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SURVEY OF MARINE WETLAND AND ESTUARINE WATER QUALITY AND ECOLOGICAL PROBLEMS IN CORPS OF ENGINEERS FIELD OFFICES

by

Peter Hamilton

Science Applications, Inc.
4900 Water's Edge Drive, Suite 255
Raleigh, N. C. 27606

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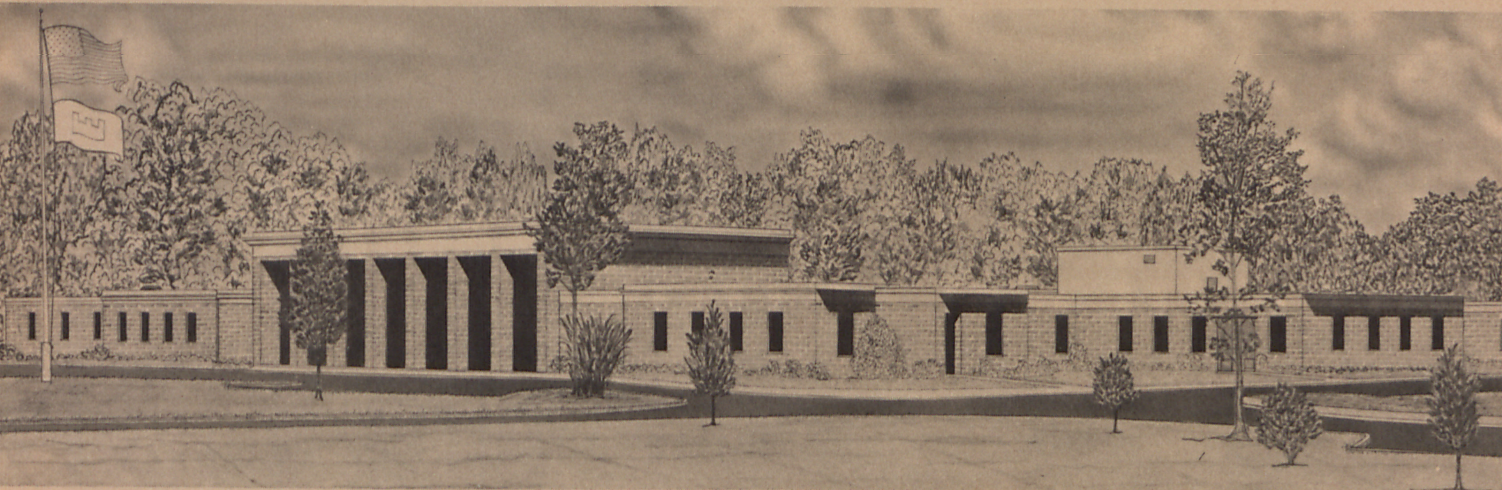

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This report presents the results of a survey of Corps of Engineers (CE) field offices that have coastal zone responsibilities. The purpose of the survey was to investigate existing or anticipated water quality and ecological problems associated with CE activities in marshes and estuaries. Emphasis was placed on identifying those problems amenable to analysis through application of predictive modeling techniques.

The identified problems represent the perceptions of the (Continued)

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20. ABSTRACT (Continued)

field personnel as interpreted by Science Applications, Inc. In some cases, perceived problems have been extensively researched or are being presently studied. The survey was designed to identify problems perceived by the field offices and may not reflect current understanding.

Three general problems were emphasized by all offices: (a) the uniqueness of the specific environments in their District; (b) water quality and environmental problems are functions of local concerns of the public; and (c) there is a need to evaluate effects of a change in physical regime on an estuary.

Specific problems identified are summarized below:

(a) Techniques are needed to predict the effects of Corps of Engineers activities on the hydrodynamics, dissolved and particulate transport, biological and chemical processes, and biota in coastal environments. Corps of Engineers activities include construction, channel deepening and widening, island creation and upstream projects leading to changes in freshwater flows.

(b) Selected marsh/estuarine areas need to be characterized in terms of physical, chemical, and biological structure and chemical and biological processes. Specific areas identified include the east and northeast coasts, infrequently flooded marshes, mangrove swamps, and buffer areas such as the saline flatlands of the western gulf. Included in the characterization would be a uniform methodology of classification and a means to assess the value of the wetland to the total ecosystem.

(c) The types and magnitudes of stresses the marsh/estuarine ecosystem may be subjected to in terms of structural stability and deviations in the rates of selected chemical and biological processes need to be determined. Included would be estimation of the assimilative capacity for effluents from diked impoundments, dredged material disposal sites, storm runoff, and agricultural runoff. Indices of structure and processes include fish and invertebrate nursery grounds, fish production, water quality, and import/export relationships of nutrients and detritus.

(d) Techniques to evaluate the cumulative impacts of dead-end canals, small boat harbors, and marinas on the adjacent coastal ecosystem need to be developed. Procedures are needed to assess the magnitude of perturbations of water quality due to point and nonpoint sources of contaminants entering the canals and small harbors. Design criteria to minimize adverse water quality degradation within the canals and harbors and in the adjacent ecosystem need to be formulated.

