

A Program for the Control of Contaminants in Natural Waters

by

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Introduction

Natural waters receive large amounts of chemical and biological-pathogenic contaminants from natural and cultural sources. In some instances the concentrations of the contaminants will be such that some of the beneficial uses of a natural water system are impaired. There is a vast amount of literature in the area of sources, cycling-fate, effect, and control of pollutants in natural waters. No attempt will be made in this paper to review this literature, but instead, focus here will be on conclusions about the overall situation that exists today on the control of pollutants in natural waters. Also, a set of recommendations will be presented which, if adopted, will ultimately lead to better control of pollutants in natural water systems. Throughout this paper mention will be made of the coastal zone. For the purposes of this discussion the coastal zone shall be defined as that part of any natural water system, river, lake, stream, estuary and the oceans, and the associated lands where the activities of man in the water or on the land influence its water quality.

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Conclusions

The following general conclusions regarding control of contaminants in natural water systems are presented.

1. Current Cultural Patterns and Expected Trends Coupled with Current Technology for Waste Management will Ultimately Lead to Exceeding the Contaminant Assimilative Capacity in Essentially All Natural Waters of the U.S.

Current technology for removal of pollutants from domestic and industrial waste waters generally involves the removal to a specified level or by a specified amount. For example, the current practice of the U.S. is to require that domestic waste waters receive secondary treatment as the minimum. Secondary treatment generally means removal of 90 percent of the biochemical oxygen demand. For many natural waters such as near urban centers, secondary treatment represents a significant reduction in the amount of waste discharge to the water. Ultimately, because of the increased population, the total biochemical oxygen demand load for the water, even with complete secondary treatment, will exceed the waste assimilative capacity for oxygen demand materials in the region receiving the waste.

Similarly, the projections for the use of coastal zone waters for once-through cooling at electric generating stations ultimately will lead, if current cultural trends continue and the expected increase in demand for power materializes, to a significant deterioration of water quality in the coastal zone due to the heating of these waters.

In order to minimize and, where possible, eliminate situations of this type, it will be necessary to conduct a three-prong

attack on this problem. One of these will be an expanded effort toward improving the technology available for removal of contaminants from waste waters at a reasonable cost. The second will involve efforts to control population growth. The third must be toward changing the cultural patterns of U.S. citizens so that they do not place ever-increasing demands on various commodities which eventually lead to water quality problems. Further, because of the current cultural patterns which tend to concentrate increasing populations near water, a thorough examination of the possible control of people and/or their activities in the coastal zone which constrain other uses of this zone must be made.

The reprogramming of people toward accepting a way of life which generates less demand for those goods and utilities whose production causes significant environmental harm must also be accompanied by a reprogramming toward a more personal, ecologically sound approach to everyday living. The enormous problem of littering of lands and waters in the United States is a prime example of the general lack of concern on the part of the U.S. public for maintenance of high environmental quality. The public as a whole and individually must want high water quality to a sufficient degree so that they will pay substantial amounts of money for it and will adjust personal living habits to minimize environmental degradation.

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In order to obtain a somewhat better control of chemicals in the environment, a different attitude must be adopted by individuals toward the use and disposal of chemicals. The general attitude which seems to prevail today of "dumping it down the

sewer in order to get rid of it" must be changed. The public must be educated to the point where they understand the possible consequences of such actions and a sincere desire must be developed within the populace as a whole to act in a manner which minimizes the chances of environmental contamination by the use of any chemical.

Increasing pressures for water development will ultimately lead to deterioration of water quality because of the population pressure problems. Steps are already being taken in some parts of the U.S. to minimize problems of this type. For example, the Dane County Planning Commission, located in Madison, Wisconsin, has recently ruled that a land developer may not develop a certain area because of the fact that this development would ultimately lead to increased transport of nutrients to Lake Mendota from urban storm water drainage and therefore would cause further deterioration of water quality in this lake. A further example of this type is legislation recently passed in the state of Illinois which prohibits the use of certain types of fertilizers in excess of a specified amount on lands with a slope greater than a certain value. This legislation is designed to prevent the runoff of nutrients from a land to nearby water courses. It is clear that, ultimately, effective zoning must be utilized to a much greater extent in order to protect the natural waters from further deterioration due to excessive populations in the adjacent areas.

2. Any Reach of the Coastal Zone Has a Finite Assimilative Capacity for a Particular Contaminant Without Causing Significant Deleterious Effects on the Aquatic Ecosystem.

There are some who advocate that, within a few years, there will be no waste discharge to natural water systems. It is felt that this approach is not technically feasible and is not in the best interest of the public. Any natural water, or part thereof, has a finite contaminant assimilative capacity without causing significant harm to the aquatic ecosystem. The assimilative capacity is a function of the particular part of the coastal zone or water body. It is determined by physical processes such as mixing, geomorphology, types of sediments, types of water, chemistry, and biology. The "no waste discharge" approach would likely result in a needless waste of the financial resources of the country and would ignore the fact that nature can provide for significant waste treatment without significant harm. The problem develops when man attempts to apply a certain waste load which is applicable to one area to another without giving consideration to the characteristics of each area. This is the problem associated with using effluent standards as is commonly advocated today. Each region of the coastal zone or body of water should be considered for its own merit, its own uses and characteristics and the contaminant load should be adjusted accordingly. The latter approach requires a much better understanding of the aquatic ecosystem than exists today. However, in the long run, the funds spent obtaining this understanding will ultimately lead to a wiser utilization of the water resources available to man.

It is important to note that, in considering the assimilative capacity of a reach of the coastal zone, consideration must be given to the specific form of the element or compound entering the coastal zone and the transformations of this element within the zone. For example, there are certain types of mining tailings which contain potentially significant amounts of toxic trace elements such as copper. However, the copper present in the tailings is tied up in a silicate matrix and cannot be transformed into a form that is available to aquatic organisms. Therefore, even though large amounts of a potentially toxic element are discharged to a particular water, no toxicity results because of the characteristics of the water and the form of the element in the discharge. It is in the best interest of the public to give consideration to this type of situation in managing pollutants in natural waters. Further, it is often in the best interest of the public to allow for a small finite mixing zone where the water quality standards applicable to the water as a whole must be adjusted. Using this approach, it is recognized that there will be a limited deterioration of water quality in a small area associated with the discharge. However, this mixing zone can be kept small and the amount of deterioration that occurs can be adjusted so that it is insignificant in terms of the coastal zone ecosystem as a whole.

