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THE UNCERTAIN SEARCH FOR ENVIRONMENTAL POLICY: THE COSTS AND BENEFITS OF CONTROLLING POLLUTION ALONG THE DELAWARE RIVER*

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I. INTRODUCTION

A. *A Statement of Purpose*

This is the second in a series of articles which examine the scientific and economic foundations of water pollution control policy as it is presently evolving in the United States. As in an earlier article,[1] we focus upon a paradigmatic environmental control decision, often hailed as one of the high points in the American experience,[2] to expose the premises of current policy.

On March 2, 1967, the members of the Delaware River Basin Commission (DRBC)[3] met to adopt a massive program to control the enormous wasteload imposed upon the Delaware as it flows through the densely urbanized area centering on Philadelphia, Pennsylvania. In framing policy for the river, the DRBC had the benefit of a pioneering federal study, in which an expert staff constructed a mathematical model that simulated the impact of pollutants discharged by the industries and cities bordering upon the river. Using the model, the federal Delaware Estuary Comprehensive Study (DECS) attempted to quantify the costs and benefits of embarking upon a variety of cleanup programs that were under consideration by the Commission.[4]

Our focus in this Article will be on the cost-benefit analysis tendered to the DRBC by the DECS. In attempting a thorough scrutiny of the DECS *Report*, we have three major ends in view. First, since the environmental goals selected by the DRBC in the 1960's have been imposed upon all industrialized regions by federal statute in the 1970's,[5] we shall ultimately be in a position to evaluate the pollution control objectives being pursued not only in the Delaware Valley but throughout the United States. As we consider the premises of the Delaware effort to be fundamentally misguided, our critique of the DECS cost-benefit analysis is intended to induce our readers to question the direction of the current multibillion-dollar effort to control the pollution of our nation's waters.

Second, in examining the DECS *Report* carefully, we shall be able to consider in a concrete context the extent to which cost-benefit analysis enhances the rationality of decisions made by functioning

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1 Ackerman & Sawyer, *The Uncertain Search for Environmental Policy: Scientific Factfinding and Rational Decisionmaking Along the Delaware River*, 120 U. PA. L. REV. 419 (1972).

2 *See, e.g.*, A. KNEESE & B. BOWER, MANAGING WATER QUALITY 224-35 (1968).

3 The Delaware River Basin Compact establishes the regional jurisdiction of the DRBC over the water quality of the Delaware River and its tributaries as well as the authority to develop hydroelectric power and recreational areas, to promote wildlife conservation and flood protection, and to control water supply. The formal acts of consent to the Compact by the signatory governments may be found in Act of Sept. 27, 1961, 75 Stat. 688; DEL. CODE ANN. tit. 7, §§ 6501-13 (Supp. 1970); N.J. STAT. ANN. §§ 32:11D-1 to -115 (1963), *as amended*, (Supp. 1973); N.Y. CONSERV. LAW §§ 801-12 (McKinney 1967); PA. STAT. ANN. tit. 32, §§ 815.101-.106 (1967).

4 FEDERAL WATER POLLUTION CONTROL ADMINISTRATION, U.S. DEP'T OF INTERIOR, DELAWARE ESTUARY COMPREHENSIVE STUDY: PRELIMINARY REPORT AND FINDINGS (1966) [hereinafter cited as DECS]. The mathematical model is described and analyzed in Ackerman & Sawyer, *supra* note 1.

5 *See* text accompanying notes 159-76 *infra*.

agencies. Although theoretical problems in cost-benefit analysis have generated a substantial literature, the way in which cost-benefit analysis is actually practiced is deserving of far more scholarly attention than it has been given.[6] Rather than advert summarily to the inevitable imperfections of cost-benefit analysis in the "real world," one must treat the problems of practice seriously if the university is to train students who can analyze the problems concealed by a set of summary cost-benefit ratios. Moreover, when, as in the instant case, analysis reveals that a methodology is currently being practiced in the field under the "cost-benefit" label which bears almost no relationship to the economist's insights, it seems incumbent upon the academy to make that fact known. Finally, when the gap between the theory of cost-benefit analysis and its practice is perceived, both lawyers and economists can begin to consider the ways in which institutions may be designed to control the use of the methodology to maximize its contribution to enlightened decisionmaking.

Third, an analysis of the DECS *Report* serves as an appropriate vehicle to consider the relationship between the economist's cost-benefit methodology and alternative ways of understanding the environmental problem. It should be no secret that many who are active in environmental regulation look with grave suspicion upon the efforts of economists to bring "rationality" to the policymaking process. They believe that environmental protection generates substantial benefits which, for one reason or another, are unquantifiable within the confines of the economist's methodology. Consequently, they suggest that even if a cost-benefit analysis conformed as closely as practicable to the welfare economist's paradigm, the resulting policy recommendations should not be given decisive weight. After dealing with the factors considered by the cost-benefit study, this essay therefore attempts to provide a structure within which the doubts of the non-economist may be coherently expressed and given appropriate consideration by decisionmakers.

We hope, then, not only to attempt a substantive critique of water pollution policy but also to consider the inherent limitations of the economist's analysis of the issue of environmental degradation.

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[6] This is not to say that such attention has been totally lacking. Among the recent works in this area are BROOKINGS INSTITUTION, MEASURING BENEFITS OF GOVERNMENT INVESTMENTS (R. Dorfman ed. 1965); R. HAVEMAN, THE ECONOMIC PERFORMANCE OF PUBLIC INVESTMENT: AN EX-POST EVALUATION OF WATER RESOURCES INVESTMENTS (1972); PUBLIC EXPENDITURES AND POLICY ANALYSIS (R. Haveman & J. Margolis eds. 1970); A. RIVLIN, SYSTEMATIC THINKING FOR SOCIAL ACTION (1971); Margolis, *Secondary Benefits, External Economies, and the Justification of Public Investment,* in AMERICAN ECONOMIC ASSOCIATION, READINGS IN WELFARE ECONOMICS 372 (K. Arrow & T. Scitovsky eds. 1969).

In a subsequent study, these issues will be developed further, both by considering the weight each of the five voting members of the DRBC—Governors Hughes (New Jersey), Rockefeller (New York), Shafer (Pennsylvania) and Terry (Delaware), and Secretary of the Interior Udall—gave to the DECS *Report*, and by assessing the ways in which the DRBC's 1967 decision has been implemented up to the present time.[7] It is only on the basis of this further analysis that it will be possible to consider the ways institutions may be structured to best develop the environmental policies suggested in the present Article. Consequently, the critical issues of institutional design will not be considered here, but will be reserved for our book length treatment.

B. *The Pollution Problem on the Delaware: A Review of the DECS Approach*

Before one can assess the ambitious DECS attempt to analyze the costs and benefits of environmental improvement, it is necessary to understand the terms in which the DECS staff and other leading researchers seek to describe the physical phenomena which the layman associates with the "pollution problem." As we have explored the nature and limits of contemporary scientific factfinding efforts in an earlier Article in this *Review*,[8] the briefest summary will serve our purposes here. The DECS *Report* focused principally on a single water quality parameter, dissolved oxygen (DO), which traditionally has been of the greatest concern for professionals in water quality management. DO is important for two reasons. First, if oxygen levels fall below three or four parts per million (ppm), and if the oxygen deficiencies are substantial and sustained, the resident fish population will die and migrant species will find it impossible to survive their journeys.[9] Second, if DO levels plummet further and approach zero, the river will generate a stench—similar to that of rotten eggs—which can make recreation and residence in or about the afflicted region unattractive. While river stench is, as yet, not a serious problem in any portion of the estuary,[10] the survival of fish and other forms of aquatic life is of considerable concern. During the summertime, DO levels of one ppm are common in the highly industrialized segments of the river between Philadelphia and Wilmington, making it impossible for a well-

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[7] B. Ackerman, S. Rose-Ackerman, J. Sawyer & D. Henderson, The Uncertain Search for Environmental Quality chs. 11-19 (forthcoming) [hereinafter cited as B. Ackerman].

[8] Ackerman & Sawyer, *supra* note 1.

[9] *See id.* 437.

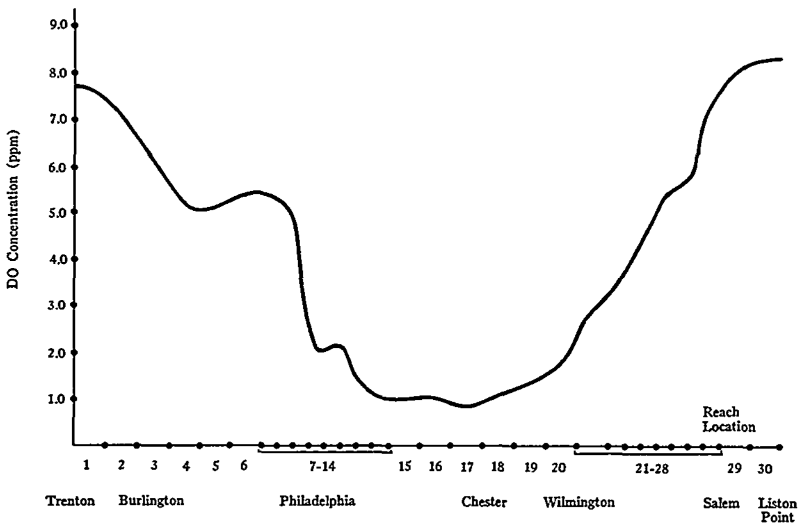
[10] Interviews with DRBC, Pennsylvania and New Jersey personnel, summer 1972.

developed resident fish population to survive in, or migratory fish (like the shad) to pass through, this "critical zone."

Like a number of other pollutants, materials which deplete the river's oxygen supply have a localized effect: their impact diminishes over time from the point of discharge. Thus, oxygen depletion is a problem in the heavily industrialized section of the river between Philadelphia and Wilmington, but as discharges containing oxygen-demanding wastes diminish in intensity below Wilmington, the DO profile improves quite rapidly, as suggested in Figure 1, reaching near-saturation levels before the estuary joins the Delaware Bay; similarly, DO levels on the estuary above Philadelphia are considerably higher than those in the "critical region." In order to provide a more precise analysis of the impact of discharges on the DO profile, the DECS developed a scientific model, which divided the eighty-six-mile estuary into the thirty sections shown on the map in Figure 2; after the staff measured all discharges into each section, the model predicted the extent to which these inputs would impair water quality, measured chiefly by DO, as they were carried into other sections of the river. Considering all polluting inputs in all sections of the river simultaneously, the model then attempted to provide a cause-and-effect

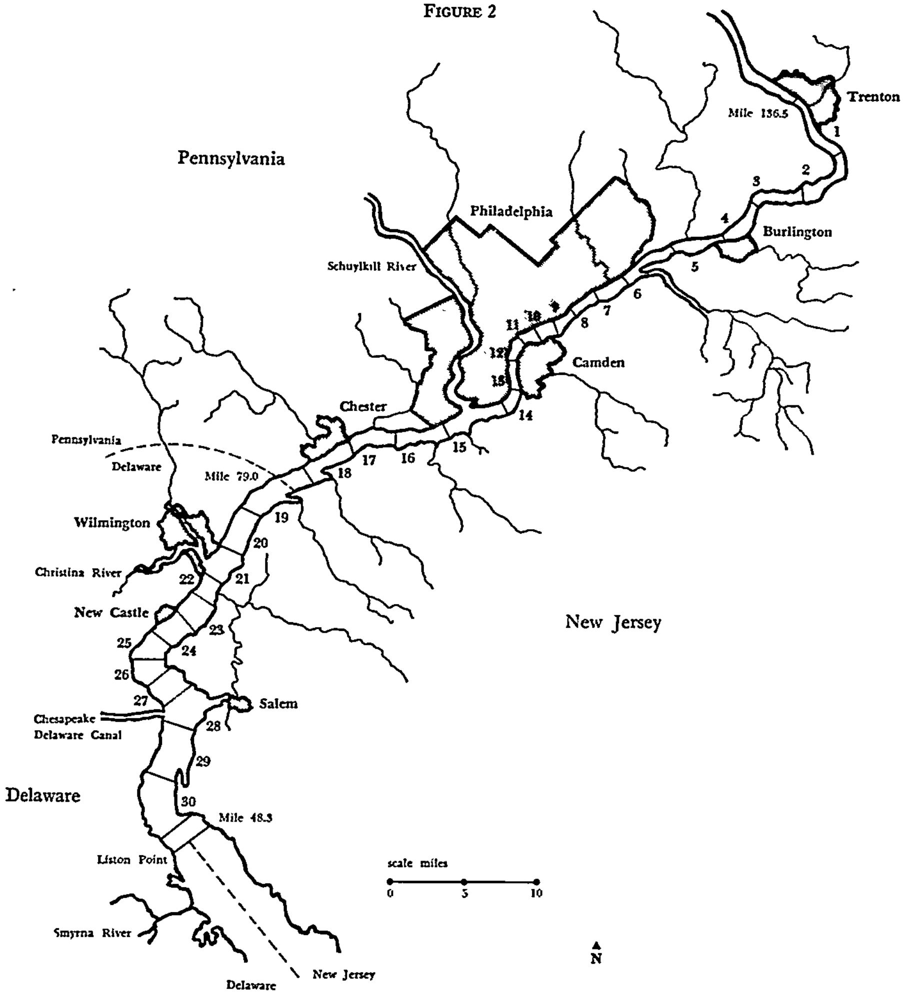
FIGURE 1

PROFILE OF AVERAGE SUMMER DISSOLVED OXYGEN IN 1964[11]



[11] Ackerman & Sawyer, *supra* note 1, at 442 (Fig. 4), *based on* G. Shaumberg, Water Pollution Control in the Delaware Estuary 44, May 1967 (unpublished thesis on file at Harvard College Library).

FIGURE 2



MAP OF THE DELAWARE ESTUARY SHOWING SECTION BREAKDOWN[12]

explanation of the river's varying water quality, and, by extension, to provide a set of predictions concerning the water quality which would result under various cutback programs.

Armed with a scientific model that described the physical parameters of the problem, the DECS could undertake an economic analysis of the costs of improving water quality. The staff began by estimating the marginal costs that each polluter would incur as it was required to eliminate more and more oxygen-demanding material from its waste stream. Once these data were obtained, the DECS could use its cause-and-effect model to determine the impact on the DO profile

[12] DECS, *supra* note 4, at 34, (Fig. 20).

of imposing one or another set of cleanup costs upon each polluter. Finally, the DECS staff arranged for the University of Pennsylvania's Institute for Environmental Studies (IES) to make estimates of the benefits which would accrue to various water users as a result of each of the control programs hypothesized by the DECS.

When the DECS issued its report in the summer of 1966, then, it provided decisionmakers with a cost-benefit analysis which seemed to clarify greatly the ultimate decisionmaking problem. The DECS *Report* considered the merits of five different water quality objectives for the polluted estuary. Objective V contemplated maintaining indefinitely existing DO levels along the river; each of the four other proposals established cutback programs which the scientific model predicted would improve DO levels, with objective IV contemplating the smallest improvement, and I, the greatest.[13] Under the regulatory system the DRBC was most seriously considering,[14] the DECS generated the following figures.

TABLE 1[15]

COST-BENEFIT ESTIMATES OF DECS POLLUTION CONTROL PLANS
(Present Values, 1964 Dollars, Discounted at 3% for Twenty Years)

Program	*Minimum DO Tolerated (ppm)*	*Cost*	*High Estimate-Low Estimate of Benefits*
I	4.5	$490 million	$355-155 million
II	4.0	275 "	320-135 "
III	3.0	155 "	310-125 "
IV	2.5	110 "	280-115 "
V	1.0	30 "	—

If the political officials on the DRBC had simply conceived it to be their task to follow the recommendations of the DECS staff, it should be clear that they would not have considered any cleanup program more ambitious than IV: moving from IV to III, for instance, would generate at a maximum $30 million more in benefits while costs would increase by $45 million; and Program II would require an extra

[13] For a detailed description of the objective sets, see DECS, *supra* note 4, at 54-58.

[14] This system required polluters located near one another to remove equal percentages of their wasteloads. The system is analyzed and alternatives considered in B. ACKERMAN, *supra* note 7, chs. 15-19.

[15] The benefit estimates are for recreation only and come from DECS, *supra* note 4, at 77 (Table 20). The cost estimates come from *id.* 66 (Table 16) (B-Zoned). Capital costs are counted as occurring in the present with operating and maintenance costs dis-

investment of $120 million over Program III to obtain at most a $10 million gain. Despite this, the DRBC not only rejected Program IV, but Program III as well, and proceeded to adopt a slightly modified version of Program II to serve as the water quality policy objective for the Delaware.

The decision on the Delaware thus poses a sharp challenge to the adherents of cost-benefit methodology. Were the politicians justified in rejecting the technocratic report? To what extent did the document mislead more than it informed? Is cost-benefit analysis inevitably inadequate in informing environmental control decisions? It is to these questions that we now turn in scrutinizing first the DECS cost estimates and then its benefit calculations. We shall conclude by suggesting that the ultimate decisionmakers were justified in doubting the reliability of the DECS numbers and suspecting that the economist's insights contained inherent limitations. Nevertheless, we shall argue that the ultimate policymakers drew precisely the wrong inference from their suspicions. Instead of deciding that a far higher level of cleanup was justified than was indicated by the DECS calculations, a sophisticated consideration of the factors involved would have overwhelmingly indicated that only a much more modest cleanup effort, and one which was not primarily concerned with DO levels, made sense along the Delaware. In reaching this conclusion, we do not mean to suggest that substantial expenditures on water pollution control do not make sense. After tracing the sources of failure in our present program, we shall attempt to advance the basic principles of an environmental policy which would generate substantial returns to a society which is committed to ameliorating the consequences of twentieth-century industrialism. Indeed, it is precisely because we believe that environmentalism has values of lasting significance that it seems to us important to urge the reconsideration of a program, costing billions of dollars across the nation, which will ultimately generate such profound disappointment with the fruits of the environmental revolution that much that is of real value will be abandoned along with much that is simply faddish.

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counted at 3% for 20 years. The benefit estimates are the present value of a 20-year stream of benefits also discounted at 3%.

The benefit estimates represent the *additional* recreation benefits over and above those generated by the river in its 1964 condition. The cost estimates include the estimated $30,000,000 cost of maintaining 1964 conditions, *id.*, and represent costs over and above those incurred in 1964 for pollution control. Thus, if the appropriate data were available, the benefits column should include the benefits that would be lost if the $30,000,000 were not spent. Unfortunately, the DECS did not attempt to estimate the value of present benefits. As long as this figure is greater than $30,000,000, however, the choice of the optimal level of pollution control will be unaffected by this omission.

II. Counting the Costs

The DECS economic analysis was profoundly shaped by the way in which its scientific model described the "facts" about the Delaware's pollution problem. As a result of the model's emphasis on DO, the economic analysis, naturally enough, concentrated upon estimating the costs of removing oxygen demanding wastes and only incidentally considered other pollutants.[16] Even when the nature of the pollution problem had been so drastically simplified, however, the DECS found it necessary to focus its concerns even more narrowly in order to make headway on what it considered to be the most important dimensions of the problem of cost estimation. We do not mean to suggest in any way that this decision to narrow the field of inquiry was an unwise one. It was necessary for the DECS to simplify its task at the beginning of its ambitious investigation. But the consequence of many of the simplifying assumptions proved to be distortions of reality which substantially limited the range and validity of the cost estimates which were provided to the DRBC at the time of its initial decision in 1967.

A. *Narrowing the Range of Inquiry*

1. The "Forty-Four" Polluters

The sources of oxygen-demanding wastes imposed upon the estuary are many and diverse: the hundred municipalities and firms discharging directly into the estuary are only the most visible components of a larger problem. In addition, oxygen is constantly demanded by wastes entering the estuary from the upper Delaware above Trenton and from the major tributaries entering the main stem at various points, and by the blanket of sludge—often from ten to twenty feet thick—on the river's bottom.[17] In order to make its task manageable, however, the DECS concentrated its energies upon the forty-four most important point-source polluters discharging directly into the estuary.[18] This decision was justified on the ground that these forty-four sources contributed more than ninety-five percent of all

[16] After calculating the cost of reaching the DO objectives, the DECS staff checked the results to determine whether the standards for acidity and bacteria were met. If not, the costs of meeting these standards were added. *Id.* 63, 66 (Table 16). These additional costs were relatively small. For example, of the $275,000,000 cost to reach Objective Set II, $20,000,000 represents the additional costs of bacteria removal. Costs of removing particular poisons were not explicitly calculated. In fact, a DECS footnote states that other water use goals (except chlorides) were assumed to be met by DO, pH and bacterial control measures. *Id.* 66 (Table 16, n.3). Furthermore, the DECS did not present the results of looking at the program in reverse by first estimating the cost of meeting pH and bacterial objectives and then recording the additional cost of meeting DO objectives. As we shall see, this would have been a most useful exercise for policymakers.

[17] *See* Ackerman & Sawyer, *supra* note 1, at 441-44.

[18] *See id.* 465.

wastes emitted by *point sources* riparian to the main stem.[19] In fact, however, when other sources of waste are taken into account, the DECS forty-four polluters contribute only sixty-five percent of the total load imposed on the estuary. Most importantly, the nonestuarine branches of the river contributed twelve percent of the estuary's load in 1964. Since a number of the major tributaries are the scenes of rapid industrial and residential growth, the waste from this source will increase substantially over time.[20] Nevertheless, by focusing its concern solely upon polluters on the main stem, the DECS ignored this increasingly important cost in its estimates.

2. The "Steady State" Assumption

Whenever it rains heavily in the Delaware Valley, oxygen-demanding inputs into the river rise dramatically, principally because of the combined storm and sanitary sewer systems which prevail in the estuary's major cities: Trenton, Philadelphia, Camden and Wilmington. In these combined systems, the same set of sewer pipes serve as conduits for both the waste water generated by the normal activities of the city's inhabitants and the far larger volume of water which runs off the streets during a rainstorm. Consequently, when after a storm the operators of municipal treatment plants are confronted with an inundation of rain water-cum-sewage which exceeds capacity, they are obliged to divert the waste stream directly into the Delaware without

19 DECS, *supra* note 4, at 62.

20 While the old central cities along the main stem of the river (Philadelphia, Trenton, Wilmington, Chester, Bristol, Marcus Hook, Morrisville, Camden, Bordentown and Burlington) suffered a population loss of over 4% between 1960 and 1970, the remainder of the Trenton and Philadelphia Standard Metropolitan Statistical Areas (SMSA's) and the Delaware and New Jersey portions of the Wilmington SMSA gained 22% in population; the bulk of this growth occurred in the drainage basins of tributaries of the Delaware. *See* 1 U.S. BUREAU OF THE CENSUS, UNITED STATES CENSUS OF POPULATION, 1970, pt. A, § 1 pt. 9, § 2 pts. 32, 40 (1971) [hereinafter cited as U.S. CENSUS 1970]. Similarly, population projections for the Delaware Valley predict the older urban areas will suffer a 2.2% loss in population between 1960 and 1985, that the older suburbs including the older towns other than Philadelphia, Camden and Trenton will grow by 39%, and that the remainder of the region will grow by 108%. *See* DELAWARE STATE PLANNING OFFICE, FINAL POPULATION PROJECTIONS: DELAWARE COUNTIES, 1970-2000, ADVANCE REPORT (1972) [hereinafter cited as POPULATION PROJECTIONS: DELAWARE COUNTIES, 1970-2000]; DELAWARE VALLEY REGIONAL PLANNING COMM'N, 1985 REGIONAL PROJECTIONS FOR THE DELAWARE VALLEY, REPORT No. 1 (1967) [hereinafter cited as DVRPC, 1985 PROJECTIONS]; OFFICE OF BUSINESS ECONOMICS, DIV. OF PLANNING & RESEARCH, NEW JERSEY DEP'T OF LABOR & INDUSTRY, NEW JERSEY PRELIMINARY POPULATION PROJECTIONS (1971) [hereinafter cited as NEW JERSEY POPULATION PROJECTIONS]; WILMINGTON COMM'N ON ZONING & PLANNING, 1985 ESTIMATES OF LAND USE, POPULATION, AND EMPLOYMENT WITHIN WILMINGTON (1966). For definitions of the "older urban areas" (Rings 1 & 2) and "older suburbs" (Ring 3), see DELAWARE VALLEY REGIONAL PLANNING COMM'N, THE IMPACT OF HIGHWAY CONSTRUCTION ON THE ECONOMY, TECHNICAL RECORD No. 6, at A-1 to A-2 (1972).

Value-added in manufacturing establishments located in the Delaware Valley but outside of the old center cities on the main stem equals value-added within these old cities, and the proportion generated by the suburbs is growing. It was 48% of the total in 1963 and 50% in 1967. 3 U.S. BUREAU OF THE CENSUS, CENSUS OF MANUFACTURERS, 1967.

any treatment whatsoever. To make matters worse, very substantial quantities of street debris are also swept directly into the river. Thus, on about ten days a year when the sewers overflow, wastes discharged into the river more than double, seriously impairing the oxygen supply during the subsequent week.[21] If a pollution program is to permit a broad range of aquatic life to maintain itself in previously heavily polluted sections of the river, the costs of dealing with the storm sewer problem should be one of the most important components of the analysis. For fish must breathe on foul days as well as fair.

Unfortunately, however, the DECS scientific investigation was structured so as to obscure the importance of the storm sewer problem. Instead of considering the way in which sudden transient impulses affected water quality, the DECS scientific team adopted a simplifying assumption common enough in model building to have a name: "the steady state approach." Ignoring all transient phenomena, the DECS staff treated their problem as if waste discharges and river conditions remained constant over time.[22] Thus, instead of confronting the consequences of these massive intermittent discharges upon water quality, the DECS scientific model treated storm sewers *as if they constantly discharged a relative trickle into the river day in and day out.* Because on an *annual average* basis storm sewers account for only four percent of total oxygen-demanding wastes,[23] the DECS model could not express the basic importance of this source in the overall pollution control scheme.[24]

As the scientific model provided the framework in which the economic analysis was to be performed, it became a relatively simple matter for the cost estimates to fail to come to grips with the vexing sewer issue. After all, sewers only accounted for four percent of the

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21 Ackerman & Sawyer, *supra* note 1, at 460.

22 To be more precise, the DECS staff did recognize the importance of storm water overflow and performed a special study to determine the frequency of such impulses and their impact on water quality. DECS, *supra* note 4, at 24-25 (Fig. 13). Moreover, the DECS *Report* notes that sewer discharges pose a special problem and lists control of storm water discharges as one of the methods by which water quality might be improved. *Id.* at 24. Nothing more is said, however, and in the actual cost-benefit analysis, the variability of storm sewer overflow is not considered.

