift through time.[1]

An attempt to utilize the payments technique would involve severe administrative limitations. Waste contributors would have an incentive to adopt, or threaten to adopt, processes which generate much waste in order to be able to collect payments for restricting waste discharges. Payments would have to continue to a firm which left the basin as a means of reducing waste discharges. Moreover, payments would have to be made to potential dischargers which would have located in the basin the absence of the payment.

Effluent standards

The sum of abatement and damage costs could be minimized through effluent standards if a regional authority had complete information on the marginal costs of abatement for each discharger in addition to the information needed for an ideal system of charges.[2] The optimum quantity of waste discharge at each outfall location for each level of stream flow could be determined by equating the marginal damage function to the marginal costs of abatement. Assuming no negotiations between private parties the discharge at each outfall would, in the short run, be the same as with an optimum set of charges.[3]

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1 M. J. Kamien, N. L. Schwartz, and F. T. Dolbear, Jr., "Asymmetry Between Bribes and Charges," Water Resources Research, Volume 2, No. 1, First Quarter, 1966, pp. 147-157.

2 Kneese, op. cit., pp. 82-83.

3 Through time the two systems would not have the same influence on industry location, Ibid., p. 83.

APPENDIX B

CONNECTICUT PUBLIC ACT NO. 792, 1967 GENERAL SESSION

AN ACT CONCERNING USE OF WATER FROM RIVERS
FOR PUBLIC CONSUMPTION

Section 1. Any town, city, borough or corporation authorized by law to supply pure water for public or domestic use shall have the power to divert and use water from any river for public or domestic use after making written application for and obtaining a permit from the water resources commission. The application shall include any information the commission requires and, if the granting of such a permit would affect the rights of any public service company, the application shall include either: The written consent of such company for such diversion or use; or an order from the public utilities commission giving its approval for such diversion or use and awarding such compensation, if any, to such public service company as it deems equitable. The power herein granted shall be in addition to any power granted by special act to any specially chartered corporation, but power to divert and use water granted by special act after January 1, 1967, to any such corporation shall be exercised only in accordance with the provisions of this act.

Sec. 2. The water resources commission, upon receipt of an application under section 1 of this act, shall (1) make such investigation as the commission deems necessary; (2) make a determination based on findings that such diversion and use is reasonably necessary and will not interfere with navigation; (3) advise, consult and cooperate with other appropriate state agencies, including the state department of health and state board of fisheries and game; and (4) hold a public hearing, after reasonable notice, at which any person who may be directly or indirectly affected by the determination of the commission with respect to such application shall be entitled to be heard, in person or by counsel.

Sec. 3. Any permit issued by the water resources commission pursuant to the provisions of this act may be revoked or modified in any manner by the commission if the commission finds it in the public interest to do so. Factors affecting the public interest, as the term is used in

this section, shall include but not be limited to changes in conditions affecting the water resources of the state or any river from which such water is diverted and used. If the commission finds that an emergency exists which is causing permanent damage to the public interest, it may revoke or modify any such permit without hearing. Any appeal by any town, city, borough or corporation aggrieved by the doings of the commission because of such emergency revocation or modification shall not stay the order of the commission. If no such emergency exists the commission, prior to revoking, modifying or changing such permit, shall hold a public hearing after reasonable notice; make such investigation as it deems necessary; and make a determination based on findings that the public interest requires such revocation or modification.

Sec. 4. Any town, city, borough, corporation or person aggreived by any order or authorization or decision of the commission under this act may appeal therefrom to the superior court as provided for in sections 16-35 to 16-38, inclusive, of the general statutes.

Sec. 5. In any case in which the law requires compensation to be made to any persons whose rights, interest or property are injuriously affected by any order of the water resources commission under this act, such person may apply to the superior court for the appointment of a committee to determine and award the amount to be paid by such town, city, borough or corporation.