CHARLESTON HARBOR PROJECT

SPECIAL AREA MANAGEMENT PLAN

09/01/99 DRAFT

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OVERVIEW OF THE CHARLESTON HARBOR PROJECT

ORIGIN AND PURPOSE

Charleston, South Carolina, with its surrounding uplands and an estuary encompassing over 50,000 acres of coastal mashes, is a unique area containing nationally significant cultural, economic, and natural resources. The wetlands and tidal creeks of the Charleston Harbor estuary and watershed provide critical habitat for many species of birds, mammals, reptiles, amphibians, fish, and shellfish. The area also has some of the most significant historic and archeological sites in the United States. The rich natural resources and deep water harbor that originally attracted settlers to Charleston three hundred years ago are still vital to the regional economy. Most of the $6.2 billion in 1990 sales revenue attributed to South Carolina's ports came through Charleston, while tourism contributes almost one billion dollars to the economy and provides an estimated 15,000 jobs.

The Charleston Harbor Project (CHP) evolved from a grass roots effort to begin planning for the rapid urban growth projected for the greater Charleston area and to protect its unique character. Citizens united in 1989 as the Charleston Harbor Estuary Committee (CHEC) to initiate a growth management plan, and then gained momentum with the assistance of the South Carolina Sea Grant Consortium (SCSGC or Sea Grant). Their objective was to protect the Charleston area from the inadvertent natural resource degradation experienced by many urban coastal communities as they have grown. Since current regulatory programs were not designed to address rapid coastal population growth, the CHEC sought a holistic, cooperative approach to manage for the long-term protection of Charleston's natural and cultural resources. Members conducted a series of educational seminars for the public and produced white papers on the status of Charleston's watershed resources.

In 1991 the National Oceanic and Atmospheric Administration Office of Ocean and Coastal Resource Management (NOAA/OCRM) approved funding for resource planning for the Charleston Harbor watershed through the Charleston Harbor Project Special Area Management Plan (SAMP). The objective of the SAMP was to provide local and state leaders with the information needed to manage rapid growth and sustain all of the varied resources of the Charleston Harbor watershed. The South Carolina Department of Health and Environmental Control Office of Ocean and Coastal Resource Management (DHEC/OCRM) administers the CHP with the NOAA/OCRM grant money. (The CHP is now a part of DHEC/OCRM's new Planning Division).

Since the current regulatory management framework evolved from many independent, single issue legislative acts (air, water, hazardous waste), there is no specific mechanism that weaves them into an effective holistic management fabric. To achieve the CHP objective of planning for future growth in the watershed, the CHP has conducted applied research specifically designed to identify and address the most significant economic, cultural, and natural resource management issues for the watershed. The initial NOAA grant provided funding for preliminary planning,and then scheduled additional years to develop the comprehensive management plan. This plan presents goals and provides managers with specific local objectives in conjunction with an ecologically meaningful management focus for the entire watershed.

CHP Organization

The CHP was organized into four levels: task forces, focus groups, the Management Committee, and the Administrative Board. The Policy Steering Committee and the Oversight Committee were also created to assist in the implementation of the CHP. The purpose of each group is described below.

Task Forces

In order to involve as many different viewpoints as possible and have public participation in the Charleston Harbor Project, twelve task forces were organized. Over 200 individuals participated on the task forces, representing the private sector, concerned citizens, and federal, state, and local jurisdictions. They identified research needs and developed investigative proposals within their focus areas. The twelve task forces were organized around the following resource management topics:

Biological Resources	Marina
Cultural Resources	Point Source
Data & GIS	Public Involvement
Dredge/Spoil Disposal	Recreation
Economic	Storm Water
Land Use	Water Quality Modeling

Each research project was associated with one of the task force groups. However, this division was too narrow in scope to efficiently formulate a comprehensive plan. Therefore, all Charleston Harbor Project research was grouped into three larger categories: water, biological resources, and urban growth. Water Resources Management, Biological Resources Management, and Growth Management were the corresponding focus groups established to analyze data and make management recommendations.