23 *See* Porges & Selzer, *Allocation of Stream Capacity in the Delaware River Estuary*, in PROCEEDINGS OF THE SECOND MID-ATLANTIC INDUSTRIAL WASTE CONFERENCE 71, 80 (Fig. 4) (1968). BOD is defined as the number of pounds of oxygen that will be consumed in the biochemical oxidation of the organic impurity present. T. CAMP, WATER AND ITS IMPURITIES 243 (1963).

24 Industrial loads are also extremely variable, depending upon the products being manufactured and the level of operations. DECS, *supra* note 4, at 22, notes this variability but the staff did not incorporate the information into their analysis. Certainly one possible way to improve river conditions during critical periods would be to require industrial polluters to dump less on such days than on others. As the volume of waste is under the control of the plant management and does not depend on the vagaries of the weather, such an approach could well be quite useful.

"average" daily load—so the model assured the staff. Consequently, it seemed sensible to avoid any discussion of the costs of correcting this problem in all the DECS published writings. If the DECS had faced the problem, it would have found that the costs of coping with it were very high. In fact, it will apparently cost at least $1 billion just to control Philadelphia's storm sewer problem (and, indeed, this large sum may well be far too conservative).[25] In other words, dealing with this four percent of the "average" daily load may be far more expensive than controlling the normal wastes generated by the estuary's polluters, even if these discharges were reduced as drastically as contemplated by the most stringent cleanup program of the five advanced to the DRBC for consideration.

3. Steady State Thinking and the Problem of Growth

While the importance of considering regional growth was perceived, the DECS treatment of the problem was primitive and failed significantly to transcend the limitations of steady state thinking. In seeking to estimate the costs of compliance for a twenty-year period between 1965 and 1985,[26] the staff assumed that none of the twenty-two firms in the sample would leave the Valley during that period or—even more importantly—that no major new industrial dischargers would locate on the banks of the river.[27] This second assumption seems particularly untenable when it is recognized that substantial quantities of shoreline in the highly industrialized Philadelphia-Camden metropolitan area are still available for development on the New Jersey side of the river, and that a new bridge is under construction which will link this land economically to markets in Pennsylvania and the West.[28]

While it is obvious that any treatment of these new industries must contain elements of uncertainty, to ignore completely what almost surely will occur because its details cannot be known is to pursue hard data at the cost of failing to generate sensible estimates. Instead the DECS might have produced a *series* of cost estimates envisioning a number of plausible scenarios for the development of vacant land in the urbanized zone over the next generation. Such an

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25 Ackerman & Sawyer, *supra* note 1, at 462 n.77.

26 The validity of using a 20-year time horizon is critically examined in Section IV.E *infra,* as is the DECS use of a 3% discount rate to calculate the present value of costs and benefits accruing over time.

27 DECS, *supra* note 4, at 62.

28 The compact providing for the Chester-Bridgeport Bridge was finally approved in August 1966, when the DECS was still at work on its report. The bridge is scheduled for completion in 1974. Interview with Delaware River Port Authority personnel, Aug. 1972.

approach would, of course, require a number of informed guesses as to the nature of industries moving to the river, their probable locations, the amount of waste they will generate and the costs of treatment at the time the industries enter the region. Nevertheless, it would give the decisionmaker a sense of the probable range in which the cost of compliance would fall. This result seems far better than providing the policymaker with a single number which ignores the possibility of entry entirely.

If we limit our concern to the way in which the DECS dealt with the forty-four largest existing polluters, the staff's treatment of temporal change again appears overly simplistic. In attempting to obtain cost data from the dischargers themselves, the DECS reports that the staff asked each of the forty-four polluters to "reflect load increases for about a 10 year period [from 1964 to 1975] . . . by estimating the cost of treatment to maintain certain levels of discharge through that time period."[29] Although the staff expected the polluters to report substantial growth, only nine of the forty-four dischargers responded that they were anticipating any increase in waste production between 1965 and 1975.[30] Since all nine growing dischargers were small municipalities,[31] the DECS questionnaires generated the rather surprising conclusion that the cost of controlling future growth was a mere $20 million.[32] The DECS explained this small figure by claiming that any increase in raw loads which might be expected to occur would be "accounted for by reduction of waste through plant modification, and by revenue obtained through product recovery."[33]

There is, however, a far more plausible explanation for the failure

[29] DECS, *supra* note 4, at 62; telephone interview with David H. Marks, former member of the DECS staff, Apr. 1972. G. Schaumberg, *supra* note 11, at 50-51, however, reports that the question asked was actually:

> How much would it cost you to reduce BOD discharges by the year 1975? Give present discharges and the cost to reduce BOD discharges (nearly) to zero. If possible give one or two levels of BOD reduction and the corresponding costs of achieving these reductions. Be sure to consider process change as an alternative to waste treatment in your estimation of costs.

This passage is surely ambiguous about how growth in loads should be considered, and it is not surprising that numerous meetings with the polluters were necessary in order to explain what data were actually desired. Interview with Professor Matthew J. Sobel, former member of the DECS staff, Yale University, Apr. 1972 [hereinafter cited as Interview with M. Sobel].

[30] Letter from Ethan T. Smith, Office of Water Programs, Environmental Protection Agency, Region II (formerly of the DECS staff) to Professor Susan Ackerman, June 28, 1971 [hereinafter cited as Letter from E. Smith].

[31] In fact, DECS, *supra* note 4, at 31, indicates that estimates of load increases were made for all municipalities. According to staff member Smith, however, this was not actually done for 13 major sources. Letter from E. Smith, *supra* note 30.

[32] The actual figure given in the DECS *Report* for Objective Set V (which involved maintaining 1964 conditions) is $30,000,000. However, the study states that $10,000,000 of this represents the cost of requiring primary treatment facilities to be installed for 5 sources which did not then treat their wasteloads at all, DECS, *supra* note 4, at 66; a sum that should not be included in the cost of maintaining 1964 conditions because the investment in primary facilities would, in fact, improve conditions.

[33] *Id.* 30.

of the questionnaires to reveal substantial wasteload growth. In industry the typical addressees of such questionnaires are plant managers, who are unlikely to have an accurate view of expansion plans being made at the head office and respond conservatively by assuming no growth at all in the future. Moreover, it is doubtful that even head office personnel—if their views were obtained—would have very clear plans over a ten- or fifteen-year time horizon.[34]

While questionnaires have their place, they clearly cannot provide the sole data source for a sensible estimate of the costs of compliance over time. At the very least the questionnaires must be checked for consistency with estimates of overall regional growth devised either by the staff itself or by other agencies concerned with regional development. The DECS had access to such regional estimates, and in fact discussed them in its 1966 *Report*, without, however, recognizing the importance of this information in assessing the validity of its own growth estimates. The regional growth analysis portrayed a booming Delaware Valley in which population would grow by thirty percent between 1964 and 1975 and industry would develop at a far more rapid rate. Translating these aggregate estimates into wasteload projections, the staff prophesied that by 1975 municipal loads would be 232 percent, and industrial wastes 187 percent, of their 1964 levels.[35] If the staff had compared these aggregate estimates with the data accumulated by questionnaire, they would have perceived at once the dramatic inconsistency. If any credence had been given to the overall *regional* estimates, it would have been clear that it would cost far more than $20 million to control future growth. In saying this, we do not mean to suggest that the regional growth figures are any more correct than the questionnaire data.[36] The divergence, however, sug-

[34] We have discussed in the text only those data collection problems involved in the questionnaire technique. Our interviews suggest, however, that the DECS did not even attempt to obtain cost estimates from the 22 municipalities in its sample. Instead, the DECS generated its own cost estimates, based upon each municipality's raw wasteload. While standard formulas exist in engineering handbooks which do provide the basis for crude cost estimates based on municipal wasteload, these formulas can only be rough first approximations. This is especially true for towns that treat industrial, as well as domestic, waste. Interview with M. Sobel, *supra* note 29.

[35] DECS, *supra* note 4, at 29. The DECS projected raw wasteloads generated by point-source polluters along the Delaware Estuary in 1975. These estimates show that industrial raw loads are expected to grow from 700,000 lbs. of carbonaceous oxygen demand per day in 1964 to 1,200,000 lbs. per day in 1975. These estimates were obtained, the DECS explains, by considering the major Standard Industrial Classifications represented along the estuary, estimating production in dollars for those discharging directly into the estuary, projecting this production rate over time and estimating raw load by using factors that related units of pollution to dollars of production in each time period. Technical change was accounted for in a rough way by changes in the factors relating pollution to dollars of output. Municipal loads were expected to grow even more dramatically from 1,200,000 lbs. per day in 1964 to 2,800,000 lbs. per day in 1975. *Id.* 29-30.

[36] The actual increase in population in the Delaware Valley between 1960 and 1970 was 12%, *see* U.S. CENSUS, 1970, *supra* note 20, and there is no reason to expect a sudden spurt between 1970 and 1974 to support the prediction of a 30% jump. In fact,

gests the magnitude of the problem and the degree to which the DECS failure to confront the problem flawed its analysis. Of course, if the DECS had confronted the problem squarely, it would not have been possible to resolve it in any simple way. Inevitably, instead of presenting decisionmakers with a single number which purported to indicate the cost of a given control program, the staff would have been obliged to suggest that compliance costs would vary considerably under plausible growth scenarios.[37]

4. Handling the Data

Having derived each polluter's cost curve on the basis of questionnaire data, the DECS problems in data manipulation were not at an end. First, in order to use a linear program which calculated the cost of reaching each of the proposed water quality objectives, the staff was constrained to choose only a finite set of points for each polluter representing the costs of reaching certain levels of waste removal. The cost of waste removal at any intermediate point was assumed to lie on the straight line connecting the chosen points, exemplified by *A* in Figure 3. Such an approximation may lead to serious over- or underestimates of costs if the solution to the linear program occurs at a point such as *E* in Figure 3, where the linear approximation differs substantially from the actual cost of cleanup, as portrayed by *B* in Figure 3. Although in the early phase of its work the DECS experimented with treatment cost points in order to select those points that best approximated continuous cost estimates in the neighborhood of the solution,[38] this practice seems to have been abandoned in later work when industry, at least, provided some hard data concerning the costs of attaining one, two or three levels of treatment.[39]

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projections of the DVRPC and the states of Delaware and New Jersey indicate that population in the region is only expected to grow by an additional 7% between 1970 and 1975. *See* DVRPC, 1985 REGIONAL PROJECTIONS, *supra* note 20, at 7 (Table 2-1). Total employment grew by only 12% over the same period, BUREAU OF LABOR STATISTICS, U.S. DEP'T OF LABOR, EMPLOYMENT AND EARNINGS: STATES AND AREAS, 1939-1970 (1971) and this figure also appears inconsistent with a growth of 187% in industrial waste loads between 1964 and 1975.

37 The problem is not so intractable as it might appear at first, however, as a few dischargers account for the bulk of the waste dumped into the river and obtaining growth estimates for these large polluters alone would result in a good estimate of overall growth. Of the total load discharged by point-source polluters in 1964, 41% came from Philadelphia's 3 treatment plants. When Camden, Wilmington and the DuPont plant at Chambers, N.J., are taken into consideration, 64% of the entire 1964 discharge is already accounted for. The addition of the next 12 largest dischargers (10 industries and 2 municipalities) raises the percentage covered to 88%. These figures are derived from DRBC data available at the DRBC.

38 Interview with M. Sobel, *supra* note 29.

39 Evidence for this statement consists of three sets of cost data provided by the DECS staff to different researchers over the years. For a discussion of this data, see Appendix A, *infra.*

FIGURE 3

HYPOTHETICAL POLLUTION CONTROL COST FUNCTION FOR A DISCHARGER WITH A GIVEN RAW LOAD

The demands of the linear program are reflected again in the DECS treatment of capital expenses as perfectly divisible. Imagine that a firm now treating at sixty-five percent reported to the DECS that it would require a capital investment of $500,000 to raise its treatment level to eighty-five percent. DECS assumed that if only eighty percent treatment were required, an investment of only $375,000 would be needed. In fact, this degree of flexibility may not be possible. The whole capital investment needed for eighty-five percent treatment may be required to treat to somewhat lower levels than eighty-five percent, so that only operating costs will be saved. Similarly, if the standard is eighty-six or eighty-seven percent, no new investment may be required and operating costs alone will rise. While the indivisibility problem may thus result in either an overestimate or an underestimate of compliance costs, our own manipulation of the DECS data reveals that if we assumed capital to be *in*divisible, the total costs of attaining the DRBC's objective increased by fifteen percent or $40 million.[40] Although this assumption is as unrealistic as the one indulged in by the DECS, it serves to demonstrate the extent to which even a minor

[40] This increased level of costs is an upper bound as the estimate was obtained by assuming that if the load removed at one data point were exceeded by only a pound, then the total capital cost of the load removed at the next data point would be incurred. Using the data in Appendix A, *infra*, such an estimate was relatively simple to obtain given the scheme, described in B. ACKERMAN, *supra* note 7, chs. 15-19, chosen by the DRBC to apportion the cleanup burden among polluters.

modification in methodology affects predictions when the data base is as weak as the one upon which the DECS operated.

To make matters worse, it is not at all clear that substantial improvement in the quality of data would be easy to achieve. One alternative is to develop comprehensive information about the costs of pollution control in different industries. While roughly accurate general cost information already exists for municipal sewage treatment,[41] estimating such data for industry is a far more difficult problem. A firm's entire production process must be understood in order to discover the possibilities of waste-saving process change as an alternative to separate treatment at the end of the process. Although pathbreaking efforts have been made,[42] we are far from the day when analysts will possess studies for many different industries relating plant age and product mix to waste water characteristics and waste reduction costs. The issue is further complicated by the fact that the current interest in pollution control should lead to a shift of engineering and scientific talent into this field with a consequent increase in the rate of technical change. The uncertainties haunting the DECS data will be typical of all but the most ambitious and expensive efforts within the foreseeable future.

5. Conclusions: Economic Science and Policy Formulation

Each of the present writers encounters in his monthly perusal of the journals a large number of empirical studies with far greater methodological difficulties than we have encountered in the DECS *Report*. The latter, however, cannot be evaluated simply in academic terms. As the *Report* was used to inform an important decision, it was imperative that the analytical team be acutely aware of the way in which its results would be used and misused in the decisionmaking process. From this perspective, it seems quite wrong to generate a single set of numbers to depict "the" cost of reaching one or another

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[41] 3 FEDERAL WATER POLLUTION CONTROL ADMINISTRATION, U.S. DEP'T OF THE INTERIOR, THE ECONOMICS OF CLEAN WATER (1970). For engineering specifications, see B. GOODMAN, MANUAL FOR ACTIVATED SLUDGE SEWAGE TREATMENT (1971); J. WHITE, THE DESIGN OF SEWERS AND SEWAGE TREATMENT WORKS (1970).

[42] *See, e.g.*, G. LÖF & A. KNEESE, THE ECONOMICS OF WATER UTILIZATION IN THE BEET SUGAR INDUSTRY (1968), C. RUSSELL, RESIDUALS MANAGEMENT IN INDUSTRY: A CASE STUDY IN PETROLEUM REFINING (1973). For a statement of the difficulties of obtaining industry-by-industry pollution control cost data, see 2 FEDERAL WATER POLLUTION CONTROL ADMINITRATION, U.S. DEP'T OF INTERIOR, THE COST OF CLEAN WATER AND ITS ECONOMIC IMPACT pt. II, at 91 (1968).

Under the Water Pollution Control Act Amendments of 1972, however, the Environmental Protection Agency (EPA) is required to perform this difficult task of estimating costs as a preliminary to setting discharge standards applicable to various classes of industries. 33 U.S.C.A. § 1314(b)(1)(B) (Supp. 1973). It seems plain, however, that given the limitations of present understanding, the EPA's cost estimates of various levels of cutback will of necessity be speculative and imprecise.

of the pollution programs under consideration, without emphasizing the limiting assumptions which were necessary to obtain the numbers. The best tack would have been to provide a series of estimates under a range of plausible hypotheses. At the very least, however, the following warning should have been appended to the DECS figures:

> WARNING TO DECISIONMAKERS: In providing these cost estimates, we have concentrated exclusively upon the costs of treatment anticipated by forty-four polluters on the assumption that each treats his own waste. Our estimates therefore do not take into account projected increases in waste loadings from tributaries and the location of new polluters on the main stem. Moreover, our consideration of the costs of treating growth in the wasteloads of the forty-four polluters on the main portion of the river relies upon information derived from questionnaires which seems inconsistent with regional growth projections. Thus, it could well be that our estimates of compliance cost are seriously understated.
>
> Finally, we have not considered the cost of solving the acute storm sewer problems experienced by Trenton, Philadelphia, Camden and Wilmington, even though if this problem is not corrected, the anticipated benefits of a water quality improvement program may in large measure fail to materialize. An informed guess places the cost of dealing with the sewers in excess of a billion dollars.

The DECS staff, we are sure, were perfectly capable in 1966 of appending such a warning to their *Report*. They failed to do so not because they lacked the ability but because they failed to appreciate the demands of the policymaking context in which they were operating. It is obvious, of course, that lay decisionmakers would be most impressed with a report which presented an unambiguous set of numbers apparently based upon a complex and sophisticated scientific model. Nevertheless, if reasoned economic analysis is to play an important role in policy formulation, its practitioners must not promise more than they can reasonably expect to deliver, or seem to deliver more than they do. Otherwise, disappointed expectations may lead over time to a complete rejection of systematic thought as an aid to framing public policy.

B. *Beyond 1966: Dealing with Cost Overruns*

If the DECS had discharged its warning function, decisionmakers would have found it most difficult to avoid taking steps to assure that the costs of compliance would be carefully monitored over time. In fact, however, neither the DECS nor the DRBC has attempted systematically to refine the initial cost estimates. Consequently, when new rough estimates were made indicating far higher costs, it was easy for the decisionmaking agencies to ignore their policy implications or, worse yet, to suppress their publication.

1. Official Revisions of the Cost Data

When the DRBC made its initial decision to select a slightly modified version of Program II as its water quality objective, the DECS enterprise lost much of its vitality. Only three of the original researchers remained at the Federal Water Quality Administration regional office which had jurisdiction over the Delaware Valley. Although required to spend the bulk of their time on other projects, these staffers made conscientious efforts to improve the initial cost estimates as best they could without the aid of substantial additional resources.

First, cost data were obtained on forty-seven small municipal polluters to supplement the original analysis of the forty-four most important estuarine dischargers. Since these small polluters contributed no more than five percent of the point-source load on the estuary,[43] the new data increased the total expected costs of reaching the DRBC water quality goal by only ten percent.[44] More importantly, the staff reconsidered the 1966 *Report's* estimate that an investment of only $20 million would be required to deal adequately with anticipated growth in wasteloads between 1965 and 1975. Finding the initial estimates far too low, they jacked up the price of dealing with growth to $140 million.[45] Although we can well understand why the early estimate was found to be so seriously mistaken, it remains far from clear how this new number was obtained. When queried by the authors, one of the remaining staffers explained that

> [t]he later estimate of 140 million included [the] nine sources [originally considered by the 1966 *Report*] plus numerous other municipal sources which in our opinion must experience additional costs to abate increasing loads if population growth continues, even if they are to discharge no greater load than in 1964.[46]

So far as it appears from this response, no effort was made to address

[43] Cost functions for these polluters were estimated by combining population data and information on existing facilities with engineering cost estimates to obtain separate estimates for each small town. Interviews with Alvin R. Morris & Ethan T. Smith, DECS staff, summer 1970.

[44] Letter from E. Smith, *supra* note 30.

[45] Smith & Morris, *Systems Analysis for Optimal Water Quality Management*, 41 J. WATER POLLUTION CONTROL FEDERATION 1635, 1643 (1969).

The $140,000,000 figure represents the cost of growth through 1975, 10 years short of the 1985 time horizon employed in the DECS computations. *See* note 140 *infra*.

[46] Letter from E. Smith, *supra* note 30.

more satisfactorily the problem of growth in industrial loads from existing sources. Nor does it appear that any effort was made to cure another serious deficiency in the earlier report by considering the cost implications of additional wasteloads imposed upon the mainstem by dramatically increasing population and industrial concentrations located along the Delaware tributaries.[47]

We are doubtful, however, that the reappraisal of costs attempted by the remaining DECS researchers was as narrow as their written response to the authors suggests. While the DECS has followed a policy of secrecy which is intended to make it impossible for outside observers to identify cost data reported by individual polluters and observe the way in which these cost estimates have changed over time, it has nevertheless proved possible for us to do so through a complex series of inferences from public documents.[48] As a result of this analysis, we have concluded that the cost estimates of no more than fourteen municipalities and four industries have changed between 1966 and 1970. Moreover, it is difficult to understand how these relatively small changes could possibly have accounted for such a large increase in the costs of dealing with growth. It appears more likely that the new $140 million figure includes, in addition to the growth in particular municipal sources cited by the DECS staff, some rough overall estimate of the costs of treating waste produced by regional growth and not assigned to particular polluters.[49]

All the imprecisions and gaps in these more recent costs estimates ultimately may be traced to a single source: neither the FWQA nor the DRBC had any real interest in a continuing effort to ascertain the costs of complying with the ambitious program selected for the Delaware River. Without resources provided by either of these agencies, three busy men working only intermittently upon the problem

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[47] *See* note 20 *supra.*

[48] *See* Appendix A, *infra.*

[49] A very rough estimate could have been obtained by estimating the total increase in load from regional projections of population and industrial growth and then using a standard sanitary engineering text to estimate the cost of building a secondary treatment plant capable of handling such a load. A more conceptually correct method would have, first, assigned the increased load to the various river sections on the basis of regional projections and information about the availability of vacant land and, second, predicted the 1975 DO profile on the assumption that none of the new load would be treated. The cost of growth could then be calculated by estimating the cost of raising the predicted 1975 profile to the actual 1964 level, using as estimates the marginal cost data already available. Costs of higher levels of cleanliness would then be calculated upward from the percentage of waste removal required to maintain 1964 conditions. The most serious problem with this method is that in practice the marginal costs of different levels of treatment will change as raw loads change.

A third possibility is perhaps the most sensible. Since the bulk of the growth will occur along the tributaries, the detailed population and employment projections of the DVRPC could be used to predict growth in each tributarial watershed; one could then estimate the cost of building regional treatment plants at the mouth of each creek to handle this load.

could do little more than in fact was accomplished.[50]

Far more important than the imperfections of the new cost estimates was the way in which they were used by the relevant decisionmaking agencies, especially the DRBC. In brief, the DRBC staff ignored the implications of the sharp increase in the cost estimates; indeed, our interviews with the responsible policymakers suggest that this early warning signal was never presented to the representatives of the states and the federal government who meet each month on the Commission.[51]

The remnant of the DECS staff was not, however, willing simply to ignore the problem posed by mushrooming compliance costs. In 1969, the FWQA prepared for release to the public a summary of the latest DECS findings, which contained a set of cost estimates that are even higher than the initial revisions.[52] In this summary, entitled *Where Man and Water Meet*, the cost of dealing with anticipated regional growth jumps once more—from $140 million to $218 million[53] —and total compliance costs are estimated at $503 million (in 1964 dollars), $233 million more than the sum proferred to the DRBC when the governors and the Secretary made their initial decision. Upon circulating this memo for comment to the states and the DRBC, the FWQA learned that these new higher cost estimates were bitterly resented by officials in these agencies precisely because they cast grave doubt upon the wisdom of the program which they were responsible for administering. In response to this protest, the FWQA suppressed the document's publication and no further exploration of this problem —so far as we know—has been attempted by the agencies involved.[54]

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[50] Two of the DECS staffers, however, did publish the results of their more recent investigations. Smith & Morris, *supra* note 45. Curiously, their account serves mainly to justify the DRBC program: it does not make clear the limitations of the original DECS analysis nor does it urge the reappraisal of policy in light of the new estimates. The tenor of the article becomes less baffling, however, in light of an understandable reluctance on the part of subordinate officials to criticize openly programs having the explicit support of their superiors.

[51] Interviews with delegates from the four states represented on the DRBC as well as the representatives from the federal government: H. Mat Adams (N.J.), Harold Jacobs (Del.), R. Stewart Kilborne (N.Y.), Vernon Northrup and Paul Van Wegen (U.S.), summer 1972; Maurice K. Goddard (Pa.), Sept. 1970.

[52] Federal Water Pollution Control Administration, U.S. Dep't of Interior, Where Man and Water Meet: Findings of the Delaware Estuary Comprehensive Study, Preliminary Draft (undated). Since Smith & Morris, *supra* note 45, appeared in September 1969, and the memo was circulated early in 1969, the two papers must have been prepared at nearly the same time. In fact, the only major difference in the two estimates is the cost of regional growth.

[53] Ethan Smith states in his letter, *supra* note 30, that the "$78 million is the increase in cost estimated by DECS due to the fact that the DRBC program now calls for nearly 90% removal whereas the DECS program called for 85% (uniform) removal. The 90% requirement is caused by the establishment of a reserve for new sources by DRBC . . . ."

[54] Furthermore, the final version of the DECS *Report* has never appeared. Several chapters exist in draft form but the sections on the dollar values of costs and benefits have apparently never been circulated for comment. Letter from E. Smith, *supra* note

2. Independent Cost Estimates

As a part of the present study, however, we sought to gain some sense of the probable costs of compliance by attempting to interview, in the summer of 1970, all of the polluters whose discharges are currently being regulated by the DRBC. In each of these interviews, we did not attempt to take the growth problem explicitly into account, but instead simply inquired how much the polluter would have to invest to meet the cleanup requirements set for his discharge. Because dischargers typically plan ahead and build their treatment facilities large enough to handle anticipated growth in wasteloads, however, their responses to some indeterminate extent will reflect expected growth.[55] Whenever it was possible, we attempted to check the verbal estimates presented in our interviews against estimates contained in the written reports filed for the polluters by consultants hired to plan the treatment projects. Whenever a discharger refused to give us data, we used the most recent DECS estimates in our total cost calculations.

When examining our data, based principally on interviews, we found that firms and municipalities were more confident in estimating the capital costs of building treatment facilities and making process changes than they were in estimating the costs of operating the treatment plants which, at the time of the interviews, had not yet been constructed. Consequently, in making our rough estimates, we concentrated on capital costs and process changes. Our data indicate that these costs, when measured in 1970 dollars, totaled some $350 million.[56] In order to make our estimate comparable to the DECS, we

30, reported to us in June 1971 that the *Report* was due for publication in the summer of 1971, but as yet no report has appeared.