3. The Scientific Information Available Today Does Not, In General, Enable a Precise Assessment of the Assimilative Capacity of the Natural Waters for Certain Contaminants.

Each part of a natural water system has a finite capacity for assimilation of a contaminant without significant harm. For some contaminants, the relationship between the effect of the contaminant on the aquatic ecosystem and the concentrations of the contaminant in a particular discharge can be predicted with a reasonable degree of reliability. For example, reasonable estimates can be made of the effects of the discharge of oxygen demand materials from domestic waste waters on oxygen depletion in the coastal zone. However, for other contaminants the ability to make predictions of this type is extremely weaker and requires much additional study. Following in the latter group are the chlorinated hydrocarbons and/or pesticides such as DDT, PCB's and toxic trace metals, etc. Additional research is needed on the aqueous environmental chemistry of potentially significant contaminants in various types of natural waters in order to better predict the contaminant assimilative capacity.

Recommendations

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Based on the above conclusions the following recommendations are presented.

1. Conduct Detailed Mass Balance and Dynamic Interactions Studies of Potentially Significant Pollutants in Selected Near-shore Environments.

Any region of the coastal zone has a certain waste assimilative capacity for contaminants without significant harm to the aquatic ecosystem or to many other beneficial uses of natural

waters and their associated lands. The current state of scientific knowledge is such that it is impossible to predict with any degree of certainty the fate of most pollutants that enter a selected region of the coastal zone. A pollutant independent of the source may react in different ways in a particular part of the coastal zone which would influence its effect on the aquatic ecosystem. A contaminant may, dependent on its form of introduction and the physical, chemical and biological characteristics of the particular part of the coastal zone into which it is introduced, be diluted below any critical concentration or, conversely, may be accumulated within a certain part of the coastal zone ecosystem (e.g., sediments, aquatic biota) to the point that it exceeds critical concentrations for aquatic life and man. In order to be better able to predict the particular effect of a contaminant on a potential beneficial use of a certain region of the coastal zone, detailed mass balance and dynamic interaction studies should be conducted in selected regions of the coastal zone for potentially significant contaminants. These studies should have the following characteristics:

- a) They must be multi-disciplinary, with the hydrodynamicist, geologist, water chemist and aquatic biologist working as a team in studying the fate of the particular contaminants under examination in a particular region of the coastal zone. MUNS 039942
- b) The study must cover a period of several years in order to be reasonably certain that the results obtained during any period of study are representative of the typical

behavior of the contaminant in that region for that particular time of the year.

- c) The overall guiding principle in these studies must be toward the eventual management of the contaminant and the potential significant effects of the contaminant on what are thought to be important parts of the aquatic ecosystem.
- d) The overall results of this study must be directed toward the development of a model for the aqueous environmental chemistry of the contaminants in the coastal zone which could be used to predict with a significant degree of reliability the ultimate fate within the coastal zone of a particular contaminant arising from various types of principal sources. This model must consider the pathways followed by the principal forms of the contaminant from the point of entry to the ultimate point of deposition or removal which could potentially have a significant effect on key components of the aquatic ecosystem and man.
- e) The coastal zone of the U.S. should be classified into major regimes which are thought to influence the aqueous environmental chemistry (fate) of various types of pollutants in a somewhat different manner. Initially, it is suggested that these coastal zone regimes include the Great Lakes, i.e., one region of one of the lake's near-shore environment, the Atlantic seaboard from Georgia to Maine, the Gulf Coast and the California-

Pacific Northwest Coast. A panel of experts in the behavior of pollutants in coastal zone areas should be convened to select the study areas. The study should be funded in each of these areas at a sufficient level and for sufficient duration to obtain meaningful results. As an initial guideline, the approach used by the Chemistry and Biology panel for the International Field Year for the Great Lakes might be a useful guide for studies of this type.

- f) It is imperative that the testing of the compounds include not only the parent compound but each of the potentially significant degradation products. It has been found that sometimes, while the acute toxicity of a particular compound to a particular group of organisms may be rapidly lost in natural water systems due to partial degradation of the compounds, there are potential problems of chronic sublethal effects of these degradation products on one or more groups of important aquatic organisms.
- g) Particular attention in these studies should be devoted to diffuse sources of contaminants such as urban storm water drainage, sediments, the atmosphere, etc. It is being recognized today that the urbanization of a watershed of a particular coastal zone can result in a significant pollutant transport to the area from atmospheric inputs and storm water drainage. It is important that studies be conducted in order to determine

the amounts of various contaminants that move from land and urban areas to natural waters. These studies should be directed in part toward developing information which can be used to predict the amounts of chemicals derived from various activities of man such as farming of various types of crops, woodlands, urban areas, etc.

Further, manipulation of the sediments such as dredging, stirring by transportation, etc., can often result in mobilization of contaminants such that they may exceed the critical concentrations for certain aquatic organisms or man. These particular processes are very poorly understood at this time and need considerable research in order that a better evaluation of the effects of such practices and urbanization on water quality can be made.

- h) The study should be conducted by a group of scientists and engineers from academic institutions, research institutes, federal, state and local regulatory agencies as well as private industry.

2. Accelerate Efforts in Developing Criteria for Critical Concentrations of Pollutants in the Coastal Zone

One of the major obstacles to determining the contaminant assimilative capacity for a particular chemical is a lack of information on the critical concentration of that chemical for aquatic life and man in natural waters. Currently, the Environmental Protection Agency has contracted with the National Academy of Sciences to publish a review which summarizes the current

knowledge on the critical concentrations of various contaminants in fresh and marine waters with respect to various types of beneficial uses of the waters such as fish and aquatic life, water supply, recreation, agriculture and industry. This publication is expected to be released in the fall of 1972 and will serve as a useful guide to the current state of knowledge in this area. A review of a draft of this publication shows that there is a very large gap in the knowledge on the critical concentrations of various chemical contaminants to aquatic life in fresh and, especially, marine waters. Those who attempted to develop the critical concentration for contaminants for marine waters were often forced to use the results of studies in fresh waters as a basis for their criteria. It is well known that the aqueous environmental chemistry of many of the potentially toxic elements such as the trace heavy metals is different in marine and fresh waters. Further, the number and types of organisms in fresh and marine waters are also different. Therefore, it is felt that there is an urgent need for at least one and preferably several national laboratories devoted to establishing the critical concentrations of various forms of various contaminants for aquatic life in estuarine and marine waters. This function is currently being filled in part by the Environmental Protection Agency's Duluth Water Quality Laboratory and its satellite laboratories for fresh waters. A similar type of laboratory should be developed for marine waters. The current operations of the EPA Laboratory which is charged with this responsibility at Narragansett, Rhode Island, are not adequate for this purpose.