(e) An increased understanding is needed of the process of marsh creation through deltaic growth including habitat creation and species succession.

(f) Existing hydrodynamic models need to be extended by including selected water quality parameters in advection-dispersion equations. Priority of inclusion is salinity, temperature, dissolved oxygen, nutrients, phytoplankton, and toxicants.

PREFACE

The survey described in this report was conducted during the period November 1978 through January 1979 by an interdisciplinary project team from Science Applications, Inc. (SAI), for the U. S. Army Engineer Waterways Experiment Station (WES) as partial fulfillment of Contract No. DACW39-78-C-0087, entitled "Survey of Existing Marsh/Estuarine Water Quality and Ecological Modeling Techniques." The research was sponsored by the Office, Chief of Engineers, U. S. Army, under the Environmental Impact Research Program. The purpose of the survey of Corps of Engineers (CE) District Offices with coastal zone responsibility was to identify existing or anticipated water quality and ecological problems associated with CE activities in marshes and estuaries.

This report is one of three reports describing the results of the contract study. Reports on other aspects of this study, including a literature review and a workshop report, are being published as WES technical reports. The workshop was held in New Orleans on 18-20 June 1979 and consisted of invited and contributed papers presented by eminent specialists in estuaries and wetlands. Both the literature review and the workshop were designed to assess the present state of knowledge of estuarine and wetland physical, chemical, and biological processes and the ability to mathematically model these complex systems.

Participants in the survey from SAI included Dr. Peter Hamilton, Mr. Ken Fucik, Mr. George Tamm, Dr. Ivan Show, Jr., Dr. Michael Rogozen, Dr. Keith Macdonald, Dr. Martin Miller, and Mr. Lon Hachmeister.

The study was monitored by Mr. Ross Hall under the direct supervision of Mr. Donald L. Robey and under the general supervision of Dr. Rex L. Eley, Chief, Ecosystem Research and Simulation Division, and Dr. John Harrison, Chief, Environmental Laboratory. Study was funded by the Environmental Impact Research Program. Mr. John Bushman was the Office, Chief of Engineers Technical Monitor.

Directors of WES during preparation of this report were COL John L. Cannon, CE, and COL Nelson P. Conover, CE. Technical Director was Mr. F. R. Brown.

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SURVEY OF MARINE WETLAND AND ESTUARINE WATER QUALITY AND ECOLOGICAL PROBLEMS IN CORPS OF ENGINEERS FIELD OFFICES

PART I: INTRODUCTION

1. This report presents the results of a survey of Corps of Engineers (CE) District Offices that have coastal zone responsibilities. The purpose of the field office survey was to investigate existing or anticipated water quality and ecological problems associated with CE activities in marshes and estuaries. A major emphasis was to investigate those water quality and ecological problems amenable to analysis through application of predictive modeling techniques. The identified problems represent the perceptions of the field personnel as interpreted by Science Applications, Inc. (SAI). In some cases perceived problems have been extensively researched or are being presently studied. However, the survey was designed to identify problems perceived by the field offices and may not reflect current understanding.

2. The methodology of the survey entailed onsite visits to each District Office by a team of two or three personnel from SAI. Prior to each visit, a letter was sent to each office describing the purpose of the survey. In addition, the letter requested confirmation of the suggested date of the visit, the name of a point of contact, and the arranging of meetings with personnel most concerned with the coastal zone problems. Meetings were arranged with personnel from Planning (Environmental Resources), Engineering (Water Quality and Hydraulics), and Constructon and Operations (Resource Management and Permits). The dates of the visits, the point of contact, and the investigators from SAI are given in Appendix A. Individual meetings were, for the most part, informal with opinions being freely expressed on a wide range of CE activities associated with coastal zone environmental quality problems. Since the interviews were informal and not structured, expressed concerns obtusely provide measures of severity and frequency of occurrence of particular problems.

3. This report is divided into three main sections: (a) marine wetlands, which deals with areas of marsh in the upper and middle intertidal zone, characterized by periodic inundations of both saline and brackish water; (b) the coastal zone, which deals with coastal waters of estuaries, harbors, and nearshore waters; and (c) environmental monitoring, which deals with data collection and environmental assessments. In each section, the results of the survey pertaining to problems perceived to be important by the CE in each District are reported. Concluding the report is a summary of the main findings and a tabulation of the identified problems, by District Office, based upon discussions during the onsite visits. The main sections of the report present a country-wide perspective and, thus, the problems of individual field offices are not discussed in detail.

PART II: MARINE WETLANDS

Introduction

4. The importance of marine wetlands is in their value to coastal marine ecosystems. Wetlands are of great benefit to the estuary because they are sites of very high primary production and provide valuable aquatic habitats for larvae and juveniles of many crustaceans, fish, and birds. Marshes can also play an important role in inorganic nutrient cycling and detritus flux with adjacent estuarine environments and habitats.

5. Dredging of naviation channels, disposal of dredged material, shore protection structures, flood control, and marsh creation projects are examples of CE activities that can have direct impact on the wetlands. CE permitting activities are also concerned with similar construction and development by private interests and state agencies.