55 Naturally, they will also reflect growth that has occurred between 1964 and 1970.

56 This estimate was obtained by combining interview data and data from consultants' reports with the DECS capital cost estimates for those dischargers giving no independent estimates. The derivation of the DECS estimates is provided in Appendix A, *infra.* These figures, which comprised only a small proportion of the total, were inflated by a factor of 1.3 to represent the increase in construction cost. *See* R. SMITH & R. EILERS, COST TO THE CONSUMER FOR COLLECTION AND TREATMENT OF WASTEWATER 23 (Fig. 6) (U.S. Environmental Protection Agency Water Pollution Control Research Series 17090-07/70, 1970). Our aggregate estimate breaks down as follows:

ESTIMATED CAPITAL COSTS OF REACHING OS-II
(millions of 1970 dollars)

Philadelphia	100
Gloucester City Regional	40
Camden City Regional	38
Camden County Regional	25
Wilmington	17
Other Cities Reporting Costs	16
Firms Reporting Costs (not in Deepwater Plant)	30
Firms Included in Deepwater Plant	65
Dischargers not Reporting Costs (DECS data)	7
	338

In addition to the results of interviews, these estimates rely on information from ENGIassumed—like the official study—that the present value of operating and maintenance costs would be approximately equal to investment in capital and process changes.[57] Thus our impressionistic survey suggests that compliance will cost roughly $700 million in the forseeable future. This figure, however, does not take into account either the costs to be borne by new entrants or the costs which will result if, as seems almost certain,[58] the DRBC finds itself obliged to order more stringent cutbacks in discharges of oxygen-demanding wastes in order to meet its water quality goals. In short, when inflation is taken into account,[59] our estimates correspond moderately well with the last set of estimates attempted by the DECS in *Where Man and Water Meet*, which was suppressed.

C. *Conclusions*

The picture we have portrayed is not a happy one. The inevitable oversimplifications required in the DECS staff's first effort at cost analysis had the net effect of biasing estimates downward. Little effort was made, however, to make lay decisionmakers aware of the limitations of the tentative estimates at the time of original decision. No systematic attempt was made to institutionalize a continuing reappraisal of the likely economic burden of the pollution control program. Our investigation shows, moreover, that reliance on individual initiative was not sufficient to assure continuing program review. Even though enterprising staffers were not stopped completely by lack of resources, they were discouraged from pointed exposition of their findings by their subordinate positions within the agency.[60] Finally, even when certain staffers did attempt to raise the cost question, the agencies concerned simply dug their heads into the sand. Internal reports were ignored or suppressed, as in the case of *Where Man and Water Meet*.

NEERING-SCIENCE, INC., DEEPWATER REGIONAL SEWERAGE SYSTEM: PRELIMINARY ENGINEERING AND FEASIBILITY STUDY, FINAL REPORT (1970) (prepared for DRBC) [hereinafter cited as DEEPWATER REPORT]; JOHN G. REUTTER ASSOCIATES, GLOUCESTER COUNTY REGIONAL SEWAGE TREATMENT FEASIBILITY STUDY (1967) (prepared for Gloucester County Bd. of Freeholders); JOHN G. REUTTER ASSOCIATES, REGIONAL SEWERAGE FEASIBILITY STUDY (1967) (prepared for Camden County Bd. of Chosen Freeholders).

The estimate includes the cost of constructing the large plant at Deepwater, N.J., which was intended to service a substantial number of industrial dischargers in that state. *See* B. ACKERMAN, *supra* note 7, ch. 19. Since this plant will apparently not be built, the actual costs of separate compliance can be expected to be higher for these plants than our estimates suggest. DEEPWATER REPORT, *supra*, (Table XIII-3), lists $79,000,000 as the total cost of onsite treatment. Using this figure instead of $65,000,000 yields a total of $352,000,000.

[57] Thus, for the purpose of comparison we assumed the same discount rate and 20-year life assumed by the DECS. These DECS assumptions, however, can be criticized on several grounds. *See* notes 140-45 *infra* & accompanying text.

[58] *See* notes 159-75 *infra* & accompanying text.

[59] The gross national product deflator rose by almost 25% between 1964 and 1970, but the E.H. Boeth index of the cost of constructing commercial and factory buildings in 20 cities including Philadelphia rose by over 40% in the same period.

[60] *See* note 50 *supra*.

This unfortunate pattern suggests the need for a more explicit institutional structure to assure the continuous study and regular public reappraisal of the economic dimensions of important governmental programs. Since a satisfactory treatment of this issue would overly lengthen this Article, however, we have deferred its detailed consideration to our forthcoming book-length study.[61]

III. COUNTING THE BENEFITS

After assessing program costs, the decisionmaker must, of course, seek to understand the extent to which each proposed cleanup program would benefit the citizens of the Delaware Valley, as well as residents of other regions. While recognizing that certain benefits could not be readily translated into dollar terms,[62] the DECS nevertheless attempted to assist policymakers by placing dollar values upon the principal recreational and commercial uses which a cleaner Delaware would make possible.[63] Since more than ninety-five percent of these benefits were found to reside in the river's increased potential for recreation, we shall concentrate upon the values of these uses in the text.[64] The

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[61] *See* B. ACKERMAN, *supra* note 7, chs. 5, 10. For a preliminary effort, see Ackerman & Sawyer, *supra* note 1, at 489-95.

[62] *See* DECS, *supra* note 4, at 71, 74, 80. The unquantifiable benefits mentioned in the *Report* include the preservation of fish and wildlife, improved drinking water taste and aesthetics.

[63] The DECS itself estimated the money value of benefits which it believed would accrue to municipal and industrial users and to commercial fishermen. For estimates of the benefits generated by enhanced recreational opportunities, the DECS relied heavily on INSTITUTE FOR ENVIRONMENTAL STUDIES, UNIVERSITY OF PENNSYLVANIA, WATER ORIENTED RECREATION BENEFITS, A STUDY OF THE RECREATION BENEFITS DERIVABLE FROM VARIOUS LEVELS OF WATER QUALITY OF THE DELAWARE RIVER, PHASE I (1966) & PHASE II (1967) [hereinafter cited as IES STUDY]. The study was directed by Anthony R. Tomazinis and Iskandar Gabbour and performed for the DECS under a contract with the Public Health Service, U.S. Department of Health, Education and Welfare. For convenience in exposition we will refer to the IES recreation benefits estimates as "DECS estimates"; the designation is not unwarranted since the DECS did make use of the IES results, thereby implicitly endorsing them.

The DECS *Report* was completed in 1966, but the IES *Study* was not completed until 1967. The recreation-benefits estimates in the *Report* are based on a preliminary version of the IES estimates. Since the completion of the final version of the IES *Study*, the DECS staff have used the IES estimates in their further analyses of recreation benefits. *See, e.g.*, Smith & Morris, *supra* note 45, at 1635.

[64] The DECS estimates for each category of benefits, over and above the benefits associated with maintaining 1964 conditions, are presented in the following table:

PRESENT VALUE OF ALL NET QUANTIFIABLE BENEFITS IN MILLIONS OF 1964 DOLLARS

Program	*Type of Estimate*	*Recreation*	*Commercial Fishing*	*Industrial*	*Total*
I	Maximum	355	12	—15	350
	Minimum	155	9		160
II	Maximum	320	12	—13	320
	Minimum	135	9		140
III	Maximum	310	7	—10	310
	Minimum	125	5		130
IV	Maximum	280	5	— 7	280
	Minimum	115	3		120

DECS, *supra* note 4, at 77 (Table 20) (recreation benefits), 80 (Table 21) (commercial fishing benefits), 74 (Fig. 43) (industrial benefits), 81 (total benefits).

dollar values the DECS placed upon enhanced swimming, fishing and boating possibilities are shown in the preceding footnote. Table 2 summarizes the additional benefits which the DECS believed would be generated by choosing a given level of pollution control rather than the next lower objective.

TABLE 2

MARGINAL BENEFITS OF DECS POLLUTION CONTROL PLANS (PRESENT VALUE, 1964 DOLLARS DISCOUNTED AT 3% FOR TWENTY YEARS)

Objective	*Net Marginal Benefits of Choosing Given Objective Instead of Next Lower Objective* Maximum	Minimum
I	$35 million	$20 million
II	10	10
III	30	10
IV	280	115

A quick glance at the chart should at once place the conscientious decisionmaker on his guard. The figures reveal a puzzling pattern; they suggest that a modest improvement in river quality will generate relatively large benefits ($115 million if one is a pessimist, $280 million if one is an optimist), whereas far more ambitious programs will generate only relatively small additional benefits to the citizens of the valley. The exceedingly expensive Program I, for instance, is expected

The negative numbers in the "Industrial" column reflect the DECS staff's discovery, *id.* 72, that cleaner water would actually impose costs on industrial users "primarily due to increased corrosion rates at the higher oxygen levels." The staff does not explain why the sums of the individual benefits categories do not equal the total benefits figures for any of the programs.

The differences between maximum and minimum net benefit figures are detailed at *id.* 76. The maximum benefit estimates assume that no swimming occurs at present, that boats contain an average of 4 people and that 25% of all recreationists value their experience at $5 per activity day with the remainder valuing the experience at $1.25. The minimum estimates assume that swimming presently occurs in the lower estuary, that each boat averages 3.5 people, and that 25% of the users value their experience at $3 per activity day with 75% valuing an activity day at $.75. IES STUDY, PHASE II, *supra* note 63, at 44-56, also reports maximum and minimum estimates of net benefits. These estimates are based on assumptions different from those underlying the DECS estimates. In particular, in the IES work both maximum and minimum estimates are based on the assumptions that swimming could take place in the lower estuary under 1964 conditions and that boats used on the estuary carry an average of 4 people. Also, the assumptions regarding the valuation of activity days are different and somewhat more complicated. The DECS staff has adopted the assumptions from the IES *Study* for use in its subsequent analyses of recreation benefits.

DECS discusses the benefits data as if only swimming, boating and fishing benefits were included. However, the discrepancies between the IES estimates for these categories and the DECS figures indicate that the DECS data may include the dollar value of picnicking benefits as well. For a fuller discussion of picnicking, see Appendix B, *infra*.

to produce benefits valued at only $40 million (or $75 million if one is an optimist) more than those anticipated from the far less costly Program IV.

Such a dramatic decline in the returns from additional expenditure on pollution control is not, of course, impossible. Nevertheless, the prediction should be enough to invite the decisionmaker to probe further: is the DECS wrong in belittling the extra benefits to be gained from far more expensive programs? Alternatively, could the DECS be wrong in placing a high valuation on the improvements resulting from moving beyond the modest objective of maintaining the environmental status quo? In the succeeding sections, we shall demonstrate that the DECS committed the second error and grossly overstated the dollar value of benefits to be gained from cleaning up the river both under Program IV and under more ambitious proposals. Since the methodology which generated these overestimates is in general use,[65] we shall take care to expose its basic conceptual flaws as well as the serious errors in execution which marred the DECS effort.

The thrust of our criticism is simply that the benefit analysis pursued along the Delaware (and elsewhere) bears little relationship to the analysis which is suggested by relatively straightforward economic reasoning and that, as a result, the DECS obscured rather than clarified the nature of the policy choices to be made by the DRBC. In stating these criticisms, we do not suggest that competent economic analysis permits the decisionmaker to reach a single "correct" answer to the problem of evaluating benefits. Indeed, after our exposition of the economist's approach is completed, we shall attempt to elaborate upon its fundamental limitations.[66] Our point here is quite modest: as classical forms of economic reasoning can illuminate certain dimensions of the pollution problem, an approach which ignores the economist's insights is at least as defective as one which looks to the dismal science as the exclusive repository of public policy.

[65] The basic conceptual framework of the IES *Study* upon which the DECS estimates are based is the same as the one employed by the Bureau of Outdoor Recreation, U.S. Department of Interior, in many of its studies. For a discussion of some variants of the basic framework and a list of the studies to which they were applied, see 3 BUREAU OF OUTDOOR RECREATION, U.S. DEP'T OF INTERIOR, CHESAPEAKE BAY STUDY, RECREATION ELEMENT, PLANNING AID REPORT No. 1, at 99-117 (undated). A relatively recent application of this framework is BUREAU OF OUTDOOR RECREATION, U.S. DEP'T OF INTERIOR, A FEASIBILITY REPORT ON THE RECREATIONAL ASPECTS OF THE PROPOSED ENGLISH RIDGE UNIT EEL RIVER DIVISION NORTH COAST PROJECT, MENDOCINO AND LAKE COUNTIES, CALIFORNIA (1968). For a study performed by researchers outside the Bureau of Outdoor Recreation which uses the same basic framework, see EDWARDS & KELCEY, INC., NEW JERSEY COMPREHENSIVE OUTDOOR RECREATION PLAN (1970) & Technical Report Nos. 7-9. A succinct summary of the basic steps used in applying the framework is given in H. GRUBB & J. GOODWIN, ECONOMIC EVALUATION OF WATER ORIENTED RECREATION IN THE PRELIMINARY TEXAS WATER PLAN, REPORT No. 84, at 6 (1968).

[66] Section V, *infra*.

A. *A Conceptual Framework*

Before considering the particular difficulties involved in valuing the benefits of pollution control, let us consider the more general problem. Suppose that the results of a government-financed research effort, when made public, led to the introduction of a new product, say automatic washing machines, which produced better results than the prior technology, say, hand washing. Imagine that an economist were asked to measure the benefits generated by the research effort so that they could be compared with its costs. How would he go about this task?

If the washing machine market is in equilibrium at $100, the number of machines demanded by consumers is just equal to the number producers find it profitable to supply. At a slightly higher price (say $101), some "marginal" consumers will balk at the offer of a washer and choose another set of competing goods instead. For these marginal purchasers, buying a washing machine at $100 *provides them with virtually no more satisfaction than they would have if washing machines were not offered on the market at all.* Thus, if we wish to estimate the net benefits generated by the new technology, we must consider exclusively the situation of those "intramarginal" consumers (often the great majority) who would stick to washing machines even if the price were significantly higher than $100.

Suppose, for example, we interviewed an intramarginal consumer named Jones and learned that he would have purchased his machine even if the price had been $150.[67] Since the market only requires Jones to pay $100, he could sacrifice $50 and still be no worse off than he was before washing machines became available.[68] If we do not exact

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[67] We assume that Jones will tell the truth. It is easy to see why he might not. If Jones knew that he would have to pay the amount he quotes, he might understate his willingness to pay. On the other hand, if he thought that his reply might affect the decision of a public authority to subsidize washing machine production, he might overstate the maximum price he would pay. For further discussion of the problems of relying on interviews with consumers, see text preceding note 71 *infra*.

[68] This "sacrifice test" is better known to economists as the "compensation test," and the sacrifice measure of benefits is called the "compensating variation."

Unfortunately, the attempt to place a dollar value on the improvement in consumers' positions brought about by some change in their opportunities is confronted with a fundamental ambiguity except under very special circumstances. While the conceptual experiment we have called the sacrifice test seems to be a reasonable one, another equally reasonable experiment can be devised. We might ask consumers how much of a bribe they would demand before they would consider themselves as well off without washing machines as they are with their original money incomes and the availability of washing machines at $100. Economists have dubbed the results of this "bribe test" the "equilibrating variation." The sacrifices (compensating variations) consumers would make in order to buy washing machines for $100 are equal to the bribes (equilibrating variations) they would accept in return for forgoing this opportunity only under the quite stringent assumption that purchases of the good under consideration do not change when all prices are held constant and money income is increased. For a proof of this assertion, see Patinkin, *Demand Curves and Consumer's Surplus*, in MEASUREMENT IN ECONOMICS: STUDIES this $50 sacrifice from Jones, the introduction of the new good has in effect put $50 in extra income into Jones' pocket. It is this "consumer's surplus" of $50 which the economist counts as the benefit to Jones of his obtaining a washing machine, not the $100 market price. The total benefit accruing from the new opportunity is obtained simply by summing the amount of money beyond the market price each intramarginal consumer would sacrifice[69] before he forsook his washing machine.[70]

IN MATHEMATICAL ECONOMICS AND ECONOMETRICS IN MEMORY OF YEHUDA GRUNFELD 83, 94 (C. Christ ed. 1963).

Although some authorities have argued that it will be clear from the situation under consideration whether the sacrifice test or the bribe test is appropriate, *e.g.*, *id.* 95, there seem to be no purely logical grounds for choosing between the two tests. This fundamental ambiguity involved in the measurement of the benefits to consumers from changes in their opportunities has practical implications. The benefits from a proposed change must be compared to the costs of achieving the change. If both the sacrifice test and the bribe test yield benefits estimates which are larger or smaller than the costs of the change there is no problem, but if one measure of benefits exceeds costs and the other falls short of them, the decisionmaker is faced with a dilemma which seems insoluble *in principle.* Our analysis will suggest, however, that this potentially troublesome ambiguity does not cause a problem in evaluating the proposed pollution control schemes for the Delaware Estuary, since the costs of the DRBC program quite clearly outweigh the benefits, however defined.

69 The figure obtained by the application of the sacrifice test to the information supplied by Jones and his fellow intramarginal consumers is a completely accurate measure of the benefits to society of government research on washing machine technology only under a set of stringent assumptions. First, it must be assumed that all goods and factor markets are perfectly competitive and that there are no taxes or subsidies associated with the consumption or production of any good or the use of any factor. Second, there must be no external effects in either consumption or production; that is, the satisfaction derived by each consumer from a given bundle of goods must be independent of how much other consumers purchase, and the level of output of each good associated with a given factor input must be independent of the level of output of all other goods. Third, it must be true that the prices of all goods except washing machines and the prices of all factors of production remain unchanged when some factors of production are switched from the production of all other goods to the production of washing machines. The assumption of constant prices is a useful first approximation when the production of the good being considered (washing machines) makes relatively limited demands on the resources available to the economy and when production does not require specialized factors of production with few alternative uses. Fourth, it must be assumed that washing machines can be produced at a constant cost of $100 per machine over the relevant range. Finally, decisionmakers must be convinced that a dollar's worth of sacrifice means the same thing to society no matter which consumer makes it.

For a discussion of the problems encountered when these restrictions are relaxed and a pessimistic conclusion regarding the usefulness of the sacrifice test, see I. LITTLE, A CRITIQUE OF WELFARE ECONOMICS 174-84 (1957). For a discussion of how to deal with some of these problems and a defense of the usefulness of the sacrifice test, see Harberger, *Three Basic Postulates for Applied Welfare Economics: An Interpretive Essay*, 9 J. ECON. LIT. 785 (1971). Some economists argue that the restrictive assumptions and information inputs required for a completely correct application of the sacrifice test under more general circumstances are so many and so complex that they cannot even be closely approximated in a practical application. But at the same time even many purists would agree that when the costs of a project *far* exceed its benefits, or vice versa, cost-benefit analysis remains a valuable tool, even though both costs and benefits have been obtained by an application of the sacrifice test to a situation which does not meet many of the restrictions which are required in principle. We shall argue that the Delaware represents just such a case.

70 Jones and his fellow consumers will probably each purchase only one washing machine. Applying the sacrifice test to the more usual case, in which the number of units of a good purchased by each consumer continues to increase as the price of the good falls when all other prices and money incomes are held constant, involves no new principles.

While we are not interested in washing machines, assessing pollution control benefits leads us to ask the same basic questions. Since pollution control provides improved opportunities for recreation, we must ask in this case: *how much money would recreationists sacrifice before they became indifferent to the choice between their improved set of opportunities and the old set previously available to them?* Once again, this question *cannot* be answered simply by ascertaining how much money people will in fact spend in order to take advantage of the better swimming, fishing and boating opportunities made available by different levels of Delaware cleanup. Our first concern remains with the consumer's surplus obtained by the intramarginal recreationist who avails himself of the improved opportunities.

If the effect of pollution control is really to make available a "new" good, our earlier discussion of washing machines provides us with a sense of direction but does not provide much help with the difficult task of trying to gain a sense of the magnitude of the consumer's surplus generated by pollution control. In applying the "sacrifice test," we imagined that satisfactory answers could be obtained by interviewing intramarginal consumers. But there are serious difficulties with this technique. Not only would the procedure be costly, but the answers received could well prove to be extremely unreliable indicators of the sacrifice consumers would in fact make: consumers are unused to speculating seriously about their potential responses to hypothetical events such as the availability of swimming in the Delaware. Similarly, while elaborate statistical analyses could in principle be developed which might give better information than consumer surveys, neither the state of the art nor the existing data base for the Delaware Valley is adequate for such an effort.[71] In sum, an economist who is attempting to be helpful to decisionmakers by placing a money value on "new" goods cannot at the present time take refuge in an expert manipulation of complex data, but must rely instead on a more informal approach which is nevertheless consistent with the basic principles we have discussed.

In order to understand how the analyst can gain a rough estimate of the increase in consumer's surplus without the use of the elaborate factfinding apparatus just described, it is once again most helpful to

However, the use of market data to determine the amount that consumers are willing to sacrifice requires somewhat greater care in this case.

71 A second cost-benefit study of pollution control on the Delaware Estuary, Davidson, Adams & Seneca, *The Social Value of Water Recreational Facilities Resulting from an Improvement in Water Quality,* in WATER RESEARCH 175 (A. Kneese & S. Smith eds. 1966), used more sophisticated statistical techniques for estimating recreational demand than the DECS *Report* and the IES *Study*. However, this study did not attempt to apply the sacrifice test to measure benefits.

explore another simple example. Rather than consider the introduction of a new product (like washing machines), consider this time the problem posed when a technological improvement simply makes it cheaper to supply an already existing good. Imagine, for instance, that paperback books formerly available for $2.50 are now reduced in price to $2.00. Given this hypothetical situation, how can the economist determine consumer's surplus by estimating in a commonsense way the amount consumers will sacrifice before they are no worse off than in the old situation in which paperbacks cost $2.50?

To make the problem simple, imagine further that the economist is told that at the old price, 2 million books were sold annually while at the new lower price 2.4 million books are purchased.[72] Given this fact, it is a straightforward matter to get a lower limit on the dollar amount consumers would be willing to sacrifice. For we know from history that 2 million books were purchased at $2.50; thus, the purchasers of these books will save 50¢ a book under the new regime, and could be required to sacrifice one million dollars without considering themselves any worse off.

To see that one million dollars is indeed a lower limit on the benefit estimate, it is necessary to turn our attention to the extra 400,000 books which by hypothesis are purchased at the lower $2.00 price. It is reasonable to suppose that some consumer's surplus will accrue to the purchasers of these volumes, although the precise magnitude of this quantity is a good deal more difficult to determine. It is possible, however, to get a first approximation. To do this, we must take into account the fact that these books would not (by hypothesis) have been purchased at $2.50. This means that if we required the consumers of these volumes to sacrifice a total of $200,000 (50¢ x 400,000 books), they would consider themselves worse off than they had been under the old regime. Thus, the consumer's surplus associated with the purchase of the extra 400,000 paperbacks must be between $200,000 and zero.

In order to be more exact than this, it would be necessary to know the number of books which would be purchased at each price between $2.50 and $2.00. Even in the absence of this information, however, it is possible for the analyst to say something meaningful and relatively precise about the size of the benefit consumers as a class will obtain in our simple example, without resort to any elaborate apparatus. The money benefit of the decline in price to paperback purchasers is between $1 million and $1.2 million per year.[73]

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72 We assume that the assumptions in note 69 *supra* are met.

73 A significant oversimplification in the discussion in the text should be noted. Even

Having explored the economics of one form of recreation (reading paperbacks), we can consider whether anything has been learned about other forms of recreation, like swimming, boating and fishing in the Delaware River. If investment in pollution control can be viewed simply as a means of reducing the cost consumers must incur in order to engage in already-existing recreational activities, then our paperback example suggests a simple methodology. Thus, if pollution control permits consumers to travel to a nearby swimming beach at a cost of $2.00 instead of to an otherwise identical beach further away for $2.50, calculating the consumer's surplus resulting from the pollution program should be just as easy in principle as in the paperback book example. If, however, pollution control generates services which are perceived to be substantially different in quality so that they may more appropriately be regarded as "new goods," it will be necessary to employ heavier doses of subjective judgment and intuition in estimating the amount of money consumers will be willing to sacrifice and still be no worse off. For here the paradigm case is represented by our discussion of washing machines rather than paperbacks.

The appropriate paradigm for an economic analysis of the benefits of pollution control cannot, of course, be determined *a priori*. Environmental improvement may generate "new" products or it may simply reduce the cost of obtaining "old" ones, or it may do both. Nevertheless, our theoretical examination has prepared us to apply the paradigms sensitively in the analysis of concrete cases, to which we shall now turn.

B. *Applying the Framework to the Pollution Problem in the Delaware*

1. Swimming in the Delaware?

Consider the swimming opportunities presently available to a resident of center-city Philadelphia. Close to home, he may pay an admission fee and swim in the pool of his choice, either public or private.[74] At a greater distance, he has four options: he may drive

if we take $1,000,000 away from consumers they will still be better off than before the price decline for paperback books, since they can substitute increased purchases of relatively cheaper paperback books for other goods. In short, the text considers a hypothetical ordinary demand curve for paperbacks which could be constructed from a market study by varying the price of paperbacks while holding other prices and money incomes constant, and suggests that if we knew the quantities purchased between $2.50 and $2.00 we could give a more exact estimate of the amount consumers would be willing to sacrifice. The area under the ordinary demand curve between the two prices is, however, a completely accurate measure of this amount of sacrifice only in the unlikely case in which purchases of paperbacks do not change when money incomes rise with all prices held constant. When the quantity purchased rises with money incomes, this area is an overestimate. The best estimate one could make from market data in this more common case would be to determine the area between the two prices under what is called a "real income compensated demand curve." For a full discussion of this point, see Patinkin, *supra* note 68.

74 IES STUDY, PHASE I, *supra* note 63, at 26, reports that there were 826 public and

between an hour and an hour and a half[75] and sample the delights of Atlantic City, or some less crowded beach at a somewhat greater distance on the Jersey Shore; he may visit one of the mountain lakes between two and one-half and three and a quarter hours away in the Pocono mountains;[76] he may drive southwest for two and a quarter hours to the relatively deserted shores of the Delaware Bay, which lies at the mouth of the Delaware River;[77] he may drive for an hour or two to the relatively small number of public swimming facilities along the Delaware River above Trenton.[78] How then will adopting one of the competing cleanup programs broaden these options?