Focus Groups

The focus groups were composed of researchers, task force members, and local, state, and federal experts in each field. Each group formed its own recommendations, based on completed research, which were then synthesized into one set of recommendations by the focus group leaders, policy makers, managers, and other officials. This set of recommendations was presented to the Charleston Harbor Project Management Committee for its approval.

Policy Steering Committee

The Policy Steering Committee was formed to develop initial policy recommendations for the Charleston Harbor Project management plan for the watershed. The Policy Steering Committee was composed of representative stakeholders in the project, from federal, state, and municipal governments to industrial and urban development interests in the private sector. The group worked closely throughout the 1997 summer with the CHP focus group leaders and CHP researchers to review research findings and develop policy recommendations, with the ultimate goal of submitting the proposed policy recommendations to the task forces and the Management Committee for review.

Management Committee

The Management Committee is composed of the chair and vice chair of each task force, the CHP Director, and representatives of DHEC/OCRM, the National Marine Fisheries Service (NMFS), and Sea Grant. The Management Committee reviewed the proposals developed by the task forces and recommended projects for funding based on the projects' priority to the overall goals of the CHP. The Management Committee also reviewed the recommendations of the focus groups, decided which would be selected to be in the final management plan, and reviewed the drafts of the management plan prior to final plan approval.

Administrative Board

The Administrative Board is composed of a NOAA/OCRM representative, two DHEC/OCRM representatives, and the CHP Director. The Administrative Board reviews CHP funding proposals and other activities to insure that they meet NOAA mandates.

Oversight Committee

The DHEC/OCRM Oversight Committee was composed of the South Carolina Coastal Council Chair and Vice Chair, members of the council whose congressional districts are within the CHP area, and members representing the three counties in the CHP area. However, as a result of the restructuring of South Carolina state government in July 1994, the Oversight Committee was disbanded.

DIRECTION FROM NOAA

Since the basic ecological and water quality studies that preceded the CHP (see page __) indicated that the Charleston Harbor estuary was in generally good condition, NOAA directed the CHP to concentrate its efforts on resource management to prevent future degradation. According to the initial directive from NOAA, the mission of the CHP is to conduct resource management-oriented research and develop workable policies that will protect the balance of economic, cultural, and natural resources of the area for the next twenty years.

CHARLESTON HARBOR PROJECT GOALS

The task forces developed goals and objectives for the CHP based on existing information for the Charleston Harbor. The goals and objectives were adopted by the Management Committee during the first year of the CHP (1991) and have guided the CHP projects:

Primary Goals

1. To maintain and enhance the quality of the environment in the Charleston Harbor estuary system.
2. To maintain the range of uses of waters and natural resources of the Charleston Harbor estuary system.
3. To anticipate and address potential problems before adverse impacts occur.

Secondary Goals

Stormwater/Nonpoint Source

1. To identify specific stormwater problems that presently exist in the Charleston Harbor drainage basin.
2. To modify, where necessary, and integrate all existing water quality monitoring programs into a basin-wide monitoring program.
3. To develop management programs to reduce/minimize stormwater/nonpoint source problems.
4. To protect and reopen shellfish grounds.

Biological Resources

1. To identify, locate and characterize important species and habitats in the Charleston Harbor drainage basin.
2. To identify historic and recent losses of important habitats and populations of important species.
3. To identify and utilize practical and successful methods of restoring or replacing habitat losses, where necessary for the recovery of important species and the long-term health of the Charleston Harbor system.
4. To identify and implement mechanisms for future protection of habitats and populations.

Point Sources

1. To identify, locate and characterize all point sources within the Charleston Harbor drainage basin.
2. To refine wasteload allocations and establish total maximum daily loads (TMDLs) for the Charleston Harbor estuary.
3. To work with municipal and industrial entities to better manage and, where possible, reduce point source loadings.

Dredge Spoil

1. To define future dredging and dredged material disposal requirements.
2. To assist responsible agencies with the selection of dredged material disposal areas.