These laboratories must be located on the coast where they have available to them a continuous supply of relatively uncontaminated sea water. They must be adequately staffed with individuals representing the various disciplines: biology, chemistry, toxicology, etc., pertinent to determining the critical concentrations of contaminants for aquatic organisms. These studies should be directed to each of the major types of aquatic organisms with representative organisms selected from each type for testing, ranging from phytoplankton through fish, including the zooplankton, shellfish, and crustaceans (lobsters and crabs). Further, some attention must be given to the effects of water pollutants on sea birds and other terrestrial animals that derive a significant part of their food from fresh or marine waters. In addition to determining the acute lethal toxicity, these studies must include an evaluation of the long-term, sublethal toxicity and testing of the effects of the chemical and its degradation products on the aquatic organism with respect to reproduction, teratological, carcinogenic, mutagenic and physiological stress. Emphasis in this type of testing must be directed toward determining the relationship (application factor) between short-term, acute toxicity of the contaminant and the long-term sublethal chronic toxicity of the contaminant.

The importance of conducting chronic toxicity studies on degradation products cannot be over-emphasized. Many compounds may readily degrade to an extent where the compound loses its acute toxicity to a particular group of organisms; however, this degradation is only partial and often the degradation products

have not been identified and/or studied for their chronic sublethal effects on a variety of types of aquatic organisms. An example of this type of problem occurs in the use of chemicals for rough fish management. State and federal fisheries agencies have all terminated the use of the chlorinated hydrocarbon, toxaphene, for rough fish control. This termination is due to the fact that in some instances, toxaphene residues have persisted in some lakes for periods of many years under conditions where successive amounts of toxaphene were originally applied to the lake. In other lakes, some of the components of toxaphene have been measured in the sediments several years after treatment. Recent studies have shown that these components show much less toxicity than the parent toxaphene.

Rather than using toxaphene, the rough fish managers have adopted the use of antimycin. This compound is much more expensive and less effective against some forms of rough fish and in some types of waters than toxaphene is. The primary justification for using antimycin is that it rapidly loses its acute toxicity to fish; however, no work has been done on the chronic sublethal toxicity of antimycin degradation products to representative types of aquatic organisms. It is conceivable that these degradation products could have significant adverse effects on the reproduction of certain types of aquatic organisms. In order to avoid problems of this type, any aquatic toxicology program must include testing of the acute and aquatic toxicities of the parent compound and all of its degradation products.

An advisory board of regulatory and nonregulatory, i.e., university and industrial personnel, should be appointed to direct the overall activities of the national laboratories. One of the most serious problems facing the existing laboratories of this type is the fact that they often must divert some of their efforts from this type of study to enforcement activities. These laboratories should not be confronted with short-term problems of enforcement of existing water quality standards facing various regulatory agencies but, instead, emphasis must be placed upon obtaining the information needed to determine meaningful water quality standards.

The importance of conducting studies on the critical concentrations of chemicals in the environment which accumulate in the aquatic food chain and thereby possibly exceed critical concentrations for ingestion by man is readily demonstrated by the current situation of chlorinated hydrocarbons such as DDT and PCB's in fish of Lake Michigan. The FDA established guideline tolerance levels for DDT and PCB's in fish at 5 ppm. Examination of the technical basis for these tolerances raises serious questions about their validity. Many health officials feel that there is no technical justification for establishing the DDT tolerance at this level. They further feel that originally-used processes for establishing this tolerance level were somewhat arbitrary. Further, to establish the PCB tolerance levels at the DDT levels because of the alleged similarity of the two types of compounds is certainly not justified.

These tolerances have had a significant ecological impact on the commercial and sport fisheries in Lake Michigan. Some of the commercial fisheries for this lake have been almost completely eliminated due to the fact that the current levels of these compounds in the fish slightly exceed the somewhat arbitrarily established tolerance levels for man. In addition, the sports fisheries for coho salmon in Wisconsin have been seriously harmed during the past year due to alleged excessive concentrations of PCB's in Lake Michigan coho salmon. This has resulted in the burial of large numbers of highly desirable fish rather than allowing sports fishermen to utilize these fish for personal consumption.

Fortunately, this situation will likely change in the near future because the restrictions on the use of DDT in some of the states bordering Lake Michigan are resulting in an apparent reduction in DDT levels in Lake Michigan fish. Hopefully, a similar pattern will be noted for the PCB's in the near future due to the elimination of the sale of these compounds for uses which could lead to environmental contamination. This reduction is the result of the fact that DDT and its degradation products are slowly degraded in the environment and, more importantly, the sediments of the lake tend to act as permanent sinks where these compounds will in time become permanently fixed in the sediments of the lake.

In connection with establishing environmental quality standards, a much more effective means must be found for periodic reviews of these standards than exists today. As a guideline, it is suggested that a mandatory review of any environmental

quality standard should be made at a maximum of a five-year period. This review should be conducted by a committee of competent scientists and engineers knowledgeable in the toxicology and other water quality effects and the water chemistry of the compound in the environment. Today it is relatively easy and frequently justified to establish stricter water quality standards for any compound based on new information. Occasionally, additional studies will show that previously established standards were too strict, such as is the apparent situation today with respect to DDT, PCB's and mercury in fish. Unfortunately, the political climate at the present time is such that very few regulatory agencies will recommend that a less strict standard be adopted in the environmental quality area. Any regulatory agency that recommends a less strict standard, even when the scientific community as a whole supports this standard, faces severe criticism on the part of conservation activists, where the regulatory agency is accused of "being on the side of the polluter." Environmental quality standards are often based on inadequate information. As such, they should be subject to frequent change as new, reliable information is obtained. A mechanism by which standards can be raised or lowered without political repercussions must be found.