The answer is extremely disappointing. Even if one accepts completely the DECS predictions as to the physical consequences of abating pollution on the Delaware, swimming and other water contact recreation will be impossible under *any* of the proposed programs (including the most expensive Program I) in the industrialized area stretching from just inside the northeast city limit of Philadelphia to just below Wilmington.[79] Moreover, as an earlier Article argued in detail, there is every reason to believe that these DECS estimates are overly optimistic.[80] Thus, it is extremely doubtful that swimming would be possible, even under Program I, anywhere in the estuary except perhaps in the relatively unpopulated area below Wilmington near the Delaware Bay. In any event Program I was never seriously considered, and the potential for swimming between Trenton and Philadelphia under less ambitious cleanup projects is even more speculative. While the DECS continues to predict swimming in this region under either Program II or III,[81] this prediction seems a fond hope rather than a

private pools in the 5 Pennsylvania counties (Bucks, Chester, Delaware, Montgomery and Philadelphia) in and around Philadelphia in 1965. This estimate is based on the number of pool permits as determined from the files of the Pennsylvania Department of Health, Regional Office VII, in Philadelphia. The private pools included in the estimate are those at YMCA's, country clubs, motels and similar semipublic locations. Backyard pools are not included.

75 We estimate that the travel times to Atlantic City, Cape May and Tom's River are 65 minutes, 85 minutes and 90 minutes respectively. This calculation was made by measuring the distance to these locations along established routes and assuming an average speed of 60 miles per hour on expressways and 30 miles per hour on all other roads. Our estimates are probably best interpreted as referring to an average weekday. The experience of two of the authors, Bruce and Susan Ackerman, indicates that at peak times on summer weekends the trip to Atlantic City takes between 1½ and 2 hours.

76 Using the method described in note 75 *supra*, we estimate that the driving time to Mount Pocono is 155 minutes and that the driving time to Lake Wallenpaupack is 195 minutes.

77 The approach outlined in note 75 *supra* yields an estimate of 135 minutes driving time to Woodland Beach, located on the Delaware Bay 5 miles below the boundary between the bay and the estuary.

78 Using the approach outlined in note 75 *supra*, we estimate that it takes 125 minutes to drive to the Delaware Water Gap.

79 DECS, *supra* note 4, at 55. This area is represented by sections 7-22 in Fig. 2 accompanying note 11 *supra*.

80 *See* Ackerman & Sawyer, *supra* note 1, at 449-81.

81 DECS, *supra* note 4, at 55, shows river sections 1-4 to be suitable for water con-

probable outcome, given Trenton's sewer problem and the significant runoff from diffuse sources in a heavily populated area. Otherwise, the DECS more realistically predicts that water contact recreation will be likely only at the bottom of the estuary under Program II, III or IV.[82]

It should be clear, however, that making swimming possible in the lower estuary near the Delaware Bay broadens only slightly the range of choice open to the resident of center-city Philadelphia. But we can be more precise than that. In order to assess the amount a typical citizen of Philadelphia would sacrifice to swim in the lower estuary near the Delaware Bay, we must determine whether the problem is amenable to the relatively easy approach suggested by our discussion of the paperback books or whether it involves the difficulties suggested by our study of washing machines. The critical difference between the two paradigms, it should be recalled, is whether the good evaluated is so different in quality from those previously available that it must be considered a "new" good for purposes of benefit analysis. In considering the issue of relative quality, we should first inquire whether any existing resources provide a swimming experience similar to that offered by the lower estuary. The Delaware Bay is an obvious candidate. Indeed, the place where the estuary ends and the bay begins is not apparent to the would-be swimmer, but instead is defined scientifically on the basis of salt concentration. It is possible, of course, that even though the natural character of the two areas is identical, the manmade environments are substantially different. Most importantly, if the bay's swimming areas were crowded and it were impossible or ecologically undesirable to expand these facilities, making the lower estuary available would generate benefits for those intramarginal users of the bay area who very much dislike crowding. Moreover, more consumers might choose bay-estuary swimming if crowding were noticeably reduced. The bay's swimming potential, however, is far from exhausted, given its vast shoreline and the low population density of the surrounding area.[83] Clearly, the effect of pollution control on the Delaware is simply to bring an already existing type of swimming opportunity somewhat closer to the center-city Philadelphian. For swimmers, then, cleaning up the Delaware River is equivalent to building a better highway to the Delaware Bay

tact recreation under Programs II and III. This river segment begins opposite the middle of Trenton and ends opposite the middle of Burlington.

[82] DECS, *supra* note 4, at 55, shows river sections 27-30 to be suitable for water contact recreation under Programs II, III, and IV. Section 27 begins about 10 miles below Wilmington, and section 30 ends at the beginning of the Delaware Bay.

[83] A telephone interview with R. Howell, Delaware Division of Public Health, Sept. 1972, confirmed that there is excess capacity at the Delaware beaches with acceptable water quality on the Delaware Bay. On the New Jersey side of the bay there are virtually no developed recreational facilities because the region is remote from population centers and relatively inaccessible.

with a consequent reduction in travel time and expense. It is properly comprehended under the paperback book paradigm as a cheaper form of a good already on the market.

Proceeding on our analysis of that simple hypothetical, we note first that those already traveling to the bay for swimming would sacrifice a sum equal to their saving in travel costs[84] times the number of trips they were already making. For those new trips induced by the bay-estuary area's new proximity, the analysis is somewhat less conclusive. Nevertheless, it should be clear that each new traveler, like each new purchaser of books in the paradigm case, will obtain less intramarginal surplus than any of the old bay swimmers who now use the new facilities, because they formerly did not value bay-estuary type swimming sufficiently to make the trip to the bay. Thus, the total money benefit resulting from the new trips will be obtained by multiplying a number which is less than the travel cost saving (but greater than zero) by the number of new trips taken.[85]

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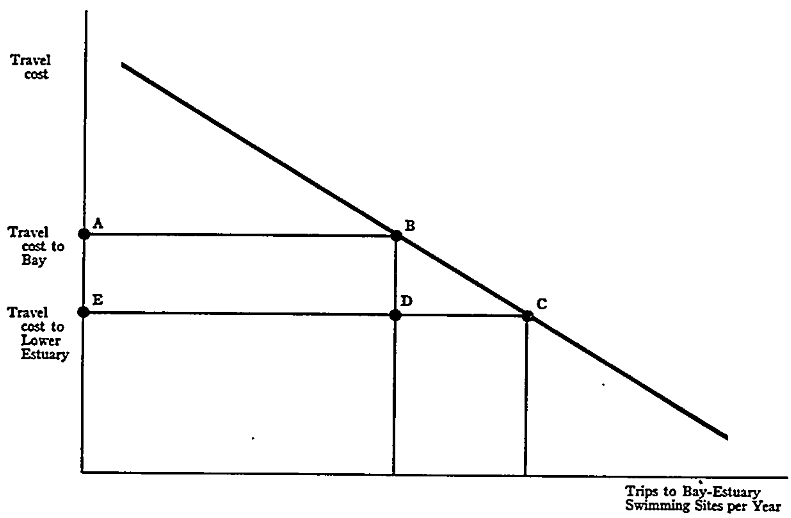
[84] Travel cost includes the price of a mass transit ticket or the gas, oil and depreciation by use costs of traveling by automobile plus a valuation of the traveler's time. If the trip is a long one, meal and lodging costs above those that would be incurred if the swimmer stayed home should also be included.

Several studies have employed estimates of travel cost. *See, e.g.*, H. GRUBB & J. GOODWIN, *supra* note 65; Knetsch & Davis, *Comparisons of Methods for Recreation Evaluation*, in WATER RESEARCH, *supra* note 71, at 138-42. These studies do not attempt to value the time spent traveling and assume that travel cost is simply related to distance traveled, an assumption which may not be justified if some roads are quite congested. For a recent attempt to deal with the problems of valuing travel time, see R. GRONAU, THE VALUE OF TIME IN PASSENGER TRANSPORTATION: THE DEMAND FOR AIR TRAVEL (1970). A good summary of similar attempts is Nelson, *The Value of Travel Time*, in PROBLEMS IN PUBLIC EXPENDITURE ANALYSIS 78 (S. Chase ed. 1968).

[85] The benefits to swimmers from pollution control can be represented by trapezoid ABCDE in the diagram below. The rectangle ABDE represents the benefits accruing to those already engaged in bay-estuary type swimming. The triangle BCD represents benefits generated by new trips. The trapezoid ABCDE is a completely accurate measure of benefits only under the restrictions outlined in note 69 *supra*.



There is room for dispute as to the precise number of new trips that will be taken and the exact money savings per trip which would result from making bay-estuary swimming available closer to population centers, but there can be no doubt that the total benefits resulting from the economist's calculation will be exceedingly small. At present, the Delaware Bay attracts a relatively small share of the millions of swimming days annually enjoyed by Philadelphians in pools, on the Jersey Shore, the upper Delaware and the Poconos. There is no reason to expect that improving the bay-estuary's competitive position by making it a bit closer to the metropolis will change matters significantly.[86]

2. Boating on the Delaware

The DECS estimates that on a pleasant weekend day thousands of pleasure boats may ply the waters of the estuary in its present "polluted" condition.[87] In other words, it would be wrong to assume (as we did in the case of swimming) that the Delaware is at present an untapped boating resource. The question remains, however, whether any of the pollution programs considered would so raise the *quality* of the boating experience that present users of the estuary would set an appreciably higher value on the boating experience there; that those boatsmen now using either the Jersey Shore or the Delaware Bay would shift in significant numbers to the estuary;[88] or that many others would abandon their former nonboating pursuits to become Delaware boatsmen.

If these are the questions, the answers are rather straightforward. There is no reason to believe that *any* of the pollution control programs will significantly improve the quality of the boating experience on the Delaware. "Pollution" may reduce the pleasure of boating if it causes such substantial oxygen depletion that the water emits a malodorous stench;[89] contains elements corrosive to hulls; or impairs

86 The DECS staff reached a different conclusion. *See* Section IV, *infra.*

87 Federal Water Quality Administration, Environmental Protection Agency, Delaware Estuary Comprehensive Study, Final Report, ch. 3B, at 10 (Feb. 3, 1970) (unpublished materials on file at the Biddle Law Library, University of Pennsylvania Law School) [hereinafter cited as DECS Final Report, Preliminary Draft], states that "[a]pproximately 15,000 boats use the estuary." This figure was reached "by estimating the number of boats using the estuary from boat registration data and from estimates from state shore patrols." IES STUDY, PHASE I, *supra* note 63, at 30, 32, using an undisclosed method, estimated that 10,000 boats were in use on the estuary "on the Pennsylvania side" in 1965 and that 3,125 boats used the northern part of the estuary "on the New Jersey side."

88 Of course, a substantial change in quality, were it to occur, might also cause boaters who now use lakes in the Poconos, the Chesapeake Bay or the Susquehanna River to switch to the estuary.

89 *See* text following note 9 *supra.*

the appearance of the river by increasing the water's turbidity.[90] As to the first threat, the presence of a large number of boating parties indicates, and the testimony of DRBC officials confirms,[91] that there is no significant odor problem on the estuary at present and that any program which seeks to improve oxygen levels cannot be justified on the ground that it is necessary to eliminate this nonexistent nuisance. As to the second risk, there is little evidence that the extra corrosion due to pollution generates costs of any considerable magnitude.[92] The third problem, dealing with visual aesthetics, is more complex. Although the Delaware is at present an extremely turbid river, none of the proposed programs is likely to transform the situation substantially since the river's cloudiness is explained in large part by tides stirring up the river bottom, dredging operations required for large-scale shipping, and the introduction of sediment from the riverbanks and tributaries.[93] Even if turbidity is somewhat reduced, this "quality improvement" may not be an unmixed blessing to the boatsman, because by making it possible for sunlight to penetrate farther below the surface, turbidity reduction will greatly encourage photosynthetic activity by algae. Thus, "solving" the turbidity problem may create a more serious problem; boaters may be greeted by green scum, which upon the algae's death will be transformed into a stinking mass of decomposing matter.[94]

Assuming, however, that turbidity will be reduced, it would be easy to overestimate the impact of this improvement on the totality of the boating experience. If one were to take a day trip down the Delaware through the highly urbanized area between Trenton and Wilmington, one would hardly notice the slight change in water color wrought by pollution control. For the river is the scene of far more arresting activities: major industrial complexes dominate the shoreline, large tankers steam by, and a host of other activities on river and

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90 "Pollution" may also take the form of oil slicks, which are both a nuisance and a danger to boaters. Although they may well be a more important problem for boaters than any of the other problems mentioned in the text, oil slicks were not a major concern of the DECS. The DECS forecast that there would be some reduction in the amount of oil and grease in the estuary as a byproduct of treatment procedures at industrial and municipal sources designed primarily to raise the DO level. Oil slicks due to spills at refineries are a somewhat different problem. The DECS did not include the expense of cleaning up these spills in their cost estimates for any of the pollution control programs. The DRBC has, however, begun to insist that major spills be cleaned up. The costs and benefits of the DRBC's policing of oil spills have not been systematically investigated.

91 Note 10 *supra.*

92 Nowhere in DECS, *supra* note 4, in IES STUDY, *supra* note 63, or in DECS Final Report, Preliminary Draft, *supra* note 87, ch. 3B, is the corrosion of hulls mentioned as a deterrent to boating activity.

93 Ackerman & Sawyer, *supra* note 1, at 445.

94 *Id.* 446.

shore remind the boatsman that he is coexisting with the life of the port which serves the fourth-largest urban complex in the United States. This visual experience has its attractions; but to imagine that a slight change in water color will transform this experience so as to attract a different class of boaters searching for a more natural setting is nonsense. These recreationists will go where they always have gone—to the Jersey Shore, the lower estuary and the bay, and even further to the Chesapeake and the Poconos. Thus, the benefits—as the economist sees them—from pollution control will be no greater for boating than they were for swimming.

3. Fishing in the Delaware

We come, finally, to those activities whose perceived quality and price will be affected appreciably by a pollution control program of the kind proposed for the Delaware. The principal purpose of each of the DRBC's proposed programs was to raise DO levels in the estuary by requiring municipal and industrial dischargers to reduce the emission of those pollutants which would otherwise consume oxygen in the river as they decomposed.[95] Since fish require dissolved oxygen for their survival, raising DO levels should permit a richer aquatic life in a wider area than that which was formerly possible. The minimum oxygen level required for survival is at best ill-defined and differs according to the breed of fish considered, but if DO levels remain generally at five ppm and rarely if ever fall below three ppm, a broad variety of aquatic life may be expected. Purporting to apply this standard,[96] the DECS used its mathematical model to predict the

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[95] The bulk of pollution control costs under each of the programs would be incurred in order to reach the DO objective. *See* note 16 *supra.*

[96] IES STUDY, PHASE II, *supra* note 63, at 20 n.10, states that a section is considered suitable for high usage fishing if there is a 90-95% chance that anadromous fish (in the case of the Delaware, primarily the American shad) can survive passage through it. This standard is translated into DO levels by the DECS staff in A. Morris & G. Pence, Quantitative Estimation of Migratory Fish Survival Under Alternative Water Quality Control Programs 6-9 (undated) (unpublished manuscript under imprint of the Federal Water Pollution Control Administration, U.S. Dep't of Interior, Edison, N.J.) [hereinafter cited as Morris & Pence]. The study reports that shad survive in water with DO levels of 3 ppm but die in water with DO levels of 2.5 ppm or less. Using experts' advice, the DECS concluded that shad could survive for several minutes if the DO level fell below 3 ppm. It then argued that if there is to be a 95% chance of shad survival in a section, the mean DO level must be high enough to insure that DO levels will not dip below 3 ppm more than 5% of the time.

The DECS staff's reasoning assumes that daily DO levels in each section have the familiar bell-shaped normal distribution. Under this assumption there is a 95% chance that the observed DO level in any section will lie within a range of 2 standard deviations on either side of the mean DO level for that section. The DECS staff report that the average standard deviation of the daily DO level for *all* sections in the Delaware is approximately 1 ppm. They reason that if the mean DO level in a section on a given day is 5 ppm, we can expect the observed DO level to lie between 3 ppm and 7 ppm 95% of the time and to lie below 3 ppm 2.5% of the time. This reasoning leads them to the conclusion that if the mean DO level in a section is 5 ppm on a given day, there is a sections which would sustain "high usage fishing" under each of the proposed cleanup programs. Similarly, it marked those sections which would satisfy a somewhat less demanding DO test as suitable for "medium usage fishing."[97] Areas available for high and medium usage fishing at the time of the survey (1964) were also recorded, permitting the DECS to formulate a chart summarizing the consequences of the four river improvement programs as well as Program V, which simply contemplated maintaining the status quo:[98]

TABLE 3

DECS ESTIMATES OF DELAWARE ESTUARY SECTIONS SUITABLE FOR HIGH AND MEDIUM USAGE FISHING

Program	*Sections Suitable for High Usage Fishing*	*Sections Suitable for Medium Usage Fishing*
I	1-10, 18-30	11-17
II	1-7, 28-30	8-27
III	1-7, 28-30	8-9, 22-27
IV	1-3, 28-30	4-9, 23-27
V	1-3, 28-30	4-9, 23-27

In sketching the way an economist would assess the impact of a DO improvement program upon fishermen, we will focus on the availability of high usage fishing resources in the upper estuary be-

95% chance that a shad could pass through the section on that day. (Strictly there would be a 97.5% chance of survival.)

We reported in our earlier essay, Ackerman & Sawyer, *supra* note 1, at 455-457, that for most of its calculations the DECS staff used a so-called steady state assumption; that is, they assumed that the same conditions would prevail in the river every day during the summer. Under this assumption, if 5 ppm is the summer average DO level in a section, it is also the daily average DO level. If there is a 95% chance that a shad could survive passage through a section on one day during the summer, under the DECS steady state assumption there is a 95% chance that a shad could survive passage any day during the summer.

Under the DECS assumptions every section for which the predicted summer average DO level is 5 ppm or more is one in which there is a 95% chance of shad survival, and so is suitable for high usage fishing.

97 None of the DECS reports we have obtained states specifically the standard which the DECS used to determine whether or not a section was suitable for medium usage fishing. We have argued in note 96 *supra* that the fragmentary evidence available suggests that a section was considered suitable for high usage fishing if the predicted summer average DO level was 5 ppm or greater. If this inference is correct, then sections with summer average DO levels of between 5 ppm and some lower bound were considered suitable for medium usage fishing. This lower bound appears to be 3.5 ppm. DECS, *supra* note 4, at 55-58, shows that under Program IV, sections 23-27 have a predicted summer average DO level of 3.5 ppm, and these sections are designated as suitable for medium usage fishing. Under Program III, sections 18-21 have a predicted summer average DO level of 3 ppm, and these sections are not designated as suitable for medium usage fishing. *But see* note 106 *infra.*

Sections deemed suitable for neither high nor medium usage fishing were designated as suitable for "low usage fishing."

98 The data for this chart was derived from DECS, *supra* note 4, at 55 (Fig. 39). The section numbers appearing in the table are identical to those shown on the map in Figure 2 accompanying note 12 *supra.*

tween Philadelphia and Trenton,[99] which the DECS subdivided into sections 1-7. Under Programs IV and V, high usage fishing is available only in the relatively small area near Trenton in sections 1-3, consisting of 28 shore miles; under Programs III and II, high usage fishing is available in sections 1-7, enlarging the area by 32.4 shore miles.[100]

Once again, we first ask whether the *quality* of the fishing experience which Programs II and III promise in sections 4-7 is comparable to the experience which already exists in programs IV and V in sections 1-3. As the physical characteristics of the river throughout sections 1-7 are roughly the same, we again focus on the manmade elements of the environment, particularly the crowding phenomenon. If a crowding problem does exist in sections 1-3, some benefits will accrue to those intramarginal fishermen who value solitude, since the population of fishermen will become somewhat more diffuse when sections 4-7 are opened up as high usage areas.[101] Although data are inadequate for a firm judgment, the information we do possess suggests that crowding is not such a problem that a significant number of fishermen would be willing to make a substantial sacrifice for more seclusion.[102] The only systematic census of estuary fishermen which has come to our attention is one attempted by the DECS in the mid-1960's which found that "7,960 fishermen us[ed] the estuary per day."[103]

99 We have limited our concern to assessing the benefits in the upper estuary because, as Table 3 indicates, the benefits of high usage fishing, however small, are far more significant there than in the southern sections where, under all but the most expensive program, no area expansion whatsoever is contemplated for this use.

100 These measurements include the shore length of islands in sections 2 and 4. Without islands the shore length for sections 1-3 is 24.4 miles, and for sections 4-7 it is 28.7 miles. These shore lengths were obtained by following the shoreline with a map reader on Coast and Geodetic Survey, Environmental Science Services Administration, U.S. Dep't of Commerce, Map No. 295 (27th ed. 1971). The boundaries of the sections were fixed by reference to DECS, *supra* note 4, at 34 (Fig. 20).

In performing our own map measurements, we discovered that the IES had seriously mismeasured the shoreline of the estuary. For example, IES STUDY, PHASE II, *supra* note 63, at 22 (Table 7), claims that the length of the shoreline of sections 1-7 and sections 28-30 is 254,700 feet. As a simple check, one can measure the length of the navigation channel in these sections and double it to obtain a rough estimate of the length of the shoreline. This procedure yields a result of 385,950 feet. More exact measurement according to the method described above yields a figure of 430,300 feet excluding islands and 480,760 feet including islands. We have not been able to discover the source of the error made by the IES.

101 Fishermen would also be attracted from other sites and other pursuits to fish in the estuary if crowding were reduced. These fishermen would be willing to sacrifice somewhat less for the improvement in quality than those who were already using the estuary because they did not consider it worth their while to engage in estuary fishing before the change.

102 DECS, *supra* note 4, at 51.

103 DECS Final Report, Preliminary Draft, *supra* note 87, ch. 3B, at 12. The method used in this census is not described in the draft chapters of the Final Report; nor were we able to find out more about it from the DECS staff. It is not clear whether the census refers to a weekday or to a weekend, whether or not an average of several samples was taken, or how the fishermen were distributed among the various sections of the estuary.

If 8,000 fishermen use the *entire* estuary, it seems highly unlikely that more than a couple of thousand use sections 1-3; the extensive shoreline available in these sections renders it implausible that a substantial fraction of even this small number of fishermen would sacrifice a considerable sum for greater seclusion, especially if it is conceded that the fishermen who value solitude the most will not fish in the river anyway but will seek their peace in more natural settings farther from the metropolis.

Thus, as in the case of swimming, the paperback book paradigm seems controlling; the principal benefit obtained by adding sections 4-7 as high usage areas can be measured by the savings in transportation time and expense accruing to fishermen in Philadelphia who will find good fishing closer at hand. In addition, increasing the proximity of good fishing will induce some citizens to substitute high usage estuary fishing for other activities. These "new" fishermen will receive a smaller benefit per trip than that obtained by the "old" fishermen, as they were unwilling to pay the old travel cost in order to engage in high quality estuary fishing. It is, of course, impossible to guess precisely how many "new" fishermen would arrive on the scene as a result of reducing the auto time between downtown Philadelphia and the fishing area from a minimum of thirty-six minutes to a minimum of twenty-four minutes.[104] In light of the relatively small change in travel time and the fact that relatively few fishermen presently use the smaller area, it seems probable that no great number of new fishermen will be attracted to sections 4-7.[105]

104 These estimates were obtained by the method described in note 75 *supra.* Thirty-six minutes is the average weekday travel time to Tullytown, which is located at the boundary of section 3 nearest Philadelphia; 24 minutes is the average weekday travel time to the Tacony-Palmyra Bridge, which marks the boundary of section 7 nearest Philadelphia.

105 It also appears that the benefits generated by increasing the area of medium usage fishing will be quite small. As indicated in Table 4 accompanying note 106 *infra,* Program IV generates no increase in the area available for medium usage fishing, and Program III will bring the availability of this activity just 1 estuary section (about 2 miles) closer to Philadelphia. Programs II and I do lead to large increases in the area available for medium usage fishing, but it would be easy to exaggerate the benefits from these increases. The estuary is virtually inaccessible on the Pennsylvania side from section 8 to section 15 because of the waterside development of the city of Philadelphia and its suburbs and on the New Jersey side from section 9 to section 14 because of the shoreline development of the city of Camden and its suburbs. On the Pennsylvania-Delaware side most of sections 17-21 are inaccessible because of the cities of Chester and Wilmington and the oil-unloading facilities at Marcus Hook. Except for section 16 and parts of sections 17 and 21, the New Jersey side is accessible along most of this shoreline. Furthermore, the most attractive forms of game fish need DO levels higher than those required to meet the medium usage fishing standard. *See* notes 96-97 *supra.* Finally to be considered is the prospect that medium usage fishing may not fully materialize in these areas, since sections 8-22 are the ones in which periodic severe oxygen problems due to storm water overflow are a serious threat to the survival of fish. Although it would be very difficult to give a precise dollar estimate of the increase in benefits due to medium usage fishing as a result of the increase in water quality projected for sections 8-21 under Programs II and I, it seems for these reasons that the benefits could not be very substantial.

Up to this point, our analysis compels the conclusion that increasing the area of rich aquatic life will generate only extremely modest benefits for the estuary's recreational fishermen. This conclusion must, however, be modified in an even more pessimistic direction once the frailties of the DECS procedure are considered. First, if as the DECS assumed, high usage fishing is defined to include all river sections for which the summer average DO level is five ppm and whose likely fluctuations will depress DO to no less than three ppm, the DECS has erred substantially in selecting the sections which satisfy the standard under the proposed programs. When we applied the DECS standard to its DO predictions,[106] our results diverged from the DECS figures in the following way:

TABLE 4

COMPARISON OF ESTIMATES OF DELAWARE ESTUARY SECTIONS SUITABLE FOR HIGH USAGE FISHING

Program	*DECS "High Usage" Fishing*	*Independent Estimate of "High Usage" Fishing*
I	1-10, 18-30	1-10, 18-30
II	1-7, 28-30	1-7, 20-30
III	1-7, 28-30	1-7, 28-30
IV	1-3, 28-30	1-7, 28-30
V	1-3, 28-30	1-7, 28-30

If our designations are correct, no benefits at all will accrue as a result of moving from Program V to Program III. Some benefits, how-

106 For the DECS DO predictions, see DECS, *supra* note 4, at 56-58 (Tables 8-12). We find that sections 4-7 meet the 5 ppm standard under Programs IV and V, while the DECS contends that these sections only become suitable under Program III. Our case for Program V rests on the DECS predictions. The DECS predictions show a *lower* summer average DO level for sections 1-7 under Program IV than under Program V (1964 conditions). Since Program IV involves more treatment, we consider this result unlikely, so we assume that conditions in sections 1-7 would be at least as good under Program IV as they are under Program V. We find that sections 20-27 meet the 5 ppm standard under Program II, whereas the DECS holds that these sections only become suitable under Program I. Here again we rely on the DECS predictions.