Land Use

1. To locate and characterize existing land uses throughout the Charleston Harbor drainage basin.
2. To work with local governments to determine likely areas of growth, and to predict land use conditions at build-out under existing zoning and land use regulations.
3. To determine the impacts of various land uses on the Charleston Harbor estuary.
4. To identify and promote land use management practices which reduce adverse impacts on the Charleston Harbor estuary.

5. To encourage local governments to actively manage land use for the maintenance and enhancement of the Charleston Harbor estuary.

Public Utilization

1. To document present levels of public utilization of the Charleston Harbor and its resources.
2. To enhance cultural, recreational, economic and public use of the estuary.
3. To increase public awareness and involvement in management of the Charleston Harbor system.

Data Management

1. To develop an accessible information management system which integrates data on the Charleston Harbor watershed pertinent to a watershed management plan.
2. To develop a geographic information system (GIS) that satisfies CHP management needs and is compatible with state/local agency requirements.

DESCRIPTION OF THE PROJECT AREA

The CHP planning boundaries follow the watershed boundaries of Charleston Harbor (see map on page __). The watershed covers a portion of Berkeley, Charleston, and Dorchester counties and includes twenty-five incorporated communities.

Waterbodies:

The drainage is characteristic of the Southeastern coastal plain. There are numerous tidal creeks draining into larger creeks and rivers that feed into Charleston Harbor or the Atlantic Ocean. The major water systems are the Ashley, Cooper, and Wando rivers, all of which drain into Charleston Harbor,and the Atlantic Intercoastal Waterway and the Kiawah and Stono rivers. The hydrology of the Cooper River has been drastically altered by the diversion and subsequent rediversion of Santee River flows. The tide range of the watershed varies from five to seven feet, with salinity from zero to thirty-five ppt.

Population:

The total population of the three counties has almost doubled since 1960 and by 2015 is projected to increase by more than 113,000 people over the 1990 census count:

1960 ---------- 279,000
1990 ---------- 507,000
2015 ---------- 620,000+

General Land Categories:

The tri-county area encompasses two million acres composed of:

upland---------- 1,300,000 acres
open water---------- 383,000 acres
estuarine marsh ---------- 142,000 acres
freshwater wetlands---------- 228,000 acres

Upland Classifications:

Upland land use is composed of:

forest ---------- 73%
urban ---------- 10%
agriculture ---------- 7%
scrub/shrub ---------- 8%
other---------- 1%

STATE OF THE NATURAL (Harbor) RESOURCES

Three recent documents provided fundamental information to the task forces and evidence that the Charleston Harbor estuary was in generally good shape from a biological and water quality perspective:

- Characterization of the Physical, Chemical and Biological Conditions and Trends in Three South Carolina Estuaries: 1970-1985 This document was published in 1992 by Sea Grant. The summary of this document concludes that the water quality of the Charleston Harbor estuary has actually improved over the last fifteen years due primarily to the upgrade of wastewater treatment facilities to secondary treatment.

- A Review of Charleston Harbor Water Quality Data 1974-1987 This document was published in 1989 by DHEC and. concludes that water quality is presently meeting appropriate state standards and EPA criteria at most of the stations examined and that most of the parameters which have been routinely monitored in Charleston Harbor have even shown improvement during the time period studied.

- A Physical and Ecological Characterization of the Charleston Harbor Estuarine System This document was published in 1990 by the South Carolina Wildlife and Marine Resources Department. The study was funded through the former South Carolina Coastal Council (now OCRM) by a grant from NOAA. The document states on page 437 that in all technical workshops conducted, there was general agreement that "concerns for water quality in the Charleston Harbor estuary are valid, despite the absence of highly visible problems." The high degree of natural variability observed among stations created a problem in attempting to study the estuary. The variability tended to obscure evidence of biological stress that could be related to various human activities in the Harbor system. The Executive Summary concludes on page 12 that the "estuary appears to be in relatively good shape from a biological/ecological perspective, and has not been drastically altered as a result of the Cooper River Rediversion Project during the period covered by this study."