3. Develop the Management Capabilities (Legal, Economic, Social and Technical) for Screening New Chemical and Degradation Products.

It has been estimated that approximately 500 new compounds are produced each year in the U.S. that could ultimately lead to significant environmental contamination. There is an urgent need to develop within the U.S. the capabilities for screening these

new compounds and their degradation products for potential environmental impact on natural waters. The justification for such screenings stems from the fact that the U.S., as well as other countries of the world, has faced in the past and is currently in a series of chemical crises in the aquatic environment. These crises were caused by the presence of such compounds as DDT, mercury, PCB's and others. At the present time no agency is reviewing the newly produced compounds with respect to their environmental impact. Several bills exist within Congress which are designed for this purpose. It is felt that the current administration bill as developed by the Council on Environmental Quality and presented by the President in February, 1971, as part of his environmental message represents a significant step toward developing the procedures by which this type of screening can be accomplished. A concentrated effort should be made to insure passage of legislation of this type in the near future and adequate funding to implement the program outlined in the legislation. Some of the key components of this legislation which must be considered are presented below.

- a) It is important that any screening of new compounds be conducted in such a way as to not become a significant deterrent to the development of new compounds by the chemical industry in the U.S. It is relatively easy to develop a screening procedure which would become prohibitively expensive and thereby completely eliminate research on new compounds. This type of procedure must be avoided. It must be emphasized that all screening

must be done in such a way as to keep the U.S. chemical industry in a favorable competitive position with foreign chemical industries, otherwise there will be a significant loss of the chemical industry in the U.S. which ultimately will lead to a significant economic disadvantage to the U.S. in domestic as well as world markets.

- b) The overall procedures for screening chemicals with respect to the potential impact should be developed by a panel of experts who are knowledgeable in this area. The actual decisions on whether a compound may be produced or not should be left to a panel, not to a single administrator. Industry should be required to conduct this screening in accord with requirements of the hazardous chemical screening panel. The criteria should be flexible depending on the type and uses of a particular compound.
- c) The industry should be required to propose a systems model of the environmental chemistry of the new compound in the terrestrial, atmospheric and aquatic environments. A model should be developed based on similarity of the proposed compound to other compounds of the same general type.
- d) Acute and chronic toxicity testing should be done for those situations where it is predicted that the compound will likely interact with terrestrial or aquatic organisms including man to a significant extent.

- e) As time and funds permit, this screening of new compounds could be expanded to a screening of existing compounds used within the U.S. in large amounts.

The current situation with respect to the control of chlorinated hydrocarbons such as DDT and PCB's readily demonstrates the need for the development of new legislation for the control of hazardous chemicals in the environment. The DDT story is interesting in that this has received considerable public attention as a widespread environmental contaminant. While there is little doubt that DDT and some of its degradation products are widespread in the environment, there is considerable question about the significance of this contamination. Many of the studies that have been done which implicate DDT as a compound causing widespread ecological damage have been conducted at concentration levels considerably above those found in the environment or with poorly designed studies. Further, there has been increasing evidence that many of the alleged environmental effects of DDT are also caused by other chemical contaminants which are not chlorinated hydrocarbons. While good technical data is lacking on the significance of small amounts of DDT and its degradation products in the environment, in the opinion of the author, the ban on the use of DDT adopted by some states and the federal government is justified in terms of the fact that DDT is not needed for urban or agricultural use. Other compounds are available which will control the insect pests to virtually the same degree as DDT yet at least superficially do not seem to persist in the environment to the same degree as DDT does.

The U.S. and the rest of the world must adopt a philosophy of using persistent chemicals under conditions where they could lead to environmental contamination only in those situations where it is shown to be of national or local interest, based on the general welfare of the public as a whole. Regulations should be adopted which restrict the widespread use of compounds like DDT which only slowly degrade in the environment under conditions where these compounds are not needed.

The ineffectiveness of the present laws in controlling environmental contamination by new chemicals is further demonstrated by the current situations with respect to the replacement of phosphates in detergents and PCB's. The situation exists today where some manufacturers of detergents are substituting replacement compounds for the phosphate without properly evaluating the potential environmental significance of these compounds. In the case of PCB's, the Monsanto Company has voluntarily placed restrictions on the sale of their product to only those situations which will not likely lead to environmental contamination. Unfortunately, several small chemical companies in the U.S. have started to manufacture PCB's to fill the demand for PCB's that was created when Monsanto withdrew their products. In addition, there is the possibility of importing PCB's from foreign manufacturers. An additional potential problem in those situations which formerly used PCB's where they are no longer available is that high molecular weight chlorinated hydrocarbons are being substituted for PCB's. Since these uses are ones that Monsanto felt could lead to environmental contamination with PCB's, it is likely that these

new chlorinated hydrocarbons will also be environmental contaminants. At the present time, the analytical procedures that have been used for PCB's and the chlorinated hydrocarbon pesticides will not measure the compounds being substituted for PCB's. Therefore, environmental contamination with these new compounds could be occurring without being detected at this time.

Effective legislation must be developed to screen new chemicals in order to be certain that situations such as those which exist today with detergent phosphate, PCB's and other related compounds do not create environmental quality problems greater than the compound which is being replaced.

4. Development of Management Plan for Pollution Control of the Coastal Zone.

A generalized management plan should be developed for the control of contaminants in the coastal zone. This plan should be developed by a group of individuals knowledgeable in the physical, chemical, biological, social and political sciences and laws pertinent to the control of contaminants in natural waters. Some of the aspects of this plan that should be considered are presented below.

- a) The existing and projected uses of a particular reach of the coastal zone should be assessed and carefully documented.
- b) The conflicts that exist between these various uses should be enumerated.
- c) The public should be brought into the process of deciding how they wish to use this particular reach of the coastal

zone, i.e., a classification of uses should be worked out. This should consider a preliminary assessment since any particular projected use may have to be adjusted according to the technology and other factors available to manipulate and allocate the uses of a particular part of the coastal zone. There are certain physical, geological, chemical, biological and cultural constraints for any particular part of the coastal zone which must be considered in any meaningful planning. For example, there is no point in trying to grow a certain type of food in a certain area if the organism simply does not grow in that area because of natural constraints on its normal habitat, such as temperature, salinity, etc.