Our application of what we take to be the DECS standards also requires some revisions of the sections regarded as suitable for medium usage fishing by the DECS as reported in Table 3. The revisions are summarized in the following table.

Program	*DECS "Medium Usage" Fishing*	*Independent Estimate of "Medium Usage" Fishing*
I	11-17	11-17
II	8-27	8-27
III	8-9, 22-27	8-9, 22-27
IV	4-9, 22-27	8-9, 22-27
V	4-9, 22-27	8-9, 22-27

Sections 8 and 9 are included under Programs III and IV, and section 22 under Program IV, because they appear to be suitable under Program V, and although the DECS predicts that DO levels will deteriorate in these sections under programs which involve more treatment, we consider this outcome to be unlikely.

ever, will be generated as a result of a movement to Program II, since high usage fishing will—it is claimed—be possible in eight additional sections, although these benefits will be small given the proximity of similar fishing opportunities in the bay. Moreover, we have argued elsewhere that the DECS predictions as to the likely DO improvement resulting from any of the control programs may well be over-optimistic.[107] Thus, it would be wise to recognize that achieving even this benefit is by no means certain.

4. The Shad Problem

Up to the present point, we have spoken as if the only significant effect of DO improvement on fishing were its impact upon recreational opportunities in the estuary itself. This is, however, to take too narrow a view. The estuary serves as a vital conduit for anadromous fish (most notably the American shad) that begin their lives in the headwaters of the river, spend much of their adulthood in the ocean, and return through the estuary to upriver spawning grounds to complete the reproductive cycle. The shad fishery in the Delaware River above Trenton is an important attraction for sport fishermen in New York, Pennsylvania and New Jersey.[108]

In order to understand the effect raising the DO level in the estuary might have on the shad fishery, one must know a little more about the life pattern of the shad.[109] An adult Delaware shad heads up the river from the ocean some time during an eight-week period beginning in late March or early April and ending in middle or late May.[110] If a shad is an early migrator, chances for a safe passage up

107 Ackerman & Sawyer, *supra* note 1, at 457-82.

108 There is also a relatively small commercial shad fishery on the Delaware.

The importance placed on the shad by those involved with the pollution control decisions in the estuary evoked this summary statement and warning from the DECS staff:

> During the development of the alternative water quality programs for the estuary, the passage of anadromous fish, specifically the shad *Alosa sapidissima*, became a matter of great interest to those having to decide on which water quality management program to select. The concern evidenced for this annual visitor to the estuary came from many quarters. The reasons for the concern were almost as numerous as the interests involved. Basically the interest was not economic—the annual value of the shad fishery is small (i.e., $20,000 commercial and $50,000 recreation benefits). The main argument seemed to be that if the river inhibits the shad migration, it is unacceptable to the general public.

Morris & Pence, *supra* note 96, at 1. The $20,000 figure is a DECS staff estimate of the market value of the yearly commercial catch. We have been unable to learn the source of the $50,000 figure for recreational benefits.

Almost all sport fishing for shad takes place at sites above Trenton. Telephone conversation with Joseph P. Miller, Coordinator, Delaware River Anadromous Fishery Project (DRAFP), May 1972. Mr. Miller also stated that sport fishing does not have a substantial impact on the size of the Delaware's shad population.

109 The description of the life pattern of the shad in the Delaware which follows is based on NEW JERSEY BUREAU OF SPORT FISHERIES & WILDLIFE, ANNUAL PROGRESS REPORT, DELAWARE RIVER ANADROMOUS FISH PROJECT (1972) [hereinafter cited as 1972 ANN. REP. DRAFP]; telephone conversation with Joseph P. Miller, *supra* note 108.

110 The beginning of the shad run depends primarily on water temperature. For a

the estuary to the headwaters are good; the combination of early spring high flow and relatively low water temperature makes it likely that the DO level in even the most polluted regions of the estuary will exceed three ppm,[111] the level below which few shad can survive for any length of time.[112] The problem for the early migrator arises once the eggs have been laid and fertilized. Adult shad do not normally eat in the river during the spawning run; they attempt to return to the ocean to feed. But by the time many of the spent or spawned-out shad have arrived again at the estuary, reduced flow and rising temperatures, combined with about the same discharge of waste materials as before, have reduced DO in some sections to lethal levels. Barred by this pollution block from the ocean, their natural feeding place, the spent shad die of starvation.[113] Not many early-migrating shad travel twice up to the headwaters of the Delaware.

The lot of the late migrator is a happier one. By the time he begins his migration DO in some sections is low enough to prevent his passage through the estuary. Consequently, he heads up a lower tributary to spawn or makes his way through the Delaware and Chesapeake Canal to the Chesapeake Bay and from there to the Susquehanna River to fulfill his reproductive urge.[114] Since his return route to the ocean is probably still open, a second or third spawning trip by a late migrator is likely.

Although the offspring of late migrators probably have little trouble in making the normal fall trip to the ocean where they will mature, juveniles born of early migrators face the same pollution block encountered by their unfortunate parents. Because juveniles feed in the river, their need to return to the ocean is not so urgent, but they must reach the ocean to mature and so must wait until temperatures are low enough to ensure that DO is above minimum survival levels. Apparently juveniles enjoy reasonable success in reaching the ocean.[115]

To gain a sense of the extent to which pollution control will benefit the shad, the DECS predicted the probability of adult shad "survival"[116] during the spring migration through the estuary under

more detailed discussion, see 1972 ANN. REP. DRAFP, *supra* note 109, at 12-34; Morris & Pence, *supra* note 96, at 4-6.

111 Morris & Pence, *supra* note 96, at 6.

112 Ackerman & Sawyer, *supra* note 1, at 437 n.25; note 96 *supra*.

113 1972 ANN. REP. DRAFP, *supra* note 109, at 56.

114 *Id.* 26-30.

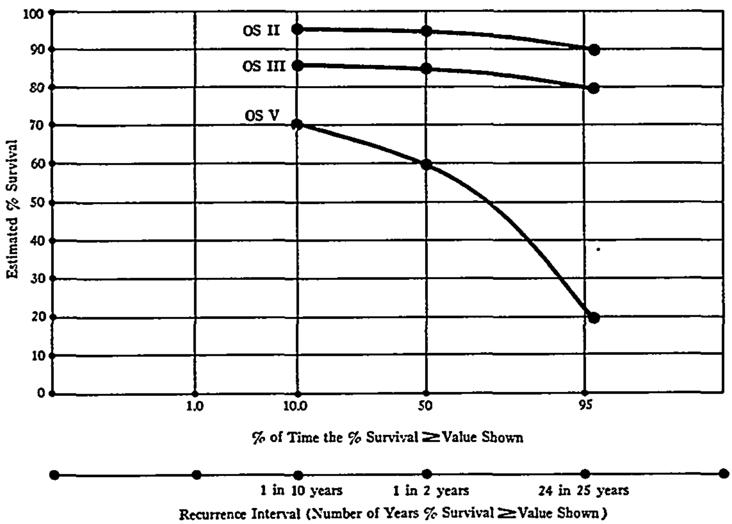
115 *Id.* 60.

116 The DECS "survival" data relate only to the percentage of shad which could pass through the estuary on their way upstream to spawn, *see* DECS, *supra* note 4, at 61; Morris & Pence, *supra* note 96, at 4 (both using "passage" and "survival" interchangeably), but our discussion shows, text accompanying note 114 *supra*, that migrating shad blocked from passage may well "survive."

some of the proposed programs.[117] The DECS task was complicated by the fact that, as we have seen, shad "survival" depends not only upon the level of waste discharges but also upon river conditions prevailing in a given year.[118] Thus, the DECS was required to estimate shad "survival" over a wide range of flow and temperature combinations which were suggested by historical observations of the river. The results may best be portrayed in the graphic form used by the DECS (Figure 4).[119] The graph indicates that under river condi-

FIGURE 4

ESTIMATED TOTAL UPSTREAM SHAD PASSAGE FOR OS II, III AND IV (PRESENT CONDITIONS)



tions likely to prevail fifty percent of the time, pollution programs II and III will significantly increase the percentage of shad which "survive" the trip through the estuary from sixty percent under present conditions (Program V) to eighty-five percent (under Program III) or ninety-five percent (under Program II). This substantial difference becomes even greater in the fifty percent of the years during which river conditions accentuate the impact of waste discharges on the DO profile. Thus under present conditions no more than forty percent of the shad will "survive" their springtime migration during the worst year in every three, while only twenty percent will complete their journey in the four worst years in every century. In contrast, "survival" rates remain high under Programs III and II.

117 DECS, *supra* note 4, at 60. The DECS discussion is based on the more detailed study by Morris & Pence, *supra* note 96.

118 Ackerman & Sawyer, *supra* note 1, at 482-84.

119 DECS, *supra* note 4, at 60 (Fig. 4).

These significant improvements forecast by the DECS model must, however, be viewed with caution for three reasons. First, the DECS "survival" data does not in fact measure what it purports to quantify.[120] As we have shown, late migrators do not, in fact, die in the Delaware but live in the Susquehanna and elsewhere. The shad which do die are early migrators attempting to *return* to the ocean, and it is not at all clear that the DECS "survival" data can be applied without substantial modification to this significant group. Moreover, many of the youthful shad spawned in the Delaware simply wait until the pollution block lifts before completing their journey to the ocean. Second, we have argued elsewhere that the DECS projections contain substantial elements of over-optimism;[121] if our arguments are correct, neither Program III nor II will generate the DO improvements assumed by the DECS survival estimates.

Third, the DECS predictions must be viewed against the Army Corps of Engineers' plan for the construction of a large dam at Tocks Island in the upper Delaware as part of a flood control program which has the approval of the DRBC. The Tocks Island Dam, as the DECS itself notes in an unrelated section of its report,

> will probably be a hindrance to the normal migration of shad to and from the principal spawning areas above the dam site. Because of this obstacle, it is the general opinion of biologists that shad spawning success will be considerably reduced in the Delaware River.[122]

The DRBC's recent pronouncements are somewhat more sanguine, but they must be balanced against conservationists' claims that Atlantic shad are simply too weak to climb the proposed dam's fish ladder and hence will die. The uncertainty surrounding the dam is compounded by the success of conservationists thus far in delaying its construction despite the DRBC's support of the project.

Until the dam's fate is determined and its impact is better understood, it would seem reasonable to defer any large expenditure justified primarily on shad-protection grounds. This wait-and-see strategy finds support in the plain fact that a sizeable shad population is sustaining itself under present conditions.[123] Although a further deterioration of

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120 *See* note 116 *supra.*

121 Ackerman & Sawyer, *supra* note 1, at 457-82.

122 DECS, *supra* note 4, at 79.

123 Telephone interview with Joseph P. Miller, *supra* note 108. According to 1972 ANN. REP. DRAFP, *supra* note 109, at 41, techniques used so far have not succeeded in generating enough data for a reliable statistical estimate of the number of American shad spawning in the upper reaches of the Delaware River. Estimates of the size of the shad population must, therefore, be quite impressionistic. NEW JERSEY BUREAU OF SPORT FISH-

DO levels in the estuary would over time mean that no shad would reach the upper Delaware, maintaining present conditions (as contemplated by Program V) is a viable shortrun alternative until the long-range prospects can be more intelligently assessed. Rather than counsel such a strategy, however, the DECS *Report* ignored the dam problem and proceeded to offer decisionmakers a determinate set of shad "survival" probabilities, associated with each pollution program, which had only a tangential relationship to ecological realities.

5. Conclusion

The DECS rests its case for pollution control almost entirely upon the benefits to be derived by swimmers, boaters and fishermen from enhanced recreational opportunities. Yet, *from an economist's perspective,* these benefits seem trivial in comparison to the costs which we have estimated the DRBC's program will impose upon private firms and government. Although we shall later consider whether a persuasive case for pollution control can be made on grounds not considered by conventional cost-benefit analysis, it is important at this point to consider the fundamental reasons why the DECS estimated the recreational benefits to be many times the order of magnitude we have suggested. For an exploration of the basic conceptual errors in the DECS approach, which is common to many similar efforts,[124] reveals how a quantitative approach divorced from a solid foundation in elementary economic theory can be worse than useless, resulting in a set of numbers which obscures the fundamental issues at stake.

IV. The DECS Approach to Benefit Estimation

The hallmark of the simple economist's approach we have considered thus far is its emphasis on the consumer's perspective. From this perspective, the central fact is that the Delaware Valley consumer already has open to him a wide range of water-based recreational alternatives; for it is this fact that makes cleaning up the Delaware seem of relatively small importance. Obviously, if the other recreational facilities available in the valley were less bountiful, consumers would be willing to sacrifice more for improved fishing and swimming

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ERIES & WILDLIFE, ANNUAL PROGRESS REPORT, DELAWARE RIVER ANADROMOUS FISH PROJECT 17 (1970), for example, states that "there appeared to be a fair run of adult spawning shad" in the early spring of 1969. The DECS "survival" estimates cited in the text indicate that under current conditions 20% or more of the migrating shad should reach the headwaters of the Delaware 96% of the time.

124 *See* note 65 *supra.*

opportunities even in those sections of the estuary relatively far from population centers. It is this consistent effort to view pollution control as a way of adding to *an already existing set of consumer activities* which sets the economist's approach apart from that pursued by the DECS.

A. *The DECS Definition of the "Study Area"*

Instead of taking a consumer's perspective, the DECS suffered from a characteristic form of planner's myopia. After all, the planner has been charged with the task of investigating the effects of pollution control *on the estuary;* what is more natural than to isolate the estuary in the analysis and give it more prominence than it deserves from the consumer's perspective? For example, the analyst's first task is to fix the boundaries of the "study area" which will be considered in detail. Under the economist's approach, any consumer who considers himself substantially affected by enhanced water quality in the Delaware should be included in the "relevant population" of consumers. By the same principle, the "study area" should include not only the estuary but all those sites considered important recreational alternatives by a substantial portion of the relevant population.[125] In contrast, the DECS defined the "study area" to include only the population and the alternative recreational sites located in the highly-urbanized eleven counties nearest the estuary.[126] Under this arrangement, the fact that residents of Trenton, Camden, Philadelphia and Wilmington might prefer to go to the Jersey Shore, the Poconos or the Delaware Bay could be ignored on the question-begging ground that these recreational sites, which are by far the most popular ones, were outside the "study area."[127] Thus it seemed as if the residents of the eleven urbanized counties who ventured outside the "study area" were being required to

[125] Of course, judgment must be used in giving empirical content to the general concepts of the "relevant population" and the "recreational alternatives considered important by a substantial portion of the population." It is usually not practical to include every user or potential user in the relevant population, or to account for people who will never visit the site being evaluated but who may benefit from its existence because the sites they do visit will become less crowded. For a study which confronts these dilemmas sensibly, see H. GRUBB & J. GOODWIN, *supra* note 65.

[126] The "study area" which served as the basis for the DECS benefits estimates is described in IES STUDY, PHASE I, *supra* note 63, at 1. The counties included are New Castle County, Delaware; Burlington, Camden, Gloucester, Hunterdon, Mercer and Salem Counties, New Jersey; and Bucks, Chester, Delaware, Montgomery and Philadelphia Counties, Pennsylvania.

[127] The DECS approach also eliminated some of the relevant population, those who would seriously consider the improved estuary or sites made less crowded as a result of estuary cleanup as places for recreation. However, given the distribution of population in the Delaware Valley and the surrounding area, the DECS "study area" probably contains a large fraction of the relevant population. The deflation of benefits produced by considering only the population of the 11 counties nearest the estuary therefore seems relatively small.

undertake an onerous journey to another country to fulfill their desires for a good swim, while in fact they were only making the familiar day-trip on the specially built throughway to Atlantic City.[128] In contrast, the DECS assumed that the four million residents of the eleven counties could move costlessly throughout the study area. Since there are few alternative water resources other than swimming pools in the eleven counties, the artificial circumscription of the study area naturally ensured a DECS prediction that sections of the estuary made available for recreation by pollution control would be heavily utilized: we are presented with the prospect of teeming masses of city dwellers converging on each square foot of the reclaimed estuary, seeking their place in the sun.

B. *The Concept of "Capacity"*

If it had been clearly perceived, such an implausible result would have called into question the basic premises of the DECS approach. Unfortunately, the introduction of yet another concept prevented a retreat to common sense informed by basic economic theory. The concept which obscured the imperfect DECS logic was a peculiar notion of "capacity," often used by planners of public projects.[129] When understood in one limited sense, "capacity" has a clear, if trivial, conceptual content. For example, a given stretch of river front is "filled to capacity" by fishermen when it is so crowded that it is *physically impossible* for another fisherman to muscle his way to the water's edge to conduct his favored activity. This notion of ultimate physical constraint was not, however, the key to the DECS concept of capacity. Rather, the DECS used the idea to mask a confused set of economic and aesthetic premises. For example, the "capacity" of the estuary for fishing was calculated on the assumption that each fisherman in some sense required ten feet of shoreline in order to operate successfully. Since it is physically possible for fishermen to be spaced much more closely than this, the fishing "capacity" calculation must be based on some other ground. The capacity notion might depend upon a normative judgment about how much shoreline ought, *in the*

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[128] Using the method described in note 75 *supra*, we estimate that the travel time from center city Philadelphia to Atlantic City along the limited-access Atlantic City Expressway on an average weekday is 65 minutes. Calculations using the same method suggest that a Philadelphia resident would have to drive for 95 minutes, for example, to reach Augustine Beach, a potential swimming site in the lower estuary.

[129] The concept of capacity is referred to briefly in DECS, *supra* note 4, at 75. As note 63 *supra* explained, the DECS recreation benefits estimates were based on IES STUDY, *supra* note 63, which refers to the concept of capacity at several points in its analysis, *e.g.*, *id.*, PHASE II, at 12, 17-18, 22. *See also* DECS Final Report, Preliminary Draft, *supra* note 87, chs. 3-5 & Figs. 13, 44-45.

analyst's view, to be allocated to each individual fisherman. However, it is far from clear that the benefit analyst is entitled to import his own value judgments into his calculations through the use of a concept which disguises them from the political actors who are charged with making the ultimate value decision.

We suspect that, if pressed, the analyst would defend the capacity concept in a quite different way. Instead of invoking his own personal norms, he might appeal to an economically based argument which, though it possesses some surface appeal, is fundamentally misconceived. In defense of its "capacity" concept, the DECS might have reasoned that it is only when fishermen become "too" closely packed along the estuary that they will venture beyond the "study area" to seek a satisfactory experience. While this argument contains an element of truth, the "capacity" concept distorts the role of crowding in a completely unacceptable way. It implies that, so far as the estuary is concerned, crowding has no effect on fishermen's preferences before the magic ten-foot standard is reached, and that it is no longer worth fishing if that standard is exceeded. This is highly implausible. Even more important, it ignores the fact that recreationists may well choose to fish at locations outside the "study area" even though the estuary is not crowded at all, for the simple reason that fishing is more enjoyable elsewhere.

C. *The "Demand" for Recreation in the Study Area*

Having determined the size of the new recreational "capacity" that would be generated by pollution control expenditure, the DECS turned to the consideration of whether consumer demand would fill this increased "capacity." Even at this stage in the analysis, it would have been possible to transcend the limitations of the DECS conceptual structure by a set of carefully designed demand estimates, based on an accurate perception of the relative desirability of the estuary when compared to other, more popular, recreational areas. No matter how great the estuary's "capacity," its recreational value would be appreciably diminished if it were ignored by the overwhelming majority of would-be swimmers, boatsmen and fishermen.

The DECS demand estimates, however, were designed in a way that obscured the bleak prospects such an inquiry would have disclosed. To determine the number of days the residents of the eleven-county area wished to spend boating, fishing and swimming, the DECS took recourse, as have many other analysts before and since, to a basic study performed by a special Outdoor Recreation Resources Review

Commission (ORRRC) sponsored by the Bureau of Outdoor Recreation in the Department of the Interior.[130]

The ORRRC study is based on a set of questions asked of a sample of people over twelve years old throughout the United States in 1960. The questionnaires asked respondents to report whether or not they participated at all in a given recreational activity during the survey period, and, if they participated, how many times they did so. Each respondent was also asked to supply certain demographic data about himself including his age, income, sex, race, educational level, occupation, and residence by locational type.[131] The ORRRC investigators used this information to attempt to determine the rate at which various groups participate in each of several types of recreational activity. Speaking more technically, an ORRRC "participation rate" is the number of days per year that the average person over twelve in a well defined subgroup of the population can be expected to engage in a particular recreational activity.[132] Once the participation rate for a given population subgroup has been determined, obtaining the ORRRC measure of the total demand for a given recreational activity is simply an exercise in multiplication. If, for example, there are 10,000 white males, between the ages of twenty and thirty, earning between $10,000 and $20,000, etc., and ORRRC has found that the participation rate for fishing for this group is three days per year, then the number of days the group can be expected to fish in a year is simply 30,000 days.[133]

The aspect of this exercise which is most important for our pur-

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130 OUTDOOR RECREATION RESOURCES REVIEW COMM'N, STUDY REPORT No. 19, NATIONAL RECREATION SURVEY (1962); OUTDOOR RECREATION RESOURCES REVIEW COMM'N, STUDY REPORT No. 20, PARTICIPATION IN OUTDOOR RECREATION: FACTORS AFFECTING DEMAND AMONG AMERICAN ADULTS (1962); OUTDOOR RECREATION RESOURCES REVIEW COMM'N, STUDY REPORT No. 26, PROSPECTIVE DEMAND FOR OUTDOOR RECREATION (1962) [hereinafter cited as ORRRC REP. No. 19, 20 or 26].

131 ORRRC REP. No. 19, *supra* note 130, at 377-87.

132 In ORRRC REP. No. 26, *supra* note 130, participation rates are generated by a 1-step procedure, using a relatively complicated system based upon the results of ORRRC REP. No. 20, *supra* note 130. More recent studies, using the data from ORRRC REP. No. 19, *supra* note 130, and BUREAU OF OUTDOOR RECREATION, U.S. DEP'T OF INTERIOR, 1965 SURVEY OF OUTDOOR RECREATION ACTIVITIES (1967), have estimated participation rates using a 2-step procedure. Under this procedure ORRRC first estimates the proportion of each well defined subgroup which will take part in the given activity at least once in a given year; it then determines what might be called an activity rate, the number of days that the average participant in each well-defined subgroup will engage in the given activity during the year. The product of the percentage participation figure and the activity rate gives the participation rate. For a summary discussion of these studies and a comprehensive bibliography, see Cicchetti, *A Review of the Empirical Analyses That Have Been Based Upon the National Recreation Surveys*, 4 J. LEISURE RESEARCH 90-107 (1972).

133 The procedure used in ORRRC REP. No. 26, *supra* note 130, forecasts the participation rate for the total population over 12 years in a given geographical area for a given year by multiplying the participation rate for each well defined subgroup of the population by the proportion of that subgroup in the population in the year in question,

poses is its failure to take adequately into account the recreational opportunities facing each of the respondents in the sample. For sampling purposes the ORRRC divided the entire country into four regions in calculating its participation rates, and its estimates therefore represent the response of a consumer facing the *average* opportunities prevailing in each region. Since the DECS made use of the ORRRC figures for the Northeast, which embraces the Delaware Valley, the participation rate estimates used in the DECS benefit analysis represent the rate at which a member of the various subgroups would engage in a given activity *if he faced the average opportunity cost prevailing in the entire Northeast in 1960*. Obviously, an element of error will enter if the opportunities actually open to residents of the eleven-county region are not representative of the Northeast. Far more important for our purposes, however, is the error that will result from an arbitrary restriction of the area in which the demand will be satisfied so as to exclude the Jersey Shore, the Upper Delaware, the Poconos and the Delaware Bay. After restricting its "study area" in this way, the DECS should no longer have relied on ORRRC demand estimates, which assumed that the opportunities available within the "study area" are representative of those prevailing in the entire Northeast. Only by mistakenly using the ORRRC participation rates in conjunction with a drastically truncated inventory of recreational opportunities could the DECS have arrived at its conclusion that new estuarine opportunities will be fully utilized.[134]

The power of a misconceived methodology to blind the analyst is thrown into high relief when the facts available to the DECS are considered. According to the DECS method, those sections of the estuary presently available for high usage fishing (before any water quality enhancement is undertaken) have a "capacity" to accommodate 390,000 activity days of fishing each fishing season.[135] Sufficient

and adding the results. The participation figures so generated are reported in *id.* 17-19, and reprinted in IES STUDY, PHASE I, *supra* note 63, at 81. To obtain total demand for a given activity in a given year by the total population over 12 in a particular geographical area, the weighted participation rate described above is multiplied by the total population figure. This procedure is used to generate the total demand figures in *id.*, PHASE II, at 5.

134 IES STUDY, PHASE II, *supra* note 63, at 16 (Table 4), 21 (Table 6), 24 (Table 8).

135 *Id.* 22 (Table 7). The DECS staff seems to have adopted the IES *Study* figure in their later work. DECS Final Report, Preliminary Draft, *supra* note 87, ch. 3B, at 45 (Fig. 13). However, DECS, *supra* note 4, at 48, gives 1,620,000 activity days per year as the present capacity of the estuary for fishing. In IES STUDY, PHASE II, *supra* note 63, at 22, this figure is reported to be the fishing capacity of nonestuary inland water in the 11-county study area.

In addition, it should be noted that all the IES capacity calculations (for all the proposed cleanup programs as well as for existing conditions) contain a fundamental technical error. The IES fishing capacity formula is:

$$C_i = .66(L_i)(M)(T)(P)$$

where .66 is the proportion of the total shoreline in the region of "high usage fishing" assumed to be accessible; C_i is the capacity under Program *i* (in activity days per year);

"demand" was seen by the DECS to ensure full usage of estimated estuary capacity.[136] Yet the DECS notes elsewhere that in fact fishermen spend only 130,000 activity days along the estuary annually.[137] The unsettling implications of this fact are simply ignored—for according to DECS, fishermen should be neatly spaced every ten feet at all times during the fishing season. Although this inconsistency should constitute a source of embarrassment for the DECS, it poses no particular difficulty for the economist's approach. All it suggests is that fishermen in heavily populated areas, when faced with the choice of traveling substantial distances either to estuarine high usage fishing sites or to ocean, lake or stream sites outside the "study area," choose overwhelmingly the nonestuarine options.