Regionalization of the Wetlands

6. The type, areal extent, and degree of knowledge about the wetlands vary considerably around the country. For this reason, the country is divided into three regions. They are the Gulf and Southeast Atlantic Coasts, the Northeast Coast, and the West Coast.

7. The Gulf and Southeast Atlantic Coasts, for the purpose of this report, range from Cape Hatteras, North Carolina, to the Mexican border and include the District Offices at Wilmington, Charleston, Savannah, Jacksonville, Mobile, New Orleans, and Galveston. The wetlands in this region are the most extensive in the country (except for Alaska) and are also the most studied. The types of wetlands vary considerably due to different hydrologic and geomorphic conditions. The western Gulf Coast has large areas of saline flatland, and the Mobile District has areas of infrequently flooded *Juncus* marsh. Both these areas have received little study. However, the *Spartina alterniflora* marshes of Louisiana and the Atlantic coasts have been extensively studied.

8. The Northeast Coast ranges from the Canadian border to Cape Hatteras and includes the District Offices of New York, Philadelphia, Baltimore, and Norfolk, and the New England Division. The coastal wetlands north of Cape Hatteras are not as extensive in areal extent as those of the Southeast Atlantic and Gulf Coasts. However, the existing literature from Virginia, Maryland, New Jersey, and Rhode Island is extensive.

9. The West Coast District Offices include Alaska, Seattle, Portland, San Francisco, and Los Angeles, and the Pacific Ocean Division (Hawaii). Except for Alaska, wetlands in this region are a very scarce resource and little is known about them. District personnel expressed concern that some of these wetlands, particularly the San Francisco Bay area, seemed more stressed than elsewhere due to heavy agricultural and urban pressures. The West Coast District Offices were aware of the increasing loss of these resources and have assigned high priority to providing wetlands maximum protection under the law. A major concern is the development of procedures for salt marsh restoration and creation.

Classification

10. In the regions where wetlands have received little study, there was a problem of classifying existing wetlands to assess their value to the total ecosystem. This is a necessary first step in order to predict the effects of making changes to the wetland on fish and invertebrate nursery grounds, fish production, water quality, and the import/export relationships of nutrients and detritus into the estuarine system.

11. Environmental assessments were also influenced by local concerns of the public that can vary considerably from region to region and are often very specific.

12. A further classification problem was the role of buffer regions in maintaining wetland ecosystems. In Texas there are vast stretches of saline flatlands, consisting primarily of succulent halophytes, occurring adjacent to tidal wetlands. Very little is known of

the importance and the role of these flatlands, which may act as a buffer zone between the wetlands and urban developments. They may be important in maintaining the overall "health" of the wetland ecosystem. The majority of offices have not assessed these transition areas. However, these zones need to be defined in order to more effectively evaluate permit applications.

13. There are numerous classification methods for wetlands--most are largely descriptive and of questionable reliability. The CE needs methods for classifying impacts that affect wetlands. Many offices questioned the validity of extrapolating available information on studied wetland areas, mainly in the southeast, to the wetlands in their District. Quantitatively evaluating wetland ecosystems is a very complex problem. In only a few regions was there sufficient basic knowledge to conduct reasonable environmental assessments, even though these are still largely subjective.

14. A uniform classification scheme was desired that attempts to evaluate the kinds of stresses to which a wetland can or cannot be subjected. As a first step to quantifying the ecosystem contribution of the wetlands, productivity measurements are needed. The CE permitting activities also required methods for assessing marsh value that provides a basis of comparison with potential social and economic benefits. This is particularly important when evaluating cumulative effects of small operations over a long period of time.

Dredged Material Disposal

15. Methods for disposal of dredged material in the wetland environment include disposal directly onto the wetland, the use of diked areas on or adjacent to a marsh, and the creation of new marshland.

Disposal directly onto the wetland

16. Only two offices mentioned use of this method: New Orleans, where use is made of old marsh disposal sites and where the method is also employed in selected new projects, and Savannah, where dredged material from the Intercoastal Waterway is pumped directly onto the marsh.

In the latter case, the material was very fine, clean silt, and the CE office maintained that the material is rapidly assimilated and enhances productivity. Expanded use of this technique is becoming increasingly difficult due to emerging emphasis prohibiting disposal directly onto wetlands.

Diked areas

17. Diked areas are usually existing settling ponds that have been in use for many years. With the exception of rare total containment, the water within the diked area is released into the surrounding marsh or estuary usually with fine silts and clays accumulating in the impoundments. The main concerns were impacts on water quality through the release of impounded waters into the estuary or adjacent marsh. Wetland areas may act as a sink and filter out and trap nutrients and polluted sediments associated with discharged effluents. However, discharge from the containment area directly into the estuary may, at times, be a better method of disposal. In both cases the impact on water quality, including turbidity in the estuary, was the main concern. Thus, management of the diked impoundments becomes important, and information is needed on when and where the discharge should take place. Mosquito abatement in the impoundments was also a concern in a few offices. In some areas, seepage into the aquifer was an additional concern.