- d) A group of consultants expert in each of the important potential uses of the coastal zone being considered should be appointed or hired to determine whether or not the projected uses are compatible with the particular environmental and cultural system that exists in the area. An attempt should be made at this point to define the impact of any manipulation on a particular coastal zone environment being considered in order to optimize certain of the potential uses.
- e) The political, social, legal and technical tools necessary to bring about the potentially desired utilization of the coastal zone should be evaluated in a preliminary way. It is important to do this at this point in order to be

certain that there are not some other constraints on the manipulation of a particular part of the coastal zone which have not been considered previously. It is also important at this time to be certain that particular potential management of the reach of the coastal zone under consideration is compatible with the management of adjacent reaches. Further, and possibly this should be the first step in the management process, the particular reach of the coastal zone under consideration should be bounded by physical, geological and other natural characteristics rather than political boundaries.

- f) All information should be assembled and evaluated with respect to the proposed uses and their respective constraints. The managers should prepare a revised list of uses in accord with the information available and these should be submitted to the public for their approval.
5. Any manipulation of the uses of the Coastal Zone Should Be Accompanied by the Evaluation of the Effect of this Manipulation on Coastal Zone Pollution and Utilization.
- Today, in some parts of the coastal zone, large amounts of funds are being expended in order to attempt to manage that particular part for optimum utilization for certain of the activities of man. Often, the decisions are being made without having an adequate technical basis in order to fully predict the effect of a certain type of management on the behavior of pollutants in that part of the coastal zone. It is therefore recommended that

in any instance where a deliberate attempt is made to significantly alter the management of the coastal zone from current practice, sufficient funds be made available to properly monitor the effects of this attempt at management on the contaminant assimilative capacity and the effects of various pollutants in that reach of the coastal zone. In other words, attempts should be made to try to find out how the system behaves before a particular type of management is put into practice and how it responds to that management practice.

Far too often today, decisions are made which are designed to bring about a certain management practice where inadequate data is available to fully evaluate what the result has been of this practice. For example, some years ago it was decided that 80 percent of the phosphorus present in the waste water effluents entering certain of the Great Lakes would be removed in an attempt to try to reduce excessive algal growth in the lakes. At the time of the decision and even today, it is not possible to predict what benefits will be derived from such a management practice. Unfortunately, insufficient funds have been available to determine what the current situation is in some of the Great Lakes with respect to phosphorus and an excessive algal growth and it is also likely that insufficient funds will be available to establish what the situation will be as a result of putting into practice the 80 percent removal of phosphorus criterion. Therefore, we are in a position of not really being able to evaluate the effect of the management practice on the lakes and cannot use this situation as a learning tool by which we could possibly

predict what effect similar management practices could have in other parts of the coastal zone. It is likely that similar types of management practices will be put into practice in various parts of the coastal zone. It is important that a small but definite percentage of the total cost of such practice be devoted to evaluating the effect of this practice on the aquatic ecosystem and man.

6. Closed Cycle-Minimum Discharge Waste Water Disposal Systems Should Be Adopted where Possible for Municipal and Industrial Wastes.

It is being increasingly recognized today that domestic and industrial waste waters contain chemical compounds which although not considered pollutants at this time will be found through further research to have a significant deleterious effect on the aquatic ecosystem in the region of the discharge. The chemical crises that have occurred in the aquatic environment of the U.S. are of this type. It has been known for many years that waste waters contain small amounts of mercury, PCB's, etc. It is only within the past few years, however, that there has been a realization of the significance of these chemicals on the aquatic environment. It is therefore recommended that, where possible, closed cycle systems be attempted for a particular municipal or industrial waste. Often it is not possible to achieve completely closed cycle operations. In these instances, maximum technically feasible treatment, i.e., minimum discharge in terms of concentration of various contaminants and total load should be the recommended practice.

Any discharger of wastes to a region of the coastal zone should be required to have a competent consulting firm examine the operations of the plant in sufficient detail to insure that there are not methods by which closed cycle-minimum discharge can be achieved to a greater extent than is practiced today. There are examples in the literature where pressure on a particular industry has caused the industry to examine its operation and waste water disposal practices in detail. This examination has resulted in the company completely changing its waste water disposal and sometimes deriving a benefit from a particular change which was not originally realized. Some of the benefits derived include the recovery of a valuable by-product, a greatly reduced waste water discharge due to increased recycle in the plant, etc. It should also be noted that such situations do not occur with every type of industry or even within various plants of the same type. A detailed examination of each particular situation must be made in order to determine whether such practices are possible at any one location.

It is important to note that there is considerable confusion today regarding closed cycle systems for waste management. For example, in the area of thermal discharges from electric generating stations, it is sometimes alleged that it is possible to operate large thermal electric power plants on a completely closed cycle system. This is not the case. Going from once-through cooling to cooling towers may actually in some instances have a greater deleterious effect on the aquatic ecosystem in the region of the power plant than the once-through cooling. Cooling

tower operations often result in a significant blowdown of a concentrated brine arising from the evaporated concentration of the recirculating water. This blowdown often contains large concentrations of chemicals such as aquatic plant nutrients, i.e., phosphorus, and toxic elements such as chromium, zinc and others which are added to the cooling tower in order to minimize scale, corrosion and biological fouling. It is important to properly evaluate the potential effects of a closed cycle system on environmental quality in order to be certain that the operation of the closed cycle system does not in fact cause more harm than the original system.

Another practice of this type which is receiving considerable attention today is the use of domestic waste waters for irrigation and disposal on land. This is a conceptually attractive process; however, domestic waste waters contain large concentrations of potentially significant chemicals which may be translocated from the soil to animals and man or may, because of the inefficient or limited capacity of the soil for the removal of certain types of pollutants cause serious contamination of ground water supplies. There is little point in trading one type of water quality problem associated with discharge of waste waters to the coastal zone for what is likely to be a much more significant problem of ground water contamination due to land disposal of wastes. The soil, atmosphere, or natural waters all have finite assimilative capacity for contaminants without significant deterioration of quality. Changing methods of waste disposal from water to land may simply change one problem for another which

ultimately may be of greater significance to man than the original problem. Each of the waste water disposal systems must be carefully evaluated by competent individuals before they are put into practice.