D. *Attaching Money Values*

We have now come to the moment of truth in any benefit analysis, the point at which the benefits of the project are translated into money values. Under the economist's approach that we elaborated in Section III, the rationale for money evaluation is straightforward. The analyst simply seeks to estimate the amount consumers would be willing to sacrifice rather than do without the new facilities. Given the DECS methodology, however, it was impossible for the analyst either to pose the sacrifice question in coherent form or to devise a means by which even a rough answer could be supplied. For in order to think in terms of the sacrifice principle, it is necessary to have (a) a clear idea of the recreational options open to consumers *prior* to pollution control expenditure; (b) a careful account of the kinds of physical changes pollution control will generate; and (c) an estimate of the extent to

L_i is the total shore length designated for "high usage fishing" under Program i (in feet); M is the average spacing of anglers (1 person per 10 feet); T is the turnover rate (2 anglers per space per day); and P is the average number of activity days per fisherman (20 activity days per person per year). *Id.*; DECS Final Report, Preliminary Draft, *supra* note 87, ch. 3B, at 20 (Table 4). The product of $.66L_i$, M and T yields the number of anglers who could hypothetically be accommodated along the estuary per day. The number of anglers who can be accommodated in 1 day should be multiplied by the number of activity days per angler per day, presumably 1, and then by an estimate of the length of the fishing season in days to obtain a meaningful measure of capacity. A conceptually consistent formula is:

$$C_i = .66\,(L_i)\,(M)\,(T)\,(K)\,(S)$$

where K is activity days per angler per day, presumably 1; and S is the length of the fishing season in days. The use of P in the formula employed by the IES *Study* and the DECS *Final Report* yields a nonsense result.

136 *See* IES STUDY, PHASE II, *supra* note 63, at 24 (Table 8).

137 The 130,000 activity days per year present usage figure, DECS, *supra* note 4, at 48, is not explained in any of the documents we have been able to obtain. In the DECS Final Report, Preliminary Draft, *supra* note 87, ch. 3B, at 12, this figure was reduced to 51,750 activity days per year. The 51,750 figure was obtained by multiplying 7,960 fishermen, an estimate of the number using the estuary per day, *see* note 103 *supra*, by 6.5 activity days per year per fisherman, an estimate made by the DECS. This procedure is fundamentally misconceived: in order to obtain a sensible usage figure, 7,960 should be multiplied by an estimate of the length of the fishing season, not by an estimate of the number of days the average man fishes.

which consumers will modify their conduct in the light of their new options. As we have seen, at each basic stage in the DECS analysis concepts were developed which obscured the simple logic of this approach. The DECS definition of the "study area," its notion of "capacity," and its effort to derive "demand" estimates which were not closely tied to a clear conception of available opportunities both before and after pollution control, all made it impossible to ask: "How much money is it reasonable to expect the residents of the Delaware Valley to sacrifice in exchange for the changes in their environmental situation wrought by each of the proposed programs?"

As the DECS was unable to articulate this basic question, it is not surprising that its translation of benefits into money terms was fundamentally arbitrary. Even if it were otherwise flawless, the DECS analysis indicates merely that the new "capacity" generated by pollution control would be utilized. Yet this, in itself, is insufficient; in the absence of water quality improvement, the "new" recreationists on the reclaimed portions of the Delaware would have been doing something else. What a benefit analysis must determine, in one way or another, is the extent to which recreationists consider themselves better off as a result of their *change* in activity. Precluded by its own methodology from appealing to informed common sense, the DECS *Report*—like many other studies before and since—was obliged instead to resort to a set of dollar figures which are enshrined in Supplement No. 1 to Senate Document 97.[138] This Supplement, published in 1964, reports the general consensus of experts in the field of recreational benefit evaluation as to the dollar value to be associated with each of a wide range of recreational activities. It should be plain that this platonic approach is of no value; for it attempts to establish the intrinsic worth of a day of fishing independently of the other opportunities available to a region's fishermen. It should be banished from all subsequent efforts at an economic analysis of the problems posed by environmental degradation.[139]

138 S. Doc. No. 97, SUPP. No. 1, 87th Cong., 2d Sess. 4 (1964). A "general" outdoor recreation day is said to be worth between $.50 and $1.50 while a "specialized" outdoor recreation day is worth between $2.00 and $6.00. The activities which are supposed to fall into each of the 2 categories are set out in detail, *id.* 3.

139 The idea that an activity day of recreation has an intrinsic worth has not yet been banished from the analysis of recreation benefits. Recently a group of experts working for the Water Resources Council took notice of the relevance of consumers' willingness to pay in placing money values on a project, Water Resources Council, Proposed Principles and Standards for Planning Water and Related Land Resources, 36 Fed. Reg. 24,144, 24,157 (1971), but went on nevertheless to recommend unit values for recreation days. A "general" recreation day is now supposed to be worth between $.75 and $2.25; a "specialized" day should currently be valued at between $3 and $9. According to the Council, unit values must still be used because recreation evaluation methodology is not well enough developed to yield a better measure of results. Where this is the case, it

E. *Introducing the Time Dimension*

There remains one aspect of the DECS approach to be considered. Up to the present point, we have not directly confronted the problem posed by the fact that the benefits generated by pollution control accrue over time. In order to take this fact into account, the DECS followed a common, straightforward approach. First, it assumed that only benefits accruing within a twenty-year period from the date on which the analysis was undertaken were relevant in assessing the desirability of the competing control programs; thus the relevant time horizon became 1965-1985.[140] Second, it attempted to establish the money value of the recreational benefits that would accrue in a base year, using the method we have criticized above. In this case, the base year was 1976, the approximate midpoint of the selected time horizon. Third, it was assumed that the dollar value of the benefits accruing in 1976 would also be realized in each of the other nineteen years considered relevant.[141] Fourth, a discount rate of three percent was used to calculate the present value of the twenty year benefit stream.[142]

There are several major issues raised by this procedure. The first involves the definition of the time horizon, which seems too short for two reasons. We have been told by DECS personnel that a substantial portion of the pollution control equipment has an economic life expectancy somewhat longer than twenty years. This consideration alone suggests the desirability of a somewhat more distant time horizon, say twenty-five years. More important, however, is the fact that the installation of hundreds of millions of dollars of pollution control

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seems to us far better for the analyst to confess his ignorance than to generate a set of numbers which could obscure issues. For criticisms of other aspects of the Water Resources Council's proposals, see C. CICCHETTI, R. DAVIS, S. HANKE, R. HAVEMAN & J. KNETSCH, BENEFITS OR COSTS? AN ASSESSMENT OF THE WATER RESOURCES COUNCIL'S PROPOSED PRINCIPLES AND STANDARDS (1972).

140 DECS, *supra* note 4, at 76. What the DECS did and what it said it did are not always easily reconcilable. The DECS *Report* states that "[t]he maximum and minimum values of the range of recreational benefits to 1975-80 were computed on the following basis . . . ." *Id.* This seems to imply that the horizon considered was at most 15 years (1965-1980). The *Report* also states that "[i]n accordance with other economic calculations in this report, the 1975-80 recreation benefits in terms of 1964 dollars are reported as Present Values calculated with an interest rate of 3% and a time horizon of 20 years." *Id.* Letter from E. Smith, *supra* note 30, produced the statement that "[t]he important thing here is that the annual monetary values are discounted to compute the present values at 3%, 20 yr." The DECS staff apparently intended to use a time horizon of 20 years beginning with 1965, and there is no doubt that such a time horizon is implied by their calculations.

141 Letter from E. Smith, *supra* note 30, confirmed both that 1976 was used as the base year and that the DECS assumed, at least implicitly, that the monetary benefits which would accrue in 1976 would also accrue in each of the other 19 years. It can also be shown that this assumption is necessary in order to reconcile the annual figures for 1976 given in IES STUDY, PHASE II, *supra* note 63, at 54 (Table 22), with the present value figures presented in DECS, *supra* note 4, at 77 (Table 20).

142 DECS, *supra* note 4, at 76.

equipment distributed along the eighty-six mile estuary is a time-consuming process. Even on an optimistic view of the regulatory process, the DECS should have anticipated a lag of five years before the entire control system was in effective operation. Thus it would appear that a thirty-year time horizon would have been more appropriate than the twenty-year period selected.[143]

Second, the DECS assumption that the benefits prevailing in 1976 would be available in each of the nineteen other years between 1965 and 1985 is suspect. At best, these benefits would be available only after the five-year regulatory lag we have mentioned, during which the system would not yet be in operation. Indeed this is one of the reasons we have argued for a thirty-year time horizon, since, given the five-year lag, benefits will accrue for only fourteen or fifteen years of the time horizon used by the DECS *Report*. Thus, it would appear that the DECS neglect of regulatory lag is counterbalanced at least partially by its improper truncation of the time horizon. Sometimes, two errors may be better than one.

The DECS neglect of the implications of the regulatory lag appears somewhat more troublesome when considered in light of another aspect of its procedure: the method used to calculate the present value of the anticipated benefit stream. Although few benefits will be generated until virtually the entire system is in operation, a substantial portion of the capital costs of pollution control will be incurred during the first five years as one after another of the estuary's dischargers is induced to comply with the DRBC's regulations. Thus, instead of the DECS assumption of instantaneous compliance coupled with the realization of maximum benefits in the first year of the time period, a more realistic view is suggested in Figure 5. Since it is the essence of any discounting procedure that earlier years count for more than later years, the pattern of benefits and costs which takes the regulatory lag into account is less favorable to pollution control than the DECS hypothesis which unrealistically neglects the lag.

We come finally to the DECS choice of three per cent as the appropriate rate to use in calculating the present value of costs and benefits. In light of the ongoing controversy over whether the appropri-

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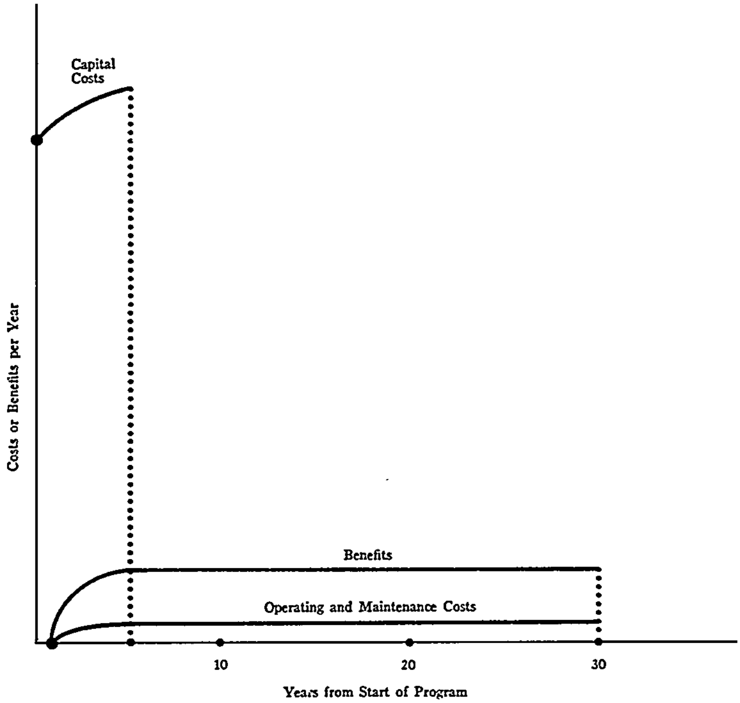
143 If, as is likely, investments are made at different times, the useful lives of these investments will end at different times. If pollution control equipment really lasts only about 20 years and a 30-year time horizon is chosen, new investment toward the end of the time period will be required by those firms which comply early. The costs of these added investments as well as the fact that equipment installed near the end of the period will have several more years of useful life after the 30-year time horizon is passed must be taken into consideration.

FIGURE 5



ate discount rate for public projects should be equal to one of the rates of return prevailing in the private sector or to a figure somewhat lower or higher than prevailing market rates,[144] it would seem prudent for the cost-benefit analyst to generate calculations using a range of different discount rates. This would properly focus the attention of the political process on the importance of an informed debate about, and principled resolution of, this basic issue. Of course, the higher the rate used, the lower the level of pollution control which will seem desirable, because a large proportion of control costs accrue early in the time period, whereas the benefits are spread evenly through the years. Although the fate of a large number of public projects depends critically upon the resolution of the issues surrounding the selection of an appropriate rate of discount, it is a common mistake to assume that this controversy vitiates entirely the usefulness of the cost-benefit

[144] A good summary of the arguments of those who support the use of one of the rates of return prevailing in the private economy is contained in Hirshleifer & Shapiro, *The Treatment of Risk and Uncertainty*, PUBLIC EXPENDITURES AND POLICY ANALYSIS 291 (R. Haveman & J. Margolis eds. 1970). The view that policy makers should use a rate different from private rates of return is presented in S. MARGLIN, PUBLIC INVESTMENT CRITERIA 98 (1967). For other provocative contributions to the debate, see A. HARBERGER, ON MEASURING THE SOCIAL OPPORTUNITY COST OF PUBLIC FUNDS (1971); Baumol, *On the Discount Rate for Public Projects*, in PUBLIC EXPENDITURES AND POLICY ANALYSIS 273, *supra*.

tool. The case before us provides a powerful counterexample. A sensible economic analysis inevitably would have concluded that even if the rate chosen were zero, no program which contemplated spending hundreds of millions of dollars on DO improvement along the "polluted" section of the Delaware could be justified by the negligible benefits provided the region's boaters and swimmers and the modest benefits offered to the region's fishermen.[145]

V. Beyond Cost-Benefit Analysis: Weighing the "Unquantifiable"

Even if it is conceded that the economist cannot make a case for massive investment of hundreds of millions of dollars in a program which will raise DO levels marginally on the Delaware, it does not follow that proper policy can be based on this single insight. Indeed, it is a truism that many benefits generated by environmental protection are "unquantifiable" and hence are beyond the economist's ken. Only by going beyond the level of platitude to examine the precise senses in which economic analysis provides an inadequate guide to policy, however, can we fairly assess the value of the current effort on the Delaware.

A. *Defining the Unquantifiable: Ecological Catastrophe*

Benefit analysis of the kind we have attempted has sought to place a value upon improved opportunities for doing relatively common things—a day's boating or fishing or swimming—and thus seems far removed from the predictions of impending ecological doom which have been heard with increasing frequency over the past decade. Nonetheless, in the strict sense, the value of avoiding world doom is not unquantifiable. Indeed, it seems safe to assume that the present inhabitants of Earth would pay almost everything in their possession to avoid imminent destruction.

Thus, there is nothing difficult about quantifying the costs of human extinction. The only difficulty for our purposes lies in assessing the chances that adopting Program II rather than Program V for the

145 As we have explained, note 63 *supra*, the DECS recognized its own lack of expertise in the field of benefit analysis and contracted the task out to a leading academic body in the region, the Institute for Environmental Studies of the University of Pennsylvania. When the IES study group completed its project and provided the DECS with numbers, its contractual obligations had been fully satisfied. Neither the DECS, the DRBC nor the federal government has funded any further analysis of the benefits generated by the cleanup program in the 6 years since the IES completed its work—another example of the failure to take adequate institutional steps to assure continuing reappraisal of complex and ongoing problems. *See* text accompanying notes 50-54 *supra*; Ackerman & Sawyer, *supra* note 1, at 489-95. For a more elaborate analysis, see B. Ackerman, *supra* note 7, chs. 5, 10.

Delaware River will measurably affect the probability of continued survival. Even here, the question is susceptible of an easy answer *if one assumes that pollution loads on other river systems do not increase over time.* Once this assumption is made, we have found no reputable scientist who believes that the absence of various forms of aquatic life in the "critical regions" around Philadelphia has any significant impact upon the human race's prospects for continued survival. This opinion, coupled with the simple fact that the Delaware's DO problem does not impair the ability of modern treatment plants to provide potable water at a low cost, seems to destroy the notion that the selection even of Program I over Program V will have a significant impact upon the prospects of continued human life.

A problem arises only if our critical *ceteris paribus* assumption is relaxed and a world is imagined in which all (or at least a large number) of river systems resemble the oxygen-depleted portion of the estuary. It is only then that a serious ecological risk to man may be discerned, although our knowledge in this regard is so imperfect that the number of oxygen-depleted river segments which can be tolerated without any significant risk of cataclysm is indeed unquantifiable at present. Nevertheless, it does not follow from this insight that the DRBC program can be placed on a solid, if unquantifiable, intellectual foundation.

First, even after $700 million is spent to raise the Delaware's DO profile marginally, the critical region of the river will still not be an important source of diverse aquatic life. Second, the DO threat should not be considered apart from other ecological risks with which our society is confronted. In light of our society's present tolerance of the discharge of substantial quantities of poisons, heavy metals and unknown chemicals into its streams, it seems capricious to single out the DO threat as justifying such enormous expenditures. If a fraction of the money spent on the removal of oxygen-demanding wastes were instead devoted to understanding and stringently controlling the impact of these other types of pollution on the Delaware River, the results could well prove far more important to human health and survival.

Third, even if the Delaware's critical region of DO depletion should be given more importance on ecological-catastrophe grounds than seems justified at present, it will be possible at some point in the future to reconsider the matter while incurring little cost in the interim. Program V, contemplating the maintenance of existing water quality, carries a pricetag which is far smaller than that of the program actually adopted by the DRBC.[146] Moreover, the fact that oxygen-demanding wastes will continue to be discharged in substantial quantities for the next decade or longer will not make it appreciably more difficult to improve DO whenever the decision is taken. For the oxygen-demanding wastes we are discussing are biodegradable and hence do not generate long-lived effects. Indeed, the costs of waste removal a decade or two hence should be far lower than at present, because for the first time in history considerable funds are now being expended on research and development of new forms of treatment technology.

In conclusion, as soon as it is recognized that we can tolerate the existence of *some* river segments with a relatively low DO, it would seem only prudent to permit those rivers which are *most expensive to improve* to remain in a degraded condition. Even if we posit that the worldwide DO problem is serious enough to justify the expensive improvement of DO profiles in the northeastern quadrant of the United States in order to prevent ecological catastrophe, it seems clear that DO should be improved along rivers like the Potomac[147] and the Susquehanna, where DO improvements can be generated at lower cost, rather than along rivers like the Delaware and Hudson, which have borne the brunt of twentieth century technology.

B. *Defining the Unquantifiable: Man and Nature in Industrialized Society.*

Even if it is conceded that the DRBC's investment program cannot be justified by invoking a plausible, though unquantifiable, threat to human health or existence, there remains another dimension to the problem which may be considered unquantifiable in a different sense. This factor requires a consideration of rather abstract issues concerning the place that the human species ought to play in the natural order.

1. The Rights of Nonhuman Species

When the economist attempts to quantify the benefits of an environmental improvement in dollar terms, he is only considering the amount of money *human beings* will sacrifice for the improvement. To consider the case at hand, the DECS attempted to calculate the benefit accruing to *fishermen* as a result of an increased population

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146 *See* Table 1 accompanying note 15 *supra.*

147 For a good discussion of the DO problem in the Potomac, see R. DAVIS, THE RANGE OF CHOICE IN WATER MANAGEMENT: A STUDY OF DISSOLVED OXYGEN IN THE POTOMAC ESTUARY (1968).

of fish in the estuary. One looks in vain to the economist to provide a value of the benefit accruing to *fish,* which have no money to sacrifice. Thus, the adequacy of the economist's approach may be attacked on the ground that the present distribution of economic power between man and other forms of nature is unjust.

This claim is obviously grounded in an ethical-religious conception of the proper relationship between man and nature, but so is the claim of the skeptic who responds that man is the measure of all things and the fate of other forms of life should be determined by man's convenience. The validity of neither is self-evident.

Although a systematic discussion of these matters is beyond the scope of this Article[148] some progress can be made in understanding the issues if we first consider two extreme positions. Imagine, for example, that the critic of economic cost-benefit analysis were to claim that the life of even one shad is priceless and hence that the DRBC's effort to improve the DO profile is well worth the $700 million it will cost. While this argument may be made sincerely, it rests upon premises that are not generally accepted in our society. For example, it would seem to require a universal commitment to vegetarianism, because it is inconsistent to demand that society refrain from the unintentional killing of fish through the discharge of oxygen-demanding wastes while tolerating the intentional murder of fish for food. In order to make his position more widely acceptable to contemporary mores, the critic could argue instead that although men may destroy animal life for some purposes, they may not destroy animals simply *to permit human beings the benefits of industrialized society.* In a society that tolerates 50,000 human deaths each year for the sake of automobile transportation, however, he would still fail to win a significant number of adherents to his view.

Because an absolute prohibition on the foreseeable destruction of animals for the purpose of technological advance is inconsistent with the premises of contemporary life, the critic of man-centered cost-benefit analysis must revise his position once again and offer a more modest formulation if he is to have a realistic opportunity to persuade his fellow citizens. Although the consequences of twentieth century industrialism cannot be undone, it does not follow that the

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148 Only a few preliminary efforts have been made to treat this issue systematically. *See, e.g.,* Morris, *The Rights and Duties of Beasts and Trees: A Law Teacher's Essay for Landscape Architects,* 17 J. LEGAL ED. 185 (1964); Stone, *Should Trees Have Standing?—Toward Legal Rights for Natural Objects,* 45 S. CAL. L. REV. 450 (1972); Tribe, *Technology Assessment and the Fourth Discontinuity: The Limits of Instrumental Rationality,* 46 S. CAL. L. REV. 617, 641-57 (1973); *cf.* J. RAWLS, A THEORY OF JUSTICE 512 (1971); R. NOZICK, ANARCHY, STATE, AND UTOPIA (forthcoming).

conflict of interest between industrialized man and lesser beasts should always be resolved to suit man's convenience. Instead, the critic may propose that men recognize the claim of nonhuman beings *by assuring that a broad range of animal and plant life exists in a substantial geographic range under conditions that these life forms find congenial, even though this goal is inconsistent with the results of man-centered cost-benefit analysis.*

Even if, however, most people assented to the notion that the human race has an obligation to assure that a broad range of animal and plant life survives, it seems implausible that this obligation would be stretched to cover the DRBC's program to improve DO along the Delaware. As the Delaware's "polluted" region will not maintain a truly diverse and vibrant range of acquatic life even after the DRBC's cleanup, it would seem wiser to invest substantial resources in the protection and enhancement of rivers which could promise greater returns in this regard. At the same time, existing water quality levels in the Delaware seem perfectly sufficient to maintain a sustaining population of Atlantic shad. Shad runs in the less-polluted estuaries on the eastern seaboard make one doubly sure that there is no serious risk of extinction. Finally, because the polluted segment of the estuary flows through a densely populated urban region, the interests of the resident land-based animal life in high water quality, which is so important in other contexts, need not be given great weight.

Of course, if more than enough funds were available to preserve and protect large wilderness areas and relatively untouched river systems against the threat of encroaching industrialism, the problems posed by DO depletion in the Delaware might be given serious consideration. However, satisfying nonhuman needs can only be accomplished at the cost of not satisfying human wants, which are often quite pressing. There would come a point, probably long before the Delaware problem was reached, at which further diversion of resources to nonhuman beings would not be acceptable even in a society which subscribed strongly to the obligation we have posited.

2. The Human Interest in the Integrity of Nature

The final criticism of conventional cost-benefit analysis that we shall consider is related to, but different from, the one we have just assessed. Instead of declaring that nonhuman life has a value *in its own right*, the critic may suggest that *humans* will obtain psychic satisfaction simply by knowing that the integrity of nonhuman life forms is being respected. The critic would insist that although a citizen may never himself engage in outdoor activities, he may well be willing to sacrifice a substantial amount of money simply to give himself the satisfaction of knowing that Nature is preserved. This, of course, is an extreme case of "naturalism." The less extreme but more common case is represented by a person who does physically use a resource but is also willing to sacrifice something to preserve it *regardless of whether he would ever use the resource.* If this amount is substantial, it must be considered an important benefit of cleaning up the river that our earlier economic analysis failed to consider.

A rigorous estimate of the amount of money that "naturalists" are willing to sacrifice could easily elude the economist-researcher. The only way of estimating the money value of this benefit is to interview a sample of the population. Yet interviewees would have a powerful incentive to exaggerate the extent of their psychic benefits unless, of course, they were actually obliged to sacrifice funds to save nonhuman life forms. If, however, an actual donation to a conservation fund were required, naturalists would then have a substantial incentive to pay an amount far less than their full psychic cost, knowing that the size of their individual contributions could have little effect on the total amount collected.

These problems, which are familiar ones in the evaluation of public goods,[149] clarify another distinct sense in which benefits can be said to be unquantifiable. Nevertheless, it is once again premature to conclude that the isolation of this unquantifiable factor will lead to the vindication of a program, like the one on the Delaware, which cannot otherwise be justified. The focus of the naturalist's concern must be considered quite precisely. It is not enough to know, for example, that our society contains many naturalists and that they would be willing to sacrifice billions and billions to preserve Nature, considered globally. Instead, we must discover the extra amount they are willing to spend on a particular resource (the "critical" region in the Delaware) to satisfy their psychic interest. As soon as this is understood, an appeal to the unquantifiable benefits accruing to naturalists from DO improvement along the Delaware seems quite problematic.

It is true, of course, that many would feel poorer after having learned that a site of exceptional value—like the Grand Canyon—has substantially deteriorated, regardless of whether they intended to visit the place. It seems far less plausible to assume, however, that many would be similarly affected if they learned that the "critical region"

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[149] For an illuminating discussion, see M. OLSON, THE LOGIC OF COLLECTIVE ACTION (1965).

of the Delaware River, from which Nature in any real sense has long since vanished, would not be partially rehabilitated.

Of course, the deteriorated condition of a particular site may be taken as a *symbol* of a more general deterioration in the environment which threatens a *generalized* interest in the continuing integrity of the world of Nature. Nevertheless, if naturalists were assured that society was fulfilling a policy, of the type discussed in the preceding section, which guaranteed a broadly based animal and plant life in areas congenial to these nonhuman forms, it is quite likely that they would no longer experience the same degree of concern when learning that the basic inconsistency between urban industrialism and Nature had not been universally resolved in favor of the latter. This is not to deny that the typical naturalist would continue to feel some regret at the tension between Man and Nature. We merely suggest that he would be unlikely to sacrifice a substantial sum to alleviate a particular symptom of this tension, such as the DO sag in the Delaware estuary, if a conservation effort of the sort we have suggested were being made in more appropriate locales.