18. Storm runoff through the wetlands, particularly if it is agricultural runoff, raises similar water quality questions. Information on how the wetland ecosystem assimilates large volumes of runoff at infrequent intervals is presently not available. There is also a need to assess the probable long-term effects of polluted discharges upon the primary and secondary production of wetlands.

Marsh creation

19. There are three principal ways in which intertidal marsh can be created. First, upland areas can be lowered to intertidal elevations by excavation. This is very uncommon due to the cost involved, but may serve as a possible mitigation measure in connection with small-scale construction activities.

20. Secondly, marsh can be created by causing a delta to form at

the mouth of a river that has either been diverted into a bay or is the result of changed river flow due to upstream flood control measures. However, there is limited experience with this type of marsh creation technique. Obviously, it is a much longer process to create a delta than to create a wetland by disposal of dredged material. Studies were desired on delta growth and resulting species succession as upland areas are created due to silt deposition.

21. The third, and most important method, involves marsh creation through the judicious placement of dredged material. The method may use confined or unconfined dredged material. Techniques for these procedures have been developed by the Waterways Experiment Station (WES). Opinion seemed to vary as to the effectiveness of this type of marsh creation, partly due to the varied experiences of individual CE offices. Many offices have had no experience in marsh creation as a method for the disposal of dredged material. In a few offices, it was doubted whether marsh creation is a practical or economic technique for dredged material disposal, but this would need to be determined on a case-by-case basis.

22. The most important information required concerning marsh creation is the assessment of the value of marsh to the total bay-estuary-wetland ecosystem as compared to the value of bay bottom area that would be displaced by the marsh. This is a very complex problem that is most likely site specific. Primary productivity in an estuary is governed, to a large extent, by physical forcing mechanisms such as tidal and wind-driven mixing, available light, water temperature, and nutrient availability. Thus, creation of a marsh may change circulation and flushing of the bay, which could possibly effect fish spawning areas and shellfish beds, both directly by changing flows over spawning areas and indirectly by changing the distribution of primary productivity. The created marsh would also reduce the surface area of the bay and may introduce more turbidity, reduce light levels, and limit primary productivity. On the other hand, primary productivity may increase when detritus is exported from a wetland and nutrients are cycled between marshes and the bay, which may cause water quality problems such as

eutrophication. Reduction of bay bottom area may mean reduction of some types of fish, crab, and mollusk habitats. Habitat creation for certain life stages of other organisms, for instance favorable habitats for larval and juvenile fishes, may increase with additional marsh areas. As can be seen from these examples, marsh-estuarine ecosystems are quite complex and require predictive techniques to make reliable quantitative assessments of the impact of the created marsh on the total environment.

23. Information was also desired in regard to long-term cumulative impacts of creating marshes. The main concerns were: how much wetland is desirable to increase the fisheries harvest of the surrounding waters and when does the creation of additional marsh at the expense of open water become detrimental to the fisheries harvest. Additional information desired included the optimum size of dike openings and fish access channels to newly established marshes. Long-term cumulative impact assessment needs to consider organisms other than fish.

24. Practical problems in creating and maintaining a new marsh usually centered around erosion due to waves and storm surges.

25. Closely related to marsh creation through dredged material dispersal is beach nourishment. This method of disposal is preferred over alternative methods when beach erosion is severe and the dredged material is suitable.

The Effect of Changes in Upland Flow in Wetlands

26. Freshwater inflows to estuarine and wetland areas may be affected by upstream water supply requirements, hydropower, and flood control projects. The specific question of most interest was the assessment of the changes in the salinity of the wetlands and estuaries affected by the change in freshwater flow.

27. The salinity of a complex area of marshes and estuaries can also be modified by channel dredging, construction of saltwater barriers, and wetland fill. Each of these may be the result of non-CE activities, but they are important particularly from the viewpoint of assessing cumulative effects of small-scale dredging or construction.

28. Similarly, the construction of roads or bridges through wetlands will affect the hydraulic regime, and techniques are needed to develop criteria for the design of openings and bridges to allow the marsh to properly flush.

Mathematical Modeling of Wetlands

29. Many of the problems discussed above require predictions to be made on the effects of a particular activity on water quality or the ecosystem. Effects on harvestable organisms are often a major concern. Some of these needs may be amenable to mathematical modeling.

30. Most District Offices considered mathematical ecosystem models of primary and secondary productivity as applied to wetlands to be of limited value. The majority opinion was that they are of limited practical use in their present stage of development and would not be accepted unless it were demonstrated that fundamental assumptions could be justified and techniques verified using field data.

31. Most offices felt that their wetlands were specific to their region. They felt that there was an inadequate data base and a lack of fundamental knowledge of their wetlands to warrant biological modeling at this time.

32. The important problem of predicting the salinity intrusion into a region of wetlands and estuaries due to changes in the hydraulic regime is amenable to mathematical modeling with current techniques and could be of practical use to the District Offices.

PART III: THE COASTAL ZONE

Introduction

33. CE activities in the coastal zone primarily affect bays, estuaries, and harbors. The physical regime of these water bodies varies considerably around the country. For example, the Southern California coast has few true estuaries remaining.