7. Monitoring Programs for Known Pollutants in the Coastal Zone Should Be Established.

One of the most frequent problems that those responsible for management of pollutants in the coastal zone face is a lack of knowledge on existing conditions within the coastal zone. Often, information is not available on the current concentration of known pollutants in the region of interest and, further, there is almost a complete lack of statistically valid information on the changes in the concentrations of various pollutants with time. Where data is available it is usually of such limited quantity, frequency and scope that it does not provide a reliable estimate of the concentration of a particular pollutant at any one time, much less changes with time, and therefore it is impossible to assess what the current situation is and predict what the situation may be unless some remedial steps are taken. In order to eliminate this type of problem, immediate large-scale monitoring programs should be established in all parts of the coastal zone designed to determine with a high degree of reliability the existing concentrations of various forms of potentially significant contaminants in the water and sediments.

The particular sampling program that is adopted for any part of the coastal zone should reflect the characteristics of the coastal zone and not be established in the frequently-used

arbitrary system of collecting one sample every so many miles every day, week, month or year. Various parts of the coastal zone have various factors which influence the concentration of pollutants. The sampling program must be designed to take this type of variability into account. Otherwise, large amounts of funds will be expended on data collection which ultimately will be of little or no value in determining the changes in concentrations with time. The analytical methods used in these monitoring programs should be designed to detect the pollutants at least at microgram to tenth of a microgram per liter concentrations and, for some of the organic components, at hundredth to thousandth of microgram per liter concentrations. Use should be made of the aquatic organisms as biological integrators of many of the contaminants of interest. For example, chlorinated hydrocarbons of the DDT-PCB type can best be monitored by examination of these compounds in fish of certain types.

For any reach of the coastal zone, sufficient preliminary studies should be made to evaluate the variability of the system with respect to the concentrations of pollutants in various parts of the aquatic ecosystem. From this data, it is then possible to design a monitoring program which will determine the particular contaminant at a sufficient degree of reliability, i.e., frequency and location, in order to detect potentially significant changes in that pollutant in the part of the coastal zone under consideration. As additional data is gathered, the ability to predict the numbers, types, frequency and locations of samples will improve and the sampling program should be adjusted accordingly.

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There is no point in conducting sampling programs which do not provide a known degree of reliability for estimating contaminants in the water under study. Some data of questionable and poor quality is not necessarily better than no data. The "some" data may actually be misleading and result in erroneous conclusions concerning the behavior of the contaminant in the system.

The monitoring program should include not only the known pollutants which are causing or are suspected to cause problems today but many of those which could potentially cause problems in the future. The latter group may be selected by examining members of certain classes of compounds, i.e., toxic metals, chlorinated hydrocarbons, etc. For example, many surveys of toxic metals include a small selected group of the metals, often excluding cadmium. The analysis of cadmium today is not that difficult; in fact, some of the most frequently-used analytical techniques for heavy metals could readily determine cadmium at the same time as the other potentially significant heavy metals are determined. The importance of including this element is that it has recently been found that critical concentrations of cadmium to certain aquatic organisms in fresh water is in the order of a few tenths of a microgram per liter. A few years ago, few individuals were concerned about cadmium in either fresh or marine environments. This element may become the next chemical crisis in the U.S. because of the extremely low concentrations which have been found to inhibit fish food reproduction in fresh waters.

8. Several Laboratories Should Be Established in the U.S. to Look for Unrecognized Pollutants in Natural Waters and Aquatic Organisms.

During the past few years, the chemical crises that have occurred in the aquatic environment have in part been discovered by accident. For example, the PCB's were discovered as a result of the fact that they interfered in the gas chromatographic analysis of DDT. As a result of finding these compounds, studies were initiated which have subsequently shown that the PCB's are worldwide contaminants possibly having a significant deleterious effect on aquatic and terrestrial organisms. It is recommended that at least two and possibly more national laboratories be established in the U.S. whose primary goal would be to examine natural waters and selected aquatic organisms for pollutants. These laboratories should be staffed by competent specialists in various branches of analytical chemistry, water chemistry, aquatic toxicology, aquatic ecology and related disciplines. Their activities should be restricted to looking for widespread contaminants which are not now recognized as being of significance or even present in aquatic ecosystems. These laboratories should be immune from any enforcement activity where their attentions would be diverted to a particular localized problem, which is frequently one of the primary problems of the existing specialized laboratories of this type within the U.S. Such a team of individuals would have detected DDT, mercury, PCB's and other contaminants in natural waters many years prior to their actual discovery. Those working in water chemistry today know that there are many compounds present in aquatic organisms which have properties similar to the

chlorinated hydrocarbons, yet are not of the known pesticide-related compounds. However, these compounds simply remain unidentified. Once a widespread contaminant is found, this information could then be passed on to the group studying the significance of various chemicals and their degradation products in natural waters with respect to their sublethal chronic toxicities. Ultimately, this group would develop the criteria for the critical concentrations of these pollutants in natural waters and lead to control programs to restrict the input of these compounds below critical levels.

9. Establish a Special Laboratory in the U.S. to Determine the Effects of Pathogenic Organisms on Water Quality.

Domestic and, in some instances, industrial waste waters contain large numbers of organisms which are potential pathogens for man. These organisms range all the way from viruses causing infectious hepatitis to typhoid and other bacteria and protozoans which result in dysentery in man. At the present time it is realized that the traditional criteria that have been used to judge the potential health hazard for using waters contaminated with these organisms are not reliable. While health officials tend to establish strict water quality standards for use of the coastal zone waters for body contact, there is little or no technical justification for these strict standards. There is an urgent need for detailed studies on the significance of pathogenic organisms in waste water discharges with respect to its effect on the utilization of coastal waters for recreational purposes of man. It is felt that this problem is of sufficient magnitude to

warrant a national laboratory devoted to this problem. This laboratory should be staffed by aquatic microbiologists, public health physicians, epidemiologists and others who can establish the critical concentrations for various types of pathogenic organisms in waste water discharges and in recreational waters. The efforts of this laboratory should be directed not only to marine waters but also to fresh waters such as the Great Lakes. It is likely that studies of this type will be of increasing importance because of the recent findings that trace amounts of chlorine arising from the chlorination of domestic waste waters have relatively high toxicity to aquatic organisms. Therefore, it is likely that a complete reappraisal of the utilization of chlorine for disinfection purposes in domestic waste waters will take place in the near future. In order to establish the need for disinfection, studies on the significance of these organisms in natural waters must be completed. In addition to establishing the critical concentrations of these organisms in water with respect to pathogenicity to man, efforts should be made toward developing analytical techniques for the rapid detection of these organisms.