Even apart from the problems which ordinarily inhere in the valuation of public goods, there is no way to verify this claim empirically. The fact remains that many thinking people attracted by naturalism have not yet been able to sort out their commitments in the relatively short time since environmentalism has risen to prominence. Given our own values, however, we are unwilling to impute to the bulk of the population the extreme form of naturalism required to justify an attack on the Delaware's DO profile when so much remains to be done to satisfy other human aspirations which themselves may be grounded in a compelling sense of justice.

VI. Conclusions

This essay has had two major purposes. First, we have attempted, by the careful inspection of the costs and benefits of a typical project, to invite a reconsideration of the basic premises of environmental regulation as it is evolving in the United States. Second, we have attempted to give the reader a sense of the gap between the economic theory of cost-benefit analysis and its actual practice, even in a study as carefully done as the DECS *Report*. In attempting to fulfill these purposes, we have refrained from moving too far away from our case study in order to give the reader an opportunity to use the data we have presented to form his own judgments on the basic issues. It does not seem inappropriate at this stage, however, to elaborate more fully on the general implications of our case study.

A. *The Substance of Environmental Policy*

It is easy to imagine that when society decides to spend three quarters of a billion dollars to "clean up" a forty-mile stretch of river around Philadelphia, something significant will come of it. The mind rebels at the thought that even these vast sums could be spent in vain. Yet in 1978 or 1980 or 1984, when the DRBC announces to the world that it has "succeeded" in achieving its DO objectives on the river, the Delaware River will be just as cloudy as it ever was; it will be just as difficult to obtain access to the river; boating will be neither better nor worse than it was; the drinking water will taste the same as it always did. Perhaps good fishing will be a few minutes closer, and during some years more shad will survive their journey up and down the main stem. Is this what all the talk about improving "the quality of life" amounts to? The question will be asked not only in the Delaware Valley, but in every major industrialized area in the nation. For Congress, as we shall see, has adopted the equivalent of the DRBC's objectives (Program II) to serve as national policy for the 1970's.[150] Although the consequences of an improvement in DO levels will vary from case to case, there is no reason to expect that the Delaware is not a typical example of the fate of current policy in heavily industrialized areas.

As the meager results of this aspect of the "environmental revolution" become apparent, the public may lose much of its interest in "the environment" and search for another ideal which has not yet been tarnished by serious commitment. But simply because the fundamental premise of current policy is mistaken, it does not follow that there is not much of value in environmentalism. Indeed, a review of the reasons for finding that the critical region of the Delaware is the wrong place to lavish environmental concerns reveals a sounder policy by contrast. Investing enormous sums in an effort to improve the Delaware's DO profile is wrong because:

1. It does nothing to control the discharge of poisons which may threaten the health of those who depend on the water for drinking supplies.[151]

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[150] *See* text accompanying notes 164-66 *infra*.

[151] Curiously, at the same time a massive effort is being made to improve the DO profile throughout the nation, both the Environmental Protection Agency and the General Accounting Office report that the quality of drinking water in a large number of

2. It does little to improve the recreational opportunities open to residents of the region.

3. It does little to improve the environment of nonhuman forms of life compared to the probable results of the expenditure of a similar sum of money on the preservation and development of areas which are relatively untouched by urban industrialism.

4. It does little to minimize the long term ecological risk to mankind's continued existence, compared to the probable results of the expenditure of similar sums on other pollutants and in other river basins located in less heavily populated areas.

This summary indictment of the Delaware's program has been framed, of course, to suggest the goals of an alternative environmental program which would yield greater benefits than our present course. Pursuit of these objectives would require decisionmakers to develop a clear distinction between goals which are appropriate in the management of heavily industrialized sectors and those suitable for control of water resources which remain relatively untouched by twentieth-century life.[152] It is in these latter areas where the unquantifiable concerns ignored by cost-benefit analysis should be given an important place in policy. Substantial sums should be expended, first to preserve and then to expand the opportunities for nonhuman life forms to thrive in a congenial environment. In so doing, policymakers will of course simultaneously be taking steps that will significantly limit the risk of long range ecological damage to mankind and will also preserve important recreational resources for outdoorsmen.[153]

The task of managing heavily industrialized river segments should be undertaken in a different spirit. It should be recognized that our society is unwilling to expend the billions and billions required to transform a place like the Delaware's critical zone into an area in

areas leaves much to be desired. *See* S. REP. No. 93-231, 93d Cong., 1st Sess. 3 (1973). Much could be done to improve the situation by introducing new methods of water treatment which, though costly, would be far less expensive than the present misguided effort to clean up oxygen-demanding discharges. The focus of current legislation on the control of these discharges may have just the opposite effect. The New York Times recently reported that water and sewer departments throughout the nation, faced with the enormous expense of improving their effluent treatment, have been cutting back their treatment of drinking water. N.Y. Times, May 13, 1973, at 8, col. 3.

152 Our distinction between "urban" and "nonurban" environmental policy relies on the traditional welfare economist's case for "separate facilities solutions." *See* J. DALES, POLLUTION, PROPERTY, & PRICES (1968); Mishan, *Pareto Optimality and the Law*, 19 (N.S.) OXFORD ECONOMIC PAPERS 255 (1967).

153 In saying this, we do not mean to minimize the conflicts which may arise when a decisionmaker seeks to reserve a natural area for both the purpose of preserving wildlife and the purpose of mass recreation. The presence of human beings in large numbers, even when they are simply enjoying themselves in outdoor pursuits, may endanger ecological balances and the ability of nonhuman forms to thrive. In such cases, a fundamentally unquantifiable judgment must be made, balancing the competing interests at stake.

which Nature pure and pristine shall reign once again. Decisions to improve separate aspects of the environment in such areas should be governed by the astute use of cost-benefit analysis. Although, if we are correct, improving the DO profile on the main stem of the estuary is not warranted by such analysis, there may be circumstances in which attempting a massive cleanup of an urban waterway would be justified in economic terms. Some likely locations may even be found in the Delaware Valley itself. The Schuylkill River, for example, is one of the major tributaries of the Delaware, and flows through the center of the City of Philadelphia, as well as a large portion of its suburbs. To make matters more promising for the would-be recreationist, access to the river is assured even in the heart of the city as the river flows through one of the largest urban parks in the United States. Although at the present time the river is the scene of substantial boating activity, making it a safe place for swimming would be an expensive proposition. It would require, among other things, the diversion of storm sewer runoff from the Schuylkill to the main stem of the Delaware, the stringent control of oil slicks and similar nuisances, and the imposition of extremely high treatment requirements on the discharge of organic waste within a twenty-five mile distance upriver from the swimming zone. Nevertheless, the total being undertaken on the far more heavily industrialized main stem of expense may be a good deal less than the DO program currently the river. Moreover, the successful completion of the Schuylkill plan would at least permit hundreds of thousands of citizens—many from the black ghetto—to have a far more pleasant summer than is currently the case.

In speaking of the possibilities of swimming in the Schuylkill, we do not mean to suggest that the merits of this program can be established without careful study. It is not self-evident that the money that cleaning up the Schuylkill would require would not be better spent on providing better schools for Philadelphians or, indeed, on providing other sorts of consumer goods through the private sector. We only wish to use the Schuylkill as an example of the kind of program which would be seriously considered if current policy were predicated upon a sophisticated conception of a plausible relationship between man and nature in contemporary society. Indeed, it seems to us quite extraordinary that most policymakers who were asked about the Schuylkill plan dismissed it as "impractical" (although its technical feasibility was not seriously questioned), while all thought it eminently "practical" to expend vast resources to achieve a pyrrhic victory over the DO sag on the Delaware's main stem.

So far as the Delaware's main stem is concerned, attention should be focused upon the discharge of exotic chemicals and heavy metals, which may well pose a palpable risk to human health when present in the water supply or in aquatic life. Paradoxically, the real cause for concern along the Delaware is not that the shad face extinction, but that a shad will survive only to be caught and served on the family table. For fish, by virtue both of their metabolism and their position on the food chain, may contain substantial concentrations of harmful substances which are present only in minute quantities in the water.[154] Although the precise magnitude of this risk to human health is unclear at present, a cost-benefit analyst would be justified in erring on the side of caution and recommending stringent controls on the esoteric discharges in question.[155] Curiously, while the DRBC has labored long on the DO issue, its concern with what should be its first priority on the estuary has been intermittent and primitive at best.[156] Indeed, this modest concern seems quite typical of the nation as a whole;[157] even the technology required to detect, let alone control, the presence of various metals and exotic chemicals is not in widespread use.[158]

B. *A Critique of the Federal Water Quality Control Act Amendments of 1972*

Having elaborated the basic substantive principles suggested by our analysis, we are in a position to assess the extent to which federal

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[154] *See, e.g., Hearings on the Effects of Mercury on Man and the Environment Before the Subcomm. on Energy, Natural Resources, & the Environment of the Senate Comm. on Commerce*, 91st Cong., 2d Sess. (1970); Berglund & Berlin, *Human Risk Evaluation for Various Populations in Sweden Due to Methylmercury in Fish*, in CHEMICAL FALLOUT: CURRENT RESEARCH IN PERSISTANT PESTICIDES 423 (M. Miller & G. Berg eds. 1969); *Hazards of Mercury, Special Report to the Secretary's Pesticide Advisory Committee, Department of Health, Education, and Welfare*, 4 ENVIRONMENTAL RESEARCH 1 (1971).

[155] For an intelligent discussion of the desirability of preserving options and allocating the burden of uncertainty, see NATIONAL ACADEMY OF SCIENCES, TECHNOLOGY: PROCESS OF ASSESSMENT AND CHOICE 32-39 (1969).

[156] Conversations with DRBC officials who prefer to remain anonymous, summer 1970.

[157] For a discussion of the primitive legal tools currently being relied upon to control aquatic life which may contain hazardous substances, see Note, *Health Regulation of Naturally Hazardous Foods: The FDA Ban on Swordfish*, 85 HARV. L. REV. 1025 (1972).

[158] On the relatively undeveloped state of surveillance, see Brown & Duncan, *Legal Aspects of a Federal Water Quality Surveillance System*, 68 MICH. L. REV. 1131 (1970). Section 307 of the Federal Water Pollution Control Act Amendments of 1972, 33 U.S.C.A. § 1317 (Supp. 1973), provides for the establishment of effluent controls on toxic substances; such controls are not to be determined with an eye to the costs which they impose, H. R. REP. No. 92-911, 92d Cong., 2d Sess. 113 (1972) [hereinafter cited as H. R. REP.], and may include absolute prohibition. However, the Administrator of the Environmental Protection Agency has discretion both in selecting the toxic substances which will be regulated under § 1317 and in setting the level of control. 33 U.S.C.A. § 1317 (a)(1) (Supp. 1973). Section 308 of the amendments, *id.* § 1318, provides for monitoring to enforce standards but does not require that a systematic program be undertaken. It remains to be seen how effective such a vague mandate will be in remedying the defi-

policy—as established in the most ambitious piece of environmental legislation yet passed by Congress—deviates from our recommendations. Since this is not the place for an exhaustive discussion of the eighty-nine pages of the Federal Water Pollution Control Act Amendments of 1972,[159] we shall limit our treatment to basic issues of principle.

First, the statute fails to distinguish between heavily industrialized rivers and those whose DO can be improved at relatively little cost. Although in setting the nationwide effluent limitations for which the Act provides, the Environmental Protection Agency (EPA) may divide polluters into subclasses to take into account "the facilities involved, the process employed"[160] and similar factors, the agency is not authorized to treat similar plants differently on the basis of their differential impacts upon the environment. Thus, the Agency's effluent limitations will not reflect our contention that it may make sense to impose extremely demanding requirements upon a factory discharging materials in the near-virgin expanses of Lake Superior,[161] but not upon an identical factory located in the critical region of the Delaware.

Second, rather than accept the inevitable conflict between nature and industrialized society and look for ways to ameliorate this tension, the Act strikes a romantic pose with its declaration that "it is the national goal that the discharge of pollutants into the navigable water be eliminated by 1985."[162] A thorough reading of the Act, however, makes it apparent that the legislators were unwilling to accept the enormous social costs which this position, if taken seriously, would entail.[163] As a result, the stated goal is merely a politically attractive mask for a policy which is similar to the one pursued on the Delaware.

As an interim measure, the EPA is to require all industrial dischargers to install the "best practicable control technology currently available"[164] by 1977. Although what is "practicable" is not self-defining, and the Agency is given considerable discretion in formulat-

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ciencies whose dimensions we have only hinted at. *See generally* text accompanying note 179 *infra.*

159 For a detailed consideration of the Act, see Zener, *The Federal Law of Water Pollution Control*, in ENVIRONMENTAL LAW INSTITUTE, FEDERAL ENVIRONMENTAL LAW 1 (draft ed. 1973).

160 33 U.S.C.A. § 1314(b)(1)(B) (Supp. 1973).

161 The Nader report on the Reserve Mining case, 1 NADER TASK FORCE REPORT ON WATER POLLUTION—WATER WASTELAND ch. 7 (prelim. draft 1971), addresses a classic example of the circumstances under which stringent standards would be appropriate.

162 33 U.S.C.A. § 1251(a)(1) (Supp. 1973).

163 *See, e.g.*, H.R. REP., *supra* note 158, at 103.

164 33 U.S.C.A. § 1311(b)(1)(A)(i) (Supp. 1973).

ing precise requirements,[165] it seems likely that industry will in general be required to construct facilities—like those currently being installed along the Delaware—which will attempt to eliminate most oxygen demanding material.[166]

By 1983, Congress demands that industrial dischargers achieve the "best available technology."[167] While this formula seems relatively unambiguous, the statute muddies the waters by indicating that only the "best available technology" which is "economically achievable" need be required.[168] This caveat must be read in light of Congress' recognition in the legislative history of the Amendments that treatment costs increase dramatically as requirements become more demanding, and that the cost of complete elimination of discharges may be unreasonable.[169] Thus, even though the 1983 limitations will be somewhat more stringent than those currently applied by the DRBC, one cannot be sure how much greater severity the EPA will consider reasonable in 1983. Moreover, even if the 1983 limitations are quite stringent, it is not at all clear that the cutbacks ordered pursuant to the statutory mandate will generate a DO profile on the Delaware any better than the one contemplated by the current DRBC program. As we have seen,[170] the wasteload to be treated along the Delaware will increase substantially due to the growth of existing dischargers and the entry of new ones.[171] Thus, on the assumption that the DRBC suc-

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165 In determining what is "practicable," the Administrator of EPA is to take into account "the total cost of application of technology in relation to the effluent reduction benefits to be achieved from such application . . . ." *Id.* § 1314(b)(1)(B).

166 In the jargon of the engineering profession these are called high-level secondary treatment facilities. Although these plants reduce carbonaceous oxygen demand by about 90%, nitrogenous oxygen demand is typically reduced by only 33%. For the importance of this point, see Ackerman & Sawyer, *supra* note 1, at 457-60.

Our suspicion that "best practicable treatment" will be construed to require secondary treatment would seem to find some basis in the statutory command that towns and municipalities install secondary treatment by the same deadline. 33 U.S.C.A. § 1311(b)(1)(B) (Supp. 1973), although there is nothing in the statute which forbids imposing higher interim standards on firms than on municipalities, and in fact the Act's strategy for the 1980's explicitly contemplates a heavier burden on industry, *see* note 167 *infra.* In any event, a more precise definition of the statutory command will be available from EPA by the end of the current year.

167 33 U.S.C.A. § 1311(b)(2)(A) (Supp. 1973).

In contrast, municipalities are only required to install the "best practicable waste treatment technology." *Id.* §§ 1311(b)(2)(B), 1281(g)(2)(A). Thus, for rivers like the Delaware, where municipally owned plants contribute 2/3 of the total oxygen-demanding load, the impact of the 1983 standards on water quality will be even less substantial than is suggested by the text accompanying notes 170-71 *infra.*

168 *Id.* § 1311(b)(2)(A).

169 *See, e.g.,* H.R. REP., *supra* note 158, at 103.

170 *See* text accompanying notes 27-37 *supra.*

171 For new sources, regardless of the date they begin discharging, the Act requires "the best available demonstrated control technology . . . including where practicable, a standard permitting no discharge of pollutants." 33 U.S.C.A. § 1316(a)(1) (Supp. 1973). The difference between the "best available demonstrated technology" and "best available technology" is unclear. *Cf.* Zener, *supra* note 159, at 28-29. For a discussion of

ceeds in enforcing its mandate under the federal Act, a generation of expensive effort will culminate in 1983 in a river whose improved quality will produce benefits only of the magnitude we have suggested.

Fortunately, the draftsmen of the statute have foreseen this unhappy possibility and have provided that where "water quality in a specific portion of the navigable waters [does not] assure . . . the protection and propagation of a balanced population of shellfish, fish and wildlife, and allow recreational activities in and on the water," treatment facilities even better than "the best available" are to be required.[172] Having driven their commitment to cleanliness-at-any-price to the point of semantic absurdity, the draftsmen pause to permit the EPA to consider whether better than the best must be imposed in every single case. Upon finding that the "best available" will not do, the EPA must hold a hearing "to determine the relationship of the economic and social costs of achieving any such [greater] limitation . . . to the social and economic benefits to be obtained . . . ."[173] If any individual discharger can show that there is "*no* reasonable relationship,"[174] the EPA will permit the "best available" technology to suffice in his particular case. The scientific and economic arguments presented in this and our previous Articles suggest that the dischargers of oxygen-demanding wastes along the "most polluted" regions of the Delaware and similar rivers should have little difficulty in making out a case even under this demanding "no relationship" test.

By 1984, then, polluters may free themselves from the requirement that treatment better than the "best available" be attained. Unfortunately, however, the larger social tragedy cannot be evaded by invoking newspeak. Billions will have been wasted in a spurious war on "pollution" which could have been devoted to constructing a sounder relationship between industrialized society and the natural environment.[175]

EPA's rather liberal notion of what will pass muster under the name of "best available demonstrated technology," see 3 BNA [Current Developments] ENV. L. REP. 1552 (1973).

172 33 U.S.C.A. § 1312(a) (Supp. 1973).

173 *Id.* § 1312(b)(1).

174 *Id.* § 1312(b)(2) (emphasis added).

175 In addition to the programs considered in the text, the Act provides EPA with the tools required to limit stringently the discharge of hazardous substances. *Id.* §§ 1317, 1321. The operative standards for action by EPA are, however, rather vague. For example,

> the Administrator . . . shall publish a proposed effluent standard . . . for [toxic] pollutant[s] . . . which shall take into account the toxicity of the pollutant, its persistence, degradability, the usual or potential presence of the affected organisms in any waters, the importance of the affected organisms and the nature and extent of the effect of the toxic pollutant on such organisms . . . .

Id. § 1317(a)(2). Moreover, the Administrator is instructed that "[a]ny effluent standard . . . shall . . . [provide] an ample margin of safety," *id.* § 1317(a)(4), though he

To bring this misdirection of concern into sharper focus, compare the multibillion-dollar effort to construct facilities to treat oxygen-demanding wastes by 1977[176] with the nation's financial commitment to other environmental priorities which our analysis has revealed are far more pressing.[177] First, in the control of poisons even the advances made by the 1972 Amendments seem inadequate. Although recent legislation grants the EPA ample power to limit or entirely ban harmful pollutants,[178] the Agency is not given authority to subsidize firms that are particularly hard hit by stringent controls, or otherwise to ameliorate the substantial dislocations caused by plant shutdowns. The significance of this omission is suggested by a paradigmatic case which has received a great deal of publicity. Recently, the EPA discovered that discharges of asbestos by the Reserve Mining Company posed a threat to the water supply of the inhabitants of Duluth, Minnesota. The Agency now is considering whether to impose controls on Reserve, which the company claims will close down twenty percent of the taconite production of the United States, and lead to the unemployment of 3,200 and the devastation of the one-industry town of Silver Bay, Minnesota, population 3,272.[179] If such choices must be made, it is likely that the EPA will often (if not always) choose to save jobs by watering down the limitations it imposes upon dischargers

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is not told explicity how much risk can be tolerated consistently with a commitment to "safety," nor whether the discharge must be "safe" only for humans or for other beings as well. As we have suggested, we are in favor of a vigorous program to control hazardous substances of all sorts. We only fear that this effort will not be forthcoming, precisely because the amendment's other commands will divert a large portion of the energy and resources which can be plausibly allocated to environmental issues. Indeed, as we have noted before, note 158 *supra*, much remains to be done even in the preliminary task of establishing an adequate monitoring system.

The effectiveness promised by these provisions of the Water Pollution Control Act Amendments should be compared to the potential bite of the proposed Safe Drinking Water Act of 1973, S. 433, 93d Cong., 1st Sess. (1973), which represents the first move by Congress to establish comprehensive national standards for drinking water. This proposal would require the Administrator of EPA to prescribe standards which establish

> the maximum permissible levels for any contaminants which may exist in any public water system in the United States which may cause or transmit disease, chemical poisoning, or other impairments to man, allowing adequate margins of safety . . . .

Id. § 4(b)(1)(A). This mandate, which gains further specificity from a definition of "contaminant" elsewhere in the bill, *id.* § 3(4), promises much better results than that contained in the Amendments, which do not define "toxic pollutants" or specify the level to which any pollutant which the Administrator brands "toxic" must be reduced.

176 Of the total $297.1 billion projected for pollution control expenditure between 1971 and 1980, $87.3 billion is slated for water pollution control. 3 CEQ ANN. REP. 276-77 (1972). Of this, $42.5 billion is scheduled for state and local treatment systems. Conversations with officials of the CEQ on Aug. 16, 1973, revealed that almost all of these funds will be expended for secondary treatment facilities, and suggested that a similar pattern could be expected for industrial expenditures.

177 *See* text accompanying notes 152-58 *supra.*

178 *See* note 175 *supra.*

179 Telephone interview with Representative Blatnik's office, July 17, 1973.

of poison.[180] In contrast, if a partial subsidy were possible, or if the Agency could successfully assist in meaningful relocation and reemployment efforts, it could act aggressively on behalf of Duluth without utterly destroying Silver Bay. Of course, subsidies will sometimes be misused, as companies or towns claim falsely that they are in dire need of assistance. Nevertheless, if one seriously wishes to embark upon a stringent poison-control strategy, it would seem this is a risk which is worth taking so long as institutional safeguards are created to minimize cheating. By failing to address the subsidy question seriously, we fear that the 1972 Amendments again promise far more than they will deliver.

A second item which we have given high priority may also be slighted by the environmental revolution wrought by recent statutes. Existing programs to protect and expand wilderness areas in the United States remain relatively undeveloped. Although a Wild and Scenic Rivers Preservation Act is on the books,[181] the program remains underfunded,[182] as do other federal wilderness programs.[183] More generally, the management of our national lands leaves much to be

180 It should be recalled that the Agency is given a good deal of discretion in limiting poisonous discharges. *See* note 175 *supra.*

181 16 U.S.C.A. §§ 1271-87 (Supp. 1973).

182 Only $17,000,000 was authorized to be appropriated for acquisitions under the 1968 Act, and when that is used up, a new authorization act will be needed, *id.* § 1287. The program is administered jointly by the Secretaries of Agriculture and the Interior, *id.* § 1274; the Secretary of Agriculture being involved primarily through his stewardship of the National Forests, 16 U.S.C. § 471 (1970). It is difficult to determine how much money has been appropriated in fact, as lands acquired by the Department of the Interior become part of either the National Park or National Wildlife Refuge Systems, 16 U.S.C.A. § 1281(c) (Supp. 1973), and are funded by Interior either out of the appropriation for National Park acquisitions, which amounted to $76,871,000 in 1973, 86 Stat. 508, 512 (1972), the appropriation for land acquisition by the Bureau of Sport Fisheries and Wildlife, amounting to $4,602,000 in 1973, *id.,* or the $1,829,000 made available for the same purpose to the Bureau of Land Management, *id.* For a detailed breakdown see S. REP. No. 92-921, 92d Cong., 2d Sess. 9-10 (1972). The Department of Agriculture could acquire land in the program through the $29,655,000 appropriated for Forest Service acquisitions, 86 Stat. 508 (1972). Finally, the Secretary of Agriculture received $7,648,000 in fiscal 1973, not classified under any budget category, which is presumably available for this program. 86 Stat. 591 (1972). The Forest Service was slated to receive $1,816,000 for "National Wild and Scenic Rivers," but this was eliminated in committee. S. REP. No. 92-921, 92d Cong., 2d Sess. 9 (1972). The total federal land acquisition budget for 1973 was $98,257,000, though appropriations totalled $112,957,000. *Id.;* 86 Stat. 508, 512 (1973).

183 The National Wilderness Preservation System gets no funds, since lands brought into the System remain under the ownership and management of their donors, 16 U.S.C.A. § 1131(b) (Supp. 1973). Although in 1972 some 1,300,000 acres of existing federal lands were proposed for inclusion in the wilderness network, 3 CEQ ANN. REP. 141 (1972), the significance of this potential addition to the 10,400,000 acres already classified as wilderness must be assessed in light of the federal government's ownership of more than 750,000,000 acres of the nation's land, PUBLIC LAND LAW REVIEW COMM'N, ONE THIRD OF THE NATION'S LAND 22 (1970) [hereinafter cited as NATION'S LAND]. As the title of the cited study suggests, about 1/3 of the land in the United States is owned by the federal government, *id.* x. It should be noted, however, that 95% of Alaska is federally owned, and this makes up almost half the federal holdings, *id.* 22. The Forest Service received $539,000 in 1973 for "wilderness and primitive areas." S. REP. No. 92-921, 92d Cong., 2d Sess. 9 (1972). The Bureau of Sport Fisheries and Wildlife received $100,000

desired from a naturalist's point of view, and it remains far from clear that recent efforts to rethink policy in this area will improve the situation.[184]

Finally, planning for the expansion of meaningful recreational opportunities for the urban masses remains confused and fragmentary. On the national level, there has been only slow development of significant projects, like the proposal to create a national seashore in New York City.[185] Nor has there been substantial development of the national park program.[186] Although events on the local and state levels are more difficult to trace, available estimates of gross expenditures suggest that a substantial expansion of recreational opportunities is not high on local agendas.[187]

In sum, the nation's environmental program for the 1970's is based upon the same confused notion of the relationship between urbanized man and Nature that afflicted the DRBC's efforts in the 1960's. The modest but conceptually sound technocratic studies that might have helped dispel this confusion have not materialized. There

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for "wilderness," *id.* 10. An additional $1,650,000 was budgeted for wilderness protection and acquisition, but this was eliminated by the House Appropriations Committee. H.R. REP. No. 92-1119, 92d Cong., 2d Sess. 15-16 (1972).