34. There was also considerable variability from District to District in the assessment of the importance of water quality problems in the coastal zone. The importance of water quality problems was usually influenced by local concerns that can often be very specific (i.e., the decline of a local oyster fishery or a single community's concern about its water supply taken from a local river).

35. Water quality problems in the coastal zone can be divided into three areas of concern: the effects of dredged material disposal and dredging operations on turbidity and overall water quality; the effect on the physical regime of an estuary by regulating or disrupting the freshwater inflow; and smaller scale problems with dead-end canals and small boat harbors, which often have severely degraded water quality.

Dredging and Disposal

36. There are two main kinds of coastal water bodies that are used for disposal of dredged material: ocean disposal and disposal in estuaries, bays, and harbors. Many of the problems reported below have been addressed by the CE Dredged Material Research Program conducted by the WES.

Ocean disposal

37. Ocean disposal may be defined as any disposal taking place seaward of the baseline from which the territorial sea is measured. In many areas of the country, this baseline approximates the outer beachline of barrier islands or the mainland in their absence. Disposal is restricted to specific sites on the sea bed. Their use is becoming more

likely because of increasing shortage of upland sites in many Districts. However, there is a counteracting pressure of very rigid and strict environmental criteria and of environmental groups opposed to ocean disposal.

38. Disposal sites must comply with regulations of the Environmental Protection Agency for implementation of Section 103 of Public Law 92-532 and with international constraints under the convention on the Dumping of Wastes and Other Matter Into the Ocean. The main technique used to ensure that the dredged material will have only minor effects on the biota of the site is the use of bioassays. Problems associated with bioassays are primarily cost and the difficulty in justifying them for small projects. Some questions were raised on the representativeness of indicator species, water, and dredged material samples used in the bioassays. Concerns were also expressed on the nature of the criteria and the difficulty in interpreting results and extrapolating them to the real environment.

Disposal in estuaries, bays, and harbors

39. The majority of dredging by the CE is in estuaries, bays, or harbors and is usually concerned with the maintenance of navigation and entrance channels. The greatest concerns were: turbidity produced by dredging operations; over-the-side disposal; and resuspension of dredged material by currents and wave action (criteria for allowable turbidity levels for these activities were thought to be rather arbitrary and not very meaningful). Turbidity plumes often degrade the water quality in an aesthetic sense. Considerable concern was expressed about adverse effects on benthos and degradation of water quality by polluted sediments. Because existing studies suggest little basis in fact for these concerns, more effective impact assessment methodologies and communication techniques need to be developed.

40. An important problem was the restriction of the dredging season because of possible dredging impacts on fish and invertebrate larvae, whose production is important to the ecosystem and commercial fisheries. However, if dredging in estuaries is restricted to the period when no commercially important larvae are in their early life

stages, then it is possible that dredging would only take place during winter periods when weather conditions are often too severe for operations. The concern of adverse effects of dredging operations on fish and invertebrate larvae may be a perception problem, but little pertinent data exist. Private dredging contractors would prefer no restrictions on the times they can dredge. Strict dredging dates meet with much opposition; private dredging permits are usually granted on a case-by-case basis. Effects of dredging operations as they relate to fish spawning habits, fish larvae production and distribution, and shellfish beds in the estuarine ecosystem need to be evaluated and predictive procedures developed.

Water Quality in Estuaries and Coastal Bays

41. The majority of CE offices considered that their main estuarine problems arise from changes in the physical regime. The main CE activities that affect the physical dynamics are channel deepening and widening projects, island creation, channelization, and upstream projects leading to changes in the freshwater inflow patterns. These alterations to the estuary may cause changes in the sediment dynamics by changing the supply of silt, its transport, and hence sedimentation. Predicting the changes in sedimentation is, at present, very difficult due to a lack of fundamental knowledge of sediment-water interactions.

42. The primary physical change in the estuarine regime due to dredging, construction, or altered freshwater inflow is in the salinity distribution. This is important because changes in salinity alter and reflect changes in the circulation and transport characteristics of an estuary and thus affect flushing time and the distribution and concentration of other water quality parameters.

43. However, sewage discharge or agricultural runoff and attendant problems of low dissolved oxygen and eutrophication were not a primary concern, unless CE activities had a potential to change an already existing water quality problem. In this latter case, pollution levels

and other possible water quality changes due to CE activities need to be assessed.

Dead-End Canals and Small Boat Harbors

44. Dead-end canals and small boat harbors are usually small bodies of water characterized by poor flushing and heavy pollution loads. In some ways, they might be regarded as examples of severe estuarine water quality problems in miniature. Of the two kinds of structures, dead-end canals tend to predominate on the east coast, particularly in the southeast, and small boat harbors on the west coast. In populated areas within easy reach of coastal recreational waters, problems with proliferation of marinas occur. These small projects are the concern of permitting activities of the CE. A major concern was the cumulative effects of many small projects, which when considered individually are not likely to have a measureable effect on the ecosystem, but a large number, developed with piecemeal growth policies over a number of years, may considerably degrade the environment. The practical problem is determining when to cease a particular type of development on the grounds that the environment has reached its assimilative capacity and further activities will cause an unacceptable and possibly irreversible degradation of the ecosystem. However, since permits may be issued with environmental or design criteria that must be met by the developer and contractor, many offices felt that more information was needed on dead-end canals and small boat harbors so that these projects may be designed, with CE guidance, to minimize adverse effects on the local estuarine ecosystem.