10. All Direct Discharges of Municipal and Industrial Waste Waters to the Coastal Zone Shall Be Required to Report Typical Chemical Composition of the Discharge to the Coastal Zone Managing Agency.

Large amounts of municipal and industrial wastes are discharged to coastal zone waters. The composition of these wastes is largely unknown at this time in many parts of the country. It is felt that it should be the responsibility of any discharger, municipal or industrial, to take representative samples of this

waste and determine in detail the chemical composition. Further, each discharger should be required to keep an accurate record of the total quantity of waste water discharged each day. The frequency of sampling and the particular chemical analyses that will be required for a certain type of discharge will be selected after consultation with appropriate water pollution control authorities at the local, state, federal and, in some instances, international level. As a minimum, the concentrations of the known pollutants typically found in that type of discharge shall be determined and this determination shall be made at monthly intervals.

Further, each industry shall be required to report the total amounts of raw materials taken into the industry, products and by-products accrued at monthly intervals. This list of raw materials shall be examined by appropriate water pollution control authorities to ascertain whether any of the raw materials or products might be present in the waste water discharge. In those instances where it is thought possible that the discharge of raw materials or products could occur, the industry should be required to report the chemical analyses of their waste waters for these materials in addition to the standard pollutants. It is important to emphasize that each industry has specific types of contaminants in its wastes. There is little point in forcing the industry to spend large amounts of money reporting on the composition of materials in the wastes which are in no way associated with the manufacturing operation.

Industries employing atmospheric and land disposal of wastes shall be required to report at least at monthly intervals the

total quantities of various types of contaminants disposed of by these means. For land disposal employing the spreading of liquid wastes on the ground or injection of these wastes into the ground, the industry and municipality shall be required to demonstrate at least on an annual basis that their disposal practices are not resulting in the contamination of ground waters. The industry and municipality shall be required to install monitoring wells and perform chemical analyses on the ground waters in the region of their disposal area.

11. Any Disposer of Solid Waste in the Coastal Zone Shall Be Required to Demonstrate with a Reasonable Degree of Reliability the Effects of Such Disposal Practice on Utilization of the Coastal Zone for Other Classified Uses.

Solid municipal and industrial wastes including concentrated liquid wastes from some types of industries, i.e., waste acids, etc., can be disposed of in the oceans without significant ecological damage to many beneficial uses of a reach of the coastal zone. Each part of the coastal zone has a certain assimilative capacity for materials of this type. However, at the present time, this assimilative capacity is poorly understood. This recommendation applies to municipal and industrial waste sludges, garbage and refuse, concentrated brines, acids, radioactive wastes, organic chemicals, etc., which are typically barged to the sea for disposal. Each municipality, industry, or other individual or group of individuals who wishes to use a coastal zone for this purpose shall be required to conduct studies designed to determine the overall effects of such practices on the aquatic ecosystem receiving the waste. The recommendation requires that anyone who wishes to use

the oceans for waste dumping purposes shall be required to demonstrate within a reasonable degree of reliability the effects of such a practice on the aquatic ecosystem and the impairment of other beneficial uses of that reach of the coastal zone for man and aquatic life. The extent and intensity of study shall be determined by a board of scientists, engineers and others knowledgeable in the effects of pollutants on aquatic ecosystems and water quality. The discharger shall be required to maintain a monitoring program designed to keep a reasonable record to be certain that the evaluation of the effects of the dumping practice based on the initial study is supported by the monitoring program.

12. The Burden of Proof for the Effect of a Certain Waste Discharge on the Environment Shall Be Placed on the Discharger to Demonstrate Its Effect.

Today, the social and legal system in the U.S. essentially allows the discharger to introduce waste contaminants into the environment without evaluating the effects of such contaminants on the local or global ecosystems and the impact on the beneficial uses of the area for man, terrestrial wildlife and aquatic life. Currently, largely by default, the U.S. cultural system allows a discharger to discharge to the environment waste contaminants until it is shown by regulatory agencies that such discharges impair other beneficial uses. In other words, the burden of proof concerning the effects of such discharges is on the public or their representatives in regulatory agencies, rather than the discharger. It is felt that this burden of proof should be shifted

to the discharger whereby he, whether municipal or industrial, must demonstrate with a reasonable degree of reliability that such discharge does not significantly impair other classified beneficial uses of the region of the coastal zone under consideration. The discharger must be required to spend the funds necessary to determine the fate of each of the pollutants or potentially significant contaminants in its discharge within the coastal zone. Once information is available on what happens to the pollutant or contaminant once introduced into the coastal zone aquatic ecosystem, then studies must be conducted to determine the effects of each potentially significant form of the contaminant and its degradation products on selected key parts of the ecosystem. The use of the coastal zone for direct discharge of pollutants shall become a privilege of the discharger dependent on his assessment of the effect of such discharge on the system and the classified uses of the coastal zone into which the waste is introduced.

13. Efforts Should Be Made to Achieve World-Wide Acceptance of These Recommendations.

Pollutants discharged from one country may not stay within the coastal zone of that country and in some instances are spread throughout the oceans even to the coastal zone of adjacent countries. Further, there are instances where the expenditure of funds by one industry for control of pollutants in accord with the best technology available today may place this industry at an economic disadvantage compared to its competitors within its own country or within other countries of the world unless similar

practices are followed by them. These recommendations must be applied throughout the U.S. to all parts of the coastal zone and where possible to all other countries. Otherwise, significant economic constraints may be placed on a particular industry which could force that industry into a position such that it would not be able to compete effectively for a representative part of the market. This type of situation could ultimately lead to widespread social disruption due to unemployment and other associated problems. It is therefore important that all dischargers of contaminants to the coastal zone be required to make every possible effort to minimize discharge and to eliminate those discharges which are found to have a significant deleterious effect on many of the beneficial uses of the coastal zone.