184 The basic study in this area is NATION'S LAND, *supra* note 183. The report analyzes policy for the management of federal lands at a truly olympian level of generality, advocating planning of land uses "to obtain the greatest net public benefit." *Id.* 45. The Commission accepts the current "multiple-use" statutory structure, *id.* 44-46, although it has been cogently argued that the multiple-use system does not provide a sound basis for federal land management. *See, e.g.*, Note, *Managing Federal Lands: Replacing the Multiple-Use System*, 82 YALE L.J. 787, 788-95 (1973).

185 *See* 3 CEQ ANN. REP. 139 (1972). The Gateway National Recreation Area was finally established in Oct. 1972, 16 U.S.C.A. §§ 460cc to 460cc-4 (Supp. 1973); a similar area was established near San Francisco at the same time, *id.* §§ 460bb to 460bb-5. These areas are just 2 among perhaps several dozen national seashore and recreation areas, each created by a separate act of Congress and each subject to different sets of uses and conditions negotiated at the time of acquisition. There is no apparent comprehensive national plan for the development of these areas. Instead, each project is lobbied through Congress in an ad hoc fashion and receives money for acquisitions in yearly increments.

186 Thirteen National Parks and National Historic Parks have been authorized by individual acts of Congress since 1960. 16 U.S.C.A. §§ 79a-j, 90 to 90e-3, 160-60k, 271-71g, 272-72f, 273-73f, 281-81f, 282-82c, 283-83e, 284-84b, 291-91b, 396, 410y to 410y-6 (Supp. 1973). Of the 4 which have been authorized since 1970, 2 were merely changes in the name of a previously existing park. 3 CEQ ANN. REP. 317 (Table 1 nn.2, 4 (1972)). Congressional authorization does not suffice, in and of itself, to bring a park into existence. At least 2, and perhaps as many as 7, of the parks which have been authorized since 1960 were not established as of August 1972. *Id.* 317.

A number of National Recreation Areas and National Seashore Recreational Areas have been authorized since 1960. *See, e.g.*, note 185 *supra*. Again the bare fact of authorization does not mean that such areas have actually been established. Specific appropriations must be made and the land actually acquired before the area is truly established.

187 This is not to deny that some significant activity is taking place. The National Recreation and Parks Association estimated that states spent $348,100,000 on state parks in 1970, $71,700,000 of which went for acquisition of new lands. 3 CEQ ANN. REP. 189 (1972). These outlays were doubtlessly enhanced in many cases by federal matching funds from the Department of Interior's Land and Water Conservation Fund. *See id.* 138. Nevertheless, even doubled, the $71,700,000 for acquisitions does not represent a level of expenditure which is in any way sufficient to meet expanding recreational demand.

remains the possibility, however, that technocratic tools may still be marshalled to shape sound policy. Section 305(b)(1)(D) of the Water Pollution Control Act Amendments requires an annual estimate from the states of "the economic and social costs necessary to achieve the objectives of this chapter" and "the economic and social benefits of such achievement . . . ."[188] "[T]he Administrator is expected to support the States in these efforts through full use of other authorities contained in the bill."[189] The Amendments also create a National Study Commission which is to make a "study of . . . all aspects of the total economic, social, and environmental effects of achieving or not achieving" the 1983 goals;[190] the Commission, two-thirds of which is composed of members of Congress,[191] may contract with outside groups in making their study[192] and must report their findings to Congress by 1975.[193] If the states and the EPA take their mandate seriously and prove willing to commit significant resources to the production of intellectually defensible estimates, or if the National Study Commission proves able, despite its essentially political makeup, to orchestrate the sophisticated survey called for by the Amendments, the results may sway a Congress whose misguided efforts have only been reinforced up to this point by analyses of the sort to which this Article has devoted its attention.

APPENDIX A

DERIVING CLEANUP COST ESTIMATES FOR INDIVIDUAL POLLUTERS ALONG THE ESTUARY

The DECS staff estimated the cost functions of each of the estuary's forty-four major dischargers to determine the costs of a variety of plausible cleanup proposals. The staff, however, maintained a policy of confidentiality which was intended to make it impossible to associate individual cost estimates with particular polluters. Thus, when researchers asked for data, cost figures were provided which did not identify each of the forty-four dischargers by name, but only by an arbitrarily selected number. Nevertheless, a complex set of inferences from documents made available to us has made it possible to identify each of the forty-four polluters' cost data with precision.

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[188] 33 U.S.C.A. § 1315(b)(1)(D) (Supp. 1973).
[189] H.R. Rep., *supra* note 158, at 110.
[190] 33 U.S.C.A. § 1325(a) (Supp. 1973).
[191] *Id.* § 1325(b).
[192] *Id.* § 1325(c).
[193] *Id.* § 1325(e).

Since a number of the statements we have made are based on them, these inferences are elaborated here, along with the various sets of cost data made available by the DECS. In keeping with the DECS policy, however, we have not identified polluters by name.

To understand the following table, it is necessary to recognize that the DECS staff have at various times provided their cost data on individual polluters to researchers. Grant Schaumberg obtained data in 1966, Glenn Graves and his coworkers in 1967, and the present authors in 1970. Grant Schaumberg kindly provided us with his data set, and Graves' data is available in an article authored by Graves, Whinston and Hatfield.[1] In each data set, dischargers are identified by number, and the marginal cost of removing waste over specified ranges is reported in dollars per pound per day. Both Schaumberg's data and that provided to us by the DECS separate capital and operating costs. Schaumberg's information also includes data indicating the state in which each polluter is located, its river section, and whether it is a municipality or a firm. Graves' data reports the level of discharge in 1964. Graves, Hatfield and Whinston also present a map of the estuary, which shows the location of each polluter along the river.[2] The polluters are numbered differently in each set of information, but the basic ranking is from upstream to downstream.

From the DRBC we know the identity of the largest dischargers and their locations along the river. We also know each polluter's estimated 1964 raw load as recorded by the DRBC, and the wasteload allocations each has received. Combining all of this information made it possible to identify each of the forty-four polluters by name, reconcile the disparate numbering systems so that changes in the data could be analyzed, and determine what levels of waste removal were indicated by the data points. Once this had been done it was a simple matter to calculate the polluter-by-polluter costs of reaching the DRBC allocations, or any other allocation pattern that specified either percentage or tonnage removal in advance. The accompanying table summarizes this information. It is important to remember that the cost figures given here are not the total costs of treating all wastes, but only the costs of reducing 1964 discharges. The cost of reaching the DRBC allocation is $289 million with Schaumberg's data, $301 million with Graves', and $267 million with the DECS staff's 1970 list. These estimates are close to, but consistently higher than, the cost of $225 million reported in *Where Man and Water Meet*. Thus there may be minor misspecifications included in the current estimates.

1 *Water Pollution Control Using Bypass Piping*, 5 WATER RESOURCES RESEARCH 27 (1969).

2 *Id.*

Table A

Polluter-by-Polluter Cost and Wasteload Data

No.[3]	Type[4]	State[5]	Section[6]	Data Source[7]	Costs (Millions of 1964 Dollars)[8] K_1	Annual O_1 & M_1	Tot_1	L_1	K_2	Annual O_2 & M_2	Tot_2	L_2	K_3	Annual O_3 & M_3	Tot_3	L_3	1964[9] Discharge	1964[10] % removal	DRBC[11] Allocation
1	M	NJ	1	S,G,D	3.20	.605	12.20	2,040									3,060	85	2,350
2 (3)	M	NJ	2	S,G,D	1.12	.212	4.30	1,133									1,700[12]	85	1,540
3 (2)	I	P	2	S,G,D	1.18	.223	4.50	1,833									2,750	85	2,110
4	I	NJ	3	S,G	.25	.032	.73	396	.64	.121	2.44	228					990[18]	66	NONE
				D	OUT OF BUSINESS														
5	M	P	3	S,G	.96	.181	3.66	2,093									3,140	85	2,410
				D	2.70	.064	3.64	1,888											
6	M	NJ	4	S,G,D	.09	.003	.13	1,333	.56	.158	2.14	445					2,000	55	510
7 (8)	I	NJ	10	S,G,D	.21	.008	.33	5,808	.32	.061	1.22	1,161					7,550	35	1,620
8 (7)	M	NJ	10	S,G	.10	.005	.17	892	.64	.121	2.44	892					2,230	75	1,530
				D	.10	.005	.17	1,095	.65	.121	2.44	1,090					2,730	75	
9	M	P	10	S,G,D	.66	.066	1.64	50,100	2.91	.256	6.75	35,070					129,000[14]	74	69,300
10	M	NJ	13	S	2.50	.020	2.80	46,332	3.60	.005	3.67	11,953					59,510	30	11,900
				G,D	2.50	.020	2.80	42,507	.70	.008	.77	8,501							
11	I	NJ	13	S,G,D	.70	.050	1.44	9,712	.72	.141	2.82	1,942					12,625	35	2,720
12	M	P	14	S	17.30	.591	26.10	130,854	2.26	.189	5.20	18,319					170,110	45	33,200
				G	—	—	26.00	130,854	—	—	5.20	94,450							
				D	17.30	.591	26.00	94,450	2.26	.189	5.20	16,590					130,000		
13	I	NJ	14	S,G,D	.10	.005	.17	12,238	.32	.060	1.22	2,448					15,910	35	3,430
14	I	NJ	14	S	1.30	.101	2.80	1,780	.64	.121	2.45	356							
				G	—	—	3.30	1,780	—	—	.31	214					3,560	0	500
				D	.0036	.099	1.45	1,780	0	.021	.31	214							
15	M	NJ	14	S,G	0	.015	.22	880	.64	.121	2.44	587					1,760	70	1,000
				D	0	.015	.22	1,077	.64	.180	2.43	715					2,150	70	
16	I	P	15	S,G,D	2.50	.175	5.12	20,673[15]									21,925[16]	65	6,560
17 (18)	I	P	15	S,G,D	2.10	.031	2.56	9,923	1.78	.336	6.76	1,985					12,900[17]	35	2,910
18 (17)	I	NJ	15	S,G,D	1.07	.054	1.87	3,346	.32	.106	1.90	305					3,955	35	6,692

TABLE A (*Continued*)

POLLUTER-BY-POLLUTER COST AND WASTELOAD DATA

No.	Type	State	Section	Data Source	K_1	Annual O_1 & M_1	Tot_1	L_1	K_2	Annual O_2 & M_2	Tot_2	L_2	K_3	Annual O_3 & M_3	Tot_3	L_3	1964 Discharge	1964 % removal	DRBC Allocation
					Costs (Millions of 1964 Dollars)														
19	M	NJ	15	S,G	.12	.006	.21	1,552	.40	.075	1.50	345					2,070	38	570
				D	.12	.006	.21	2,420	.40	.168	2.90	533					3,320		
20	M	P	16	S,G,D	18.50	.585	27.20	117,150	2.30	.202	5.31	18,223					165,000[18]	39	29,000
21	M	NJ	16	S	.09	.005	.16	1,455	.13	.024	.49	187					1,870	30	255
				G	—	—	.16	1,335	—	—	.49	267							
				D	.09	.005	.16	1,180	.13	.024	.49	236					1,650	30	
22	I	NJ	16	S,G,D	1.20	.140	3.28	9,471	2.80	.214	6.00	8,287	6.40	.430	12.72	1,973	25,650	35	4,250
23 (24)	I	NJ	17	S,G,D	.80	.007	.90	5,091	.35	.007	.45	1,389	.35	.007	.45	1,389	8,100	65	2,480
24 (26)	I	NJ	17	S	.94	.140	3.03	22,073	.90	.080	2.09	5,255	4.80	.410	10.92	5,781	34,160	35	9,800
				G,D	1.90	.232	5.37	27,160	1.90	.170	4.43	4,000	2.90	.240	6.45	2,000			
25 (23)	M	P	17	S	1.52	.363	6.90	2,107									3,160	85	4,000
				G	—	—	7.30	2,107											
				D	1.92	.364	7.30	3,720									5,580	85	
26 (25)	M	P	17	S,G	.64	.121	2.44	717									1,075	85	1,380
				D	.64	.121	2.44	1,287									1,930	85	
27	M	P	17	S,G	.10	.005	.17	1,350	.26	.048	.98	270					1,890	85	310
				D	.08	.005	.18	174	.26	.048	.97	48							
28	M	P	17	S	2.40	.032	2.88	5,962	2.24	.424	8.59	1,192					7,750	35	2,640
				G	—	—	1.87	5,365											
				D	.91	.056	.95	12,310	1.11	.039	4.26	2,460					16,000		
29 (30)	I	P	18	S	1.60	.141	3.70	5,164	2.00	.175	4.60	1,290	2.75	.585	11.45	1,033	7,745[19]	64	3,750
				G,D	1.60	.141	3.70	3,745	2.00	.176	4.60	2,000	2.60	.183	5.30	1,400			
30 (29)	M	P	18	S,G	1.30	.030	1.83	7,275	1.60	.303	6.10	1,455					10,185	35	2,830
				D	1.37	.030	1.83	13,115	1.60	.301	6.14	2,650					17,095		
31	I	P	18	S,G,D	.23	.006	.32	1,219	.31	.054	1.11	1,273	.59	.123	2.42	831	3,600[20]	35	2,650
32	I	P	18	S	.16	.061	1.07	1,694	.02	.006	.11	483	.05	.011	.21	678	3,145	35	520
				G,D	.23	.077	1.39	2,855											

Table A (*Continued*)

Polluter-by-Polluter Cost and Wasteload Data

No.	Type	State	Section	Data Source	K_1	Annual O_1 & M_1	Tot_1	L_1	K_2	Annual O_2 & M_2	Tot_2	L_2	K_3	Annual O_3 & M_3	Tot_3	L_3	1964 Discharge	1964 % removal	DRBC Allocation
					Costs (Millions of 1964 Dollars)														
33 (34)	M	P	19	S,G	.08	.005	.15	1,400	.24	.045	.92	280					1,820	35	255
				D	.08	.005	.15	1,167	.24	.044	.92	235					1,520		
34 (33)	I	NJ	19	S	2.55	.170	5.08	19,590	.60	.038	1.17	2,857	1.10	.101	2.60	3,265	32,650	20	4,390
				G,D	1.96	.130	3.88	19,590	.60	.038	1.17	2,857	1.10	.101	2.60	3,265			
35	I	P	19	S,G,D	1.60	.100	3.08	8,044	6.40	.498	13.80	16,089	4.00	.403	10.00	3,448	28,730	75	14,400
36	I	D	19	S,G,D	.67	.033	1.16	1,445	.55	.103	2.07	289					2,890	57	845
37	M	D	21	S	2.80	.006	2.89	21,493	4.00	.005	4.07	32,239	1.10	.008	1.11	8,059	85,970	20	13,400
				G,D	6.75	.162	9.20	53,732	1.10	.120	2.90	8,059							
38 (42)	M	NJ	23	S	.08	.005	.15	975	.19	.036	.73	217					1,430	40	230
				G	—	—	.15	1,073	—	—	.73	238							
				D	.08	.005	.15	855	.19	.035	.73	190					1,110		
39 (38)	I	NJ	21	S	1.90	.437	7.40	2,544	2.00	1.140	19.00	2,714					8,480	0	1,060
				G,D	1.90	.382	7.60	2,500	3.40	.700	13.90	2,750							
40 (39)	I	NJ	22	S	12.00	.733	22.90	54,154	16.00	1.200	33.90	50,769					110,000	35	21,110
				G	—	—	34.60	7,400	—	—	21.00	30,500					91,000		
				D	11.80	.885	25.00	55,000	11.90	.600	21.00	30,500					91,000		
41 (40)	I	D	22	S	.61	.007	.70	1,689	.32	.067	1.32	3,377					6,755	80	4,310
				G,D	.93	.067	1.93	5,066											
42 (43)	M	NJ	23	S	.08	.005	.15	975	.19	.036	.73	217					1,870	40	350
				G	—	—	.15	1,402	—	—	.73	312							
				D	.08	.005	.15	1,111	.19	.036	.73	246					1,480		
43 (41)	I	D	26	S,G,D	.36	.035	.88	1,923	1.60	.302	6.10	385					2,500	92	2,500
44	M	NJ	28	S,G,D	.08	.005	.15	1,298	.19	.036	.73	288					1,730[21]	40	395

NOTES TO TABLE A

[3] The numbering system is that used for the Graves *et al.* data and for the 1970 data obtained from the DECS. In cases where Schaumberg's data is numbered differently his numbers are given in parentheses.

[4] M = Municipality
I = Industry

[5] P = Pennsylvania
NJ = New Jersey
D = Delaware

[6] Section of river. The DECS divided the estuary from Trenton to Liston Point into 30 sections, *see* Fig. 2 accompanying note 11 *supra.*

[7] S = Schaumberg
G = Graves, Whinston & Hatfield
D = Data supplied to authors by the DECS staff in 1970

[8] K_i = Total additional capital costs to remove L_i
Annual
O_i & M_i = Annual operating and maintenance costs of removing L_i
Tot_i = K_i plus (O_i & M_i) discounted at 3% for 20 years [(O_i & M_i) x 14.9]
L_i = Additional load removed over and above other lower numbered data points and 1964 discharge.

[9] Pounds of oxygen demanding waste (FSUOD) per day. Where 2 figures for 1964 discharge are given the first is the discharge reported in the Graves data and the second is a revised figure used by the DRBC. When only 1 load is given, the 2 sources agree except as noted. In general the cost figures provided to us by the DECS staff are consistent with the revised DRBC discharge data because where the discharge has been changed the loadings have also changed, generally so as to keep the *percent removals* unchanged. One interesting aspect of these changes is that when the load is increased or decreased, the total cost of reaching that level of percent removal remains unchanged. Consider for example the polluters numbered 8, 12, 15, 19, 21, 25, 26 and 30. Except for dischargers 9 and 20, Graves' data is used where only 1 set of cost estimates exists and the 2 discharge estimates differ, since these figures were more consistent with the cost data. For numbers 9 and 20 the differences in reported discharges were small, and the DRBC data appeared more consistent with the cost estimates.

[10] Pounds of oxygen demanding waste removed as percentage of total pounds produced per day. DRBC data.

[11] Pounds of oxygen demanding waste (FSUOD) per day. Delaware River Basin Commission—Final Allocations, Delaware River Estuary, June 1968.

[12] Graves' data, revised figure is 1810.

[13] Graves' data, firm is now out of business.

[14] DRBC data, Graves reports 125,250.

[15] Actually, Schaumberg reports 2 data points, the first removing 6,264 pounds and the second 14,409.

[16] Revised to 21,350 by Commonwealth of Pennsylvania, 21,925 on DRBC list.

[17] Revised to 17,615 by Pennsylvania, 12,900 on DRBC list.

[18] DRBC data, Graves reports 156,200.

[19] Graves' data and figure on DRBC list, revised by Pennsylvania to 12,565.

[20] Graves data. DRBC reports 4,700, revised by Pennsylvania to 16,000.

[21] Graves' data, DRBC reports 1890.

APPENDIX B

THE MYSTERY OF THE DECS BENEFIT ESTIMATES OF PICNICKING AND POLLUTION CONTROL

According to the DECS, the only quantifiable recreation benefits are due to enhanced possibilities for swimming, fishing and boating. As one important property of scientific results is that they should be reproducible, we set out to duplicate the DECS benefits estimates. This attempt led us to examine more closely the study, performed by the Institute for Environmental Studies (IES) at the University of Pennsylvania, upon which the DECS benefits estimates are based.[1] We applied the DECS staff's discounting procedure to the net benefits which the IES asserted would arise from enhanced swimming, fishing and boating opportunities in 1976, generated by each of the proposed water improvement programs, above those associated with Program V (maintaining current conditions). The results are shown in the two columns of Table B labeled "IES SFB." The net benefit estimates from the DECS are reproduced for comparison. The discrepancy is striking. Comparing the maximum estimates, we find that the IES estimates range from twelve percent of the DECS estimate for Program IV to thirty percent of the DECS estimate for Program I. What accounts for this divergence?

TABLE B

NET BENEFIT ESTIMATES BY SOURCE
(PRESENT VALUE, MILLIONS OF 1964 DOLLARS, DISCOUNTED AT 3% FOR TWENTY YEARS)

Program	*DECS Preliminary Report*		*IES SFB*[2]		*IES SFBP*[3]	
	max.	min.	max.	min.	max.	min.
I	355	155	107	64	307	182
II	320	135	66	40	224	145
III	310	125	62	36	219	141
IV	280	115	34	24	103	70

Because neither the DECS *Report* nor our interviews with the

[1] IES STUDY, *supra* note 63.

[2] Institute for Environmental Studies—swimming, fishing and boating benefit estimates.

[3] Institute for Environmental Studies—swimming, fishing, boating and picnicking benefit estimates.

DECS staff suggest that the IES swimming, fishing or boating estimates were revised dramatically, it seemed plausible to suspect that—despite the *Report*'s contrary statement—some other kind of recreational benefit was taken into account in the figures provided by the DECS. This hypothesis gained credibility from our inspection of the IES *Study* upon which the DECS work was based. The *Study* attempts to estimate the impact pollution control will have on a fourth activity, picnicking, which is not mentioned in the DECS. By adding picnicking benefits to those for swimming, fishing and boating, calculating net benefit over Program V, and applying the DECS discounting procedure, we arrive at the results presented in the two columns labeled "IES SFBP" in Table B. A comparison of these estimates with the others in the table reveals two important facts. First, when picnicking benefits are included, the discounted IES estimates are much closer to those presented in the DECS *Report* although a considerable discrepancy remains. Comparing the maximum estimates, we find that the discounted IES estimates range from thirty-seven percent of the DECS estimates for Program IV to eighty-six percent of the DECS estimates for Program I. Second, the IES estimates including picnicking are, in general, about three times the IES estimates excluding picnicking. Given the possible importance of picnicking in the DECS estimates, we will consider the extent to which the economist would consider it significant.

The impact of cleaner water on picnicking can be analyzed into two component parts. First, although picnicking need not take place near sparkling, odor-free water, some people may enjoy it more if it does. Thus, pollution control may increase the value of the "pure picnicking" experience. Second, some may find it more valuable to picnic at a place where they can also swim, boat or fish. Thus, pollution control may redound to the benefit of those who engage in "picnicking plus."

Having defined the relevant activities with sufficient precision, we can now consider how the economist would evaluate them. As to "pure picnicking," it is easy to see that the effect of pollution control will be negligible. The odor of the river is not a significant problem now, and the appearance of the river is not likely to be changed much by pollution control. Pollution control will not alter the urban character of the Trenton and Philadelphia-to-Wilmington areas. Thus, the quality of the experience of "pure" picnicking by the Delaware will be virtually unaltered by pollution control. Of course, more parks would improve the opportunities for Delaware-type picnicking, but this observation suggests a cost-benefit analysis of parks, rather than of pollution control.

Similarly, the impact of improved water quality on "picnicking plus" will be but a small fraction of the "picnicking benefits" calculated in the IES *Study*. In applying the "sacrifice test" to "picnicking plus" the analyst should ask: "How much extra will consumers sacrifice so that they can picnic and fish (and boat and . . .) *at the same place* instead of picnicking and fishing (and . . .) *in different places?*" The question is framed in this way because we have *already* estimated the value consumers would place on "pure" picnicking, swimming, fishing and boating *when each activity is considered separately*. Consequently, to avoid double counting at this stage, we must only consider the *extra* value people would place on participating in more than one of these activities at the same place. As soon as this is recognized, we think it apparent that the DECS claim that picnicking benefits are three times the benefits accruing from boating, fishing and swimming is greatly overstated. It is implausible to assume that if a consumer will sacrifice only one dollar for the opportunity to swim, boat and fish in the Delaware, he will suddenly sacrifice three dollars simply because he can also picnic in a park close by. This is not to say that the consumer may not sacrifice something for this extra amenity. But surely this something will be only a fraction of the amount sacrificed for the new boating, fishing and swimming opportunities, since picnicking opportunities are available at a large number of parks within easy reach of the river by car and bus.

Once again, then, we are driven to consider the way in which the IES could have generated such enormous benefit figures for picnicking activities. The result was achieved by applying the same procedure we have presented and criticized in the text.[4] The same artificially restricted study area was canvassed for picnicking sites. These sites were, not surprisingly, found to be inadequate to meet 1976 "demand" for picnicking determined by the use of the ORRRC studies in the manner described in the text. The IES *Study* then assumed that all newly "available" parks would be used to "capacity." A park site was assumed to be "available" if water contact recreation could take place in the estuary at that point under a given pollution control program. Given the standards which the DECS used to determine whether or not an area was suitable for water contact recreation, this criterion for availability implies that all four of the recreational activities we have considered must be possible under the DECS water quality pre-

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4 *See* Section IV *supra.*

dictions if a park is to be considered available. Thus for each pollution control program, the total park capacity, measured in activity days, was multiplied by the value of an activity day of picnicking to obtain picnicking benefits for that pollution control program.

Since we are familiar with the shortcomings of the IES-DECS approach from our earlier discussion, we would expect the benefits from picnicking to be inflated, but even so, the absolute size of picnicking benefits is so large that it calls for further scrutiny. The explanation seems to lie in the IES method of calculation. After estimating the number of acres of available parkland, IES assumed that 500 people, or given the relative age distribution at the time of the study, 390 people over twelve years old, could be served by an acre of park land. They then took an activity rate for people over twelve for picnicking from an ORRRC study, 3.21 activity days per person per year for 1976, and multiplied it by 390 to get their estimate of the number of activity days which could be undertaken on each acre per year, 1251.9 activity days per acre per year. If the staff of the IES had applied the 1251.9 number to their own estimate of 24,000 acres of already existing parkland in the study area, they would have found a capacity of 30 million activity days. Previously, however, they had estimated that demand for picnicking by the residents of the study area would be only 16 million activity days. Thus, although the IES staff argue that picnicking land will be scarce in the study area in 1976, their own capacity estimation procedure, even when applied to existing acreage, suggests a capacity that is twice demand. Consequently, it appears that the IES estimates of picnicking benefits are grossly overstated, even if the *Study's* methodological premises are granted.