45. One problem area identified was: the lack of design criteria to improve flushing of canals and harbors, possibly by means of constrictions and varying depth profiles. Studies could result in the formulation of guidelines on appropriate depths, length-to-width ratios, and depth profiles compatible with their proposed use. Of great importance, also, are studies of pollutant introduction by point and nonpoint contaminant sources and resulting perturbation to water quality

in the canal. Evaluation of artificial means of improving water quality such as mechanical stirring or underwater aeration systems is also needed. There is a lack of understanding of the effect of a canal or harbor on the local ecosystem. Identified concerns included adverse effects on adjacent shellfish beds and eelgrass communities. The export of polluted water from the canal into the estuary or bay should be evaluated to develop criteria for use in determining the number of environmentally acceptable canals in a particular region. In all these problems, the physical, chemical, and biological characteristics of the external body of water will also influence the canal or harbor.

Hydrodynamic and Water Quality Modeling

46. Hydrodynamic numerical models of tidal and wind-driven circulations have been used by the CE in recent years to investigate circulation in estuaries, bays, and coastal waters. Often they are used in conjunction with physical model studies to evaluate the effects of proposed construction projects.

47. The hydrodynamic models most commonly used are time dependent, have two horizontal space dimensions, and are forced by wind and tide. They simulate water level changes and vertically averaged currents. A majority of hydraulic engineers considered extension of these models to include water quality parameters by the addition of advection-diffusion equations to be a necessary development. Water quality parameters should include salinity, temperature, and dissolved oxygen in order of perceived importance. Nutrients, phytophankton, and heavy metals were not often thought to be of direct importance or of immediate concern.

48. The reason for the emphasis on physical parameters was that the majority of offices took the view that if they can show, by the use of a model, that only minor changes in the circulation result from the proposed project, then the project will have minimal environmental effects. For example, if a model study can show that widening and deepening an entrance channel into a bay produces only minimal changes in the salinity distribution and circulation, then it can be assumed

that the overall biological and chemical characteristics of the system will not change significantly. This view represents a heuristic methodology that permits assessment within the limitation of present inadequate knowledge of the processes affecting biological and chemical species of direct interest. In addition, it was expressed that high-resolution, three-dimensional hydrodynamic models were needed to better describe nutrient and biological material transport.

49. However, if one of the desired goals of a project is to modify circulation to improve flushing or change sedimentation patterns, then being able to predict alterations in various biological and chemical characteristics becomes increasingly important.

50. A majority of offices found current two-dimensional numerical models to be an adequate tool and only saw a need for coupling to water quality models. However, a few offices thought that more sophisticated circulation models should be developed that include variability with depth. This could be achieved by laterally integrated two-dimensional models for narrow estuaries and full three-dimensional models for deep bays and coastal seas.

51. The development of reasonable sediment transport models was also thought to be important by a few offices despite the complexity of the hydrodynamic problem.

52. Hydrodynamic dispersion models were not often discussed, but a need for some predictive capability sometimes arose in connection with turbidity plumes generated by dredging and disposal, and occasionally with respect to siting of outfalls.

PART IV: ENVIRONMENTAL MONITORING

Introduction

53. Performing environmental assessments and writing environmental impact statements associated with CE activities are important efforts of District Offices. Generally there is a need to streamline and update the procedures for handling and storing environmental information. The use of computers for this purpose was advocated in some offices.

Data Collection

54. The collection of data for environmental assessments is for the most part funded on a project-by-project basis. Thus, planning and collecting data required for an environmental assessment are not usually initiated until the project is authorized. Preauthorization studies usually survey the data available in the literature. Often, the lead-time from authorization to construction is too short to allow meaningful pilot studies of the existing environmental conditions. Normally, project monitoring continues until construction is completed and then monitoring is discontinued. Additional data are not collected unless there is ongoing maintenance associated with the project. Generally, long-term monitoring is infrequently conducted on CE projects. Funding is often not available for detailed analysis of acquired data and, therefore, improved or more efficient sampling procedures are not developed.

55. A few long-term studies, involving collection of large amounts of data that are not tied to a particular project, have been carried out by District Offices; however, most offices felt that there is a lack of funds for long-term studies designed to fill environmental quality information gaps.

Environmental Assessments

56. The main difficulty that personnel face when preparing an environmental assessment for a project is lack of lead time. An

environmental study may have to be planned, executed, and analyzed in just a few months before construction is scheduled to begin. This means that seasonal coverage and hence seasonal variability are oftentimes inadequately assessed.