The importance of economics in the control of pollutants in natural waters cannot be overemphasized. Until recently, there has been a serious problem in the U.S. when a state or some other local regulatory agency faced the possible loss of an industry from its region if the agency enforced the water pollution control legislation. It is sometimes less expensive for an industry, especially one that is somewhat outdated, to construct new facilities at another location with less stringent water pollution laws than to construct the additional waste water treatment facilities at the existing location. This type of situation is changing today with the enactment of more or less uniform water quality standards throughout the U.S.

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There is considerable confusion today about who pays for waste treatment. There are those who advocate that it should be the

industry's responsibility to absorb the costs. In most instances this is possible to a very limited extent due to the fact that U.S. industry operates on a profit motive which is controlled to a major extent by the stockholders. For some industries, such as iron and steel, chemicals, etc., it is not possible to pass the cost of waste treatment or other steps taken to improve environmental quality to the public in the form of increased prices for goods because of foreign competition. Therefore, the control of contaminants in natural waters must be practiced uniformly in accord with contaminant assimilative capacity of the local waters because of both ecological and economic constraints.

One possible way which should receive greater attention in the future to finance pollution control and the screening of new chemicals which might become environmental hazards is through a reprogramming of the public to accept less financial return for their money invested in an industry whose operation or products lead to environmental degradation. The reduced return to the stockholders could be used to control and minimize this degradation. For example, a stockholder in a chemical company may have to accept a 4 percent return on the investment rather than the more typical 5 or 6 percent return in order that the company would have sufficient funds to properly screen new chemicals with respect to the potential environmental impact and still be able to compete effectively with other domestic and foreign competitors. The reduced return would be justified in terms of improved environmental quality. The likelihood of the public accepting such a proposal is thought to be very small. It is more likely that an

economic system which provides for tax relief to an industry that is faced with substantial cost for environmental quality control would enable the industry to provide its stockholders with essentially the same financial return for their investment as they might obtain from other investments and still enable the industry to compete with foreign industries of a similar type. In this way the public would still be paying for the maintenance of environmental quality through increased taxes. It would be the responsibility of the federal, state and local governmental units to select those industries which are thought to be of major significance to the U.S. economy, welfare and defense to warrant the special treatment for tax purposes.

Determination of Significance

Throughout this discussion mention has been made of significant deleterious effects, a reasonable degree of reliability, etc. Each of these uses require some type of judgement on the part of the management authority on what should be done or what can be allowed for a given situation. Man cannot utilize the coastal zone for waste disposal without having some deleterious effects on one or more of the beneficial uses of that particular part of the coastal zone. Since waste disposal arising from either direct or indirect discharges is one of the beneficial uses of the coastal zone, it then becomes a question of how much impairment of classified uses for a particular part of the coastal zone will be allowed by the management authority for that part. It is important that the coastal zone be divided into regions where certain

types of beneficial classified uses will be maintained. The management authority for a certain reach of the coastal zone must make the decision with the consent of the public on the amount of impairment of the other uses of the coastal zone that will be allowed by direct and indirect waste disposal. In each situation, the management authority should call on a team of scientists and engineers who can give a fair technical appraisal of the current information available on the effects of one or more waste discharges on that part of the coastal zone under consideration. From this information the management authority must then proceed to establish the amount of waste disposal that can be allowed. It will often be necessary for the authority to proceed with rather incomplete technical information. Such a situation should not delay decision, but should allow a tentative assignment of waste disposal practices to be made contingent on detailed studies supported and reviewed by representatives of the discharger, the public, and other interested parties who may be affected by the waste disposal practice. It is felt that any decision made on waste disposal practices for a certain part of the coastal zone should be reviewed at least at five-year intervals and a decision be made at that time concerning any modification of the waste disposal practice that would be allowed in the future.

The coastal zone management authority will also be faced with trying to set up reasonable requirements for monitoring the impact of a certain waste discharged or of dumping, etc. Based on past experience, it is felt that the best way to proceed in this area is to appoint an independent board of individuals who could

advise the management authority on what should be required. This advisory board should consist of representatives of each of the users of that particular part of the coastal zone who are knowledgeable in the area of studies on the behavior of contaminants in natural water systems. This advisory board should consist of a minimum of five and not more than ten individuals in order that it may function effectively. The decisions of this board should be made in accord with current technology, experience of the board members in studies of similar types from other locations and other characteristics of the system (social, legal, political, technical) under consideration.

The possible model for this type of arrangement is the Pesticide Review Board and its Technical Advisory Council for the State of Wisconsin. Several years ago, the Wisconsin legislature adopted new legislation which established the Pesticide Review Board for the State. This board consists of the administrative heads of the three agencies within the State (Department of Natural Resources, Agriculture, and Health and Social Services) which have an interest in pesticides. This board is responsible for all operating rules and regulations for pesticide control programs, etc., within the State. The Board functions through a Technical Advisory Council where technical representatives of each of the major disciplines or groups concerned with pesticides in the State and their effect on terrestrial and aquatic ecosystems serve as members of the Council. This council consists of members from each of the administrative agencies of the State, industry, universities and the public who are knowledgeable in

the area of pesticide uses and impact. This council, with the assistance of the agency attorneys, has the responsibility of developing the legislation and policy for pesticide use within the State. The scientific representatives on the Council represent such disciplines as aquatic and terrestrial ecology, entomology, soil and water chemistry, human health, natural resource engineering, and agriculture.

One of the problems of the Technical Advisory Council was that the legislature did not provide any funds to assist the Council in its activities. The enabling legislation for an advisory council of this type should carry a certain amount of funding necessary to provide for stenographic assistance and at least a part-time technical advisory assistant who could do a lot of the leg work of the council members in gathering information for council deliberations. Further, it is felt that funds should be provided to the non-agency members of the council to compensate for time spent on council activities and for travel and other expenses. If the council meetings are held on weekends, evenings, etc., outside the normal working period for the agency representatives, then these individuals should also receive compensation for their time.

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