57. Another difficulty in making accurate assessments is the practice of monitoring a project until the construction phase is completed and then stopping, unless further maintenance is contemplated. Thus, very little post-construction monitoring is carried out, with the effect that the original environmental assessment is not critically reviewed to see if the assessment was accurate and predictions correct. Therefore there appears to be little opportunity to use pre- and post-construction comparisons to improve sampling schemes and assessment procedures. This methodology of pre- and post-construction comparison would seem to be essential where characterization of processes in an estuary is uncertain and long-term efforts can only be tentatively assessed such as river diversion projects.

58. In preparing environmental assessments, a large volume of sometimes obscure literature must be reviewed. The research laboratories of the CE conduct a large number of studies that are relevant to projects of the District Offices. It was reported that exchange of technical information between the research laboratories and the District Offices is generally good, though they would like more critical synthesis of large programs made available so as to facilitate the early use of research efforts. Also, they would like to see the technical expertise of the research laboratories made available to the Districts on an informal consulting basis.

59. In contrast, it was generally agreed that the exchange of technical and project information between District Offices needed to be improved.

Information Retrieval System

60. Information retrieval systems are generally computerized data base management systems often combined with word-processing facilities.

Only a few offices were investigating the use of computers to assist in data management and environmental assessments, although most Districts were aware of a need to update their present procedures.

61. Comments on information retrieval systems by interested offices were that they be tailored to the needs of the District, be simple to use, and require somewhat minimal maintenance. Their use would be to facilitate environmental assessments by retrieving information on what data are available, what information has been published concerning a particular wetland or estuary, and where to locate the information. Useful information would include physical, chemical, and biological data; published reports; land use data; and even economic and aesthetic values.

62. A final point is that though some offices would prefer to develop their own system, others would rather tie into systems developed by other agencies (often the state) and supplement it with their own information.

PART V: SUMMARY

63. The preceding discussion represents an overall perspective of District concerns in the marsh/estuarine environment and generally omitted references to specific Districts and their problems. In this section the concerns and problems of the District Offices are summarized in Table 1. The tabulation indicates the variety of problems identified and their regional distribution as revealed during the interviews.

64. Blanks in the table mean that the office did not express a concern about that particular problem. In some cases, the problem was not discussed or was perceived as a minor concern. The perception and identification of problems reflect the environments for which the office has responsibility. Also, this summary table is the result of discussions with individuals and must necessarily reflect their personal points of view, which may not represent a concensus view of the District. Where opinions differed among personnel in the office, the majority view has been taken. The final point to be made is that no statistical survey was taken during this contract and the results are entirely due to the opinions expressed during the survey visits by SAI.

65. Three general problems were emphasized by all offices: (a) uniqueness of the specific environments in their District; (b) water quality and environmental problems were functions of local concerns of the public; and (c) there was a need to evaluate effects of a change in physical regime on an estuary. The first point emphasizes the specific nature of each District's environmental problems and sometimes their unique requirements for solution. In the second point, primary concerns were fishery, pollution, and water supply related, but sometimes recreational. The last point emphasizes that CE activities in estuaries primarily affect the physical regime, which in turn may have profound effects on water quality and the ecosystem. Evaluation of these changes is an important concern of all District Offices.

66. The points are summarized below under the main headings of this report. Each summary point is numbered and corresponds to the left-hand column of Table 1 and is followed in parentheses by the

paragraph number in which this point is discussed. Codes in the table are also explained. An X indicates concern over this issue. Points are not ranked according to importance.

Wetlands

1. The wetlands of the District need to be surveyed (X) (9). Routine air surveys are used to track changes in the wetlands and coastal zone (A).

2. Problems with applying the different kinds of available wetland classification schemes. (13,14).

3. Need for information on the role of buffer zones around wetlands (12).

4. Need for scientifically assessing wetland values by productivity measurements (14).

5. More information is needed on the management of dike impoundments (17). Techniques for mosquito abatement needed (M).

6. More information is needed on the assimilation of effluent and dredged material by the wetland (16,18).

7. Problems with delta growth as a method of marsh creation (20).

8. Creation of marsh by dredged material disposal (21-23). Experience has been successful (S), unsuccessful (U), will be attempted (A), and considered important but no experience (I). (FW-Freshwater wetlands have been created.)

9. Importance of predicting effect of created marsh on total bay-marsh ecosystem (22).

10. The evaluation of the effects of changes in freshwater flow on wetland areas (26,27).

11. Evaluating the effects of stresses on wetlands such as platforms and highway bridges (28).

The Coastal Zone

12. Need for offshore disposal sites due to lack of upland sites (37).

13. Problems with bioassays (38). Opinions on the usefulness of the technique for its function of evaluating impact on the biota. U - useful; N - not useful.

14. Concern over the effects of turbidity produced by dredging and disposal operations (39). Techniques needed for dredge operations so as to minimize environmental impact (T).

15. Water quality problems such as eutrophication or pollution exist in the District's estuaries (E) or rivers (R).

16. Water quality and impacts of cumulative development of dead end canals (D), small boat harbors (S) and marinas (M) (44,45).

17. Needs for hydrodynamic models: (1)-one dimensional; (2)-two horizontal dimensions; (2V)-two dimensional, laterally integrated; (3)-three dimensional; (D)-dispersion models (46-52).

Environmental Monitoring

18. Need to modernize methods of storing and handling data and literature for environmental assessments (53,58).

19. The need for longer lead times for comprehensive studies for evaluating the impact of a project (54,56).

20. The need for more long-term monitoring so as to evaluate impacts of projects (54,57).

21. The need for long-term studies designed to provide more information on the District's problems (55).

22. Improvement of the exchange of technical information between District Offices (59).

Table 1

Summary by District/Division

CONCERNS AND PROBLEMS	New England Div	New York	Philadelphia	Baltimore	Norfolk	Wilmington	Charleston	Savannah	Jacksonville	Mobile	New Orleans	Galveston	Pacific Ocean Div (Hawaii)	Los Angeles	San Francisco	Portland	Seattle	Alaska	NOTES
1. Survey of wetlands								A			A	A	X	X	X	X	X	X	A - Aerial surveys conducted
2. Application of wetland classification schemes									X	X			X		X	X	X	X	
3. Role of buffer areas							X					X		X		X			
4. Productivity estimates						X			X	X	X	X	X*		X	X	X	X**	
5. Management of diked impoundments			X			X	X	XM											M - Mosquito abatement
6. Assimilation of effluent by wetlands	X					X		X	X		X		X						
7. Deltaic growth and marsh creation											X	X							
8. Marsh creation by dredged material disposal		S_{FW}		S	U	U	S	S_{FW}			S	I		S_{FW}			A		S - Successful, U-unsuccessful, A - Will be attempted, I-important but no experience, FW-freshwater wetlands created
9. Effects of created marsh on bay-marsh ecosystem							X		X	X		X					X		
10. Changes in freshwater flow on wetlands	X			X			X				X	X			X		X		
11. Effects of structures construction on wetlands				X					X						X				
12. Offshore disposal sites	X	X			X		X	X	X	X		X	X	X	X	X	X		
13. Bioassays	N				N		XN		N		XU	N			XN		X		U - Useful, N - not useful
14. Turbidity effects	X		XT	X	XT			X			X					X	X	X	T - Techniques of dredging operation
15. Eutrophication or pollution	E	ER			E	E		E	E	E	ER		E†		E	R			E - Estuaries, R - Rivers
16. Water quality & cumulative development	S	DM		DM	D	DM		M	DM		M		DM	S	M		S	S	D - Dead-end canals, S - small boat harbors, M - marinas
17. Hydrodynamic models	2		1,2	2,2V		2,D		1,2,D	2	3,D	2	1,2				1	1,2		1 - One dimensional, 2 - two dimensional, 2V - two dimensional laterally integrated, 3 - three dimensional, D - dispersion models
18. Storing and handling data & literature							X		X		X	X	X				X		
19. Longer leadtimes	X	X		X	X	X			X			X	X			X	X	X	
20. Long-term monitoring					X		X						X	X	X	X	X		
21. Problem assessment studies	X	X					X		X			X		X					* All freshwater.
22. Exchange of technical information among Districts			X				X					X				X		X	** Tundra.
																			† Korea.

APPENDIX A

SURVEY VISITS TO DISTRICT OFFICES

Date 78-79	DISTRICT OFFICE	CONTACT	SAI VISITORS (in addition to P. Hamilton)
November 7	Mobile	Henry Malec (205) 690-2728	Ken Fucik (Boulder) Don Robey (WES)
8	New Orleans	Charles Grimwood (504) 865-1121	Ken Fucik Don Robey
13	Jacksonville	Gerald Atmar (904) 791-3453	Ken Fucik Martin Miller (Raleigh)
14	New England Division	Gilbert Chase (617) 894-2400	Ken Fucik Ivan Show (La Jolla)
15	New York	Joseph Debler (212) 264-4662	Ivan Show
16	Philadelphia	John Burnes (215) 597-4833	Ivan Show
29	Pacific Ocean Division (Honolulu)	James Maragos (808) 438-2263	Ken Fucik
December 1	Alaska	Claire Yager (907) 752-2740	Ken Fucik
4	Seattle	John Armstrong (206) 764-3625	Ken Fucik Lon Hachmeister (Seattle)
5	Portland	Byran Blankenship (503) 221-6437	Ken Fucik
11	San Francisco	George Domurat (415) 556-7348	George Tamm (Boulder) Michael Rogozen (Century City)
12	Los Angeles	Russel Bellmer (213) 688-5431	George Tamm Michael Rogozen
14	Galveston	David Petit (713) 763-1211	Keith Macdonald (Boulder) Ken Fucik

Date 78-79	DISTRICT OFFICE	CONTACT	SAI VISITORS (in addition to P. Hamilton)
January 8	Baltimore	Tom Filip (301) 962-3670	George Tamm Don Robey
9	Charleston	Stephen Morrison (803) 724-4614	George Tamm
10	Savannah	David Coleman (912) 233-8822	George Tamm
11	Wilmington	Richard Jackson (919) 343-4749	George Tamm
12	Norfolk	Shirley Tetterton (804) 446-3762	George Tamm