To further assess the state of the project area's resources, the CHP developed coordinated sampling protocols and created research teams composed of academic, government, and private experts. These teams inventoried, mapped, and assessed the biological, cultural, economic, aquatic and recreational resources in the project area. Over the three-year CHP research period, water quality processes were examined at a variety of spatial scales, from the Cooper-Wando river system down to very small tidal creeks. Researchers developed water quality models for waste load allocations and for simulating future impacts to the Ashley, Cooper and Wando rivers. Stormwater runoff models were developed to simulate water quality impacts of predicted land use changes. Researchers also examined biological resources and urban growth. An analysis of current and future population characteristics and land uses identified future high growth areas and restraints on growth, related to protection of wetlands and conservation lands.

SMALL TIDAL CREEKS

Small tidal creeks (less than three feet deep at mean low water (MLW)) emerged as the nexus of CHP water quality, biological, and land use research. Small tidal creeks were identified early in the project as critical estuarine nursery areas for recreationally important species (e.g., red drum, flounder, trout, shrimp) in Charleston Harbor. Subsequent research found that predictable changes to hydrology, chemistry, and biology in the creeks are related to nearby development intensity. Impacts from adjacent watershed development are more extreme in small creeks than in larger estuarine waters because small creeks incur more severe contaminant accumulation, sedimentation rates, and oxygen fluctuations. Addtionally, these habitats often contain the most sensitive life history stages of fish and shellfish. The physical changes are reflected by biological impacts in the creek. Politically, small creeks are also more at risk from urbanization because they are not wholly within the jurisdiction of local, state, and federal resource managers (see Tidal Creek Project on page __).

GROWTH MANAGEMENT

The coastal zone of South Carolina is relatively undeveloped, ranking 28th out of the 33 states with coastal environments, containing 114 individuals per square mile. This low population density contributes to the high environmental quality that characterizes the state's estuaries, yet demographic projections suggest that the population of the Charleston Harbor Project area will increase rapidly in the next twenty years. With increased numbers of people, houses, vehicles, and wastewater, substantial portions of the watershed that drain into the salt marshes and tidal creek nursery habitats are likely to be developed over the next few decades. Largely rural areas will be converted to urban uses with their associated impacts upon biological habitats and water quality.

In addition to the amount of growth projected for the region, the way growth occurs has also changed in recent years. Between 1973 and 1994, the tri-county region's population grew by 40% but its urban land area grew by 250%, a prime example of urban sprawl. People are using much more land as they develop property than in the past, so habitat is being lost more quickly with modern development practices.

MAJOR RESEARCH EFFORTS

There were over sixty research projects funded through the Charleston Harbor Project, many of which resulted in new and significant findings. Out of this research, four projects are described below in detail because of their potential impact on management of the CHP area: The Tidal Creek Project, The Belle Hall Plantation Charrette, Metropolitan Charleston 1990-2015, and the Water Quality Model.

THE TIDAL CREEK PROJECT

The projected rapid population increases for the CHP area will result in significant land use changes as forests are converted for human uses. Land use changes can degrade water quality by short-circuiting natural infiltration of runoff through the soil. As land use intensity increases from forest, to suburban, urban, or industrial uses, runoff quantity and velocity increases, and water quality declines. The Tidal Creek Project was the result of two years of CHP water quality and fishery habitat projects, examining the relationship between land use patterns and the health of small tidal creeks. It identified small tidal creeks as potential critical management areas within the Charleston Harbor estuary, and found that changes in runoff and water quality caused by development are most dramatic and potentially detrimental in small tidal creeks.

Harbor Project researchers established that small tidal creeks are critically important nursery areas for many highly valued fishes and crustaceans. They also found water quality could change drastically and quickly in tidal creeks, making conditions in these creeks much more stressful for the creatures living there, as compared to conditions in larger rivers. Although water quality management is designed to protect fishery habitats, management has been focused historically on main rivers, and may not adequately protect small tidal creeks. Since the productivity of these nursery areas is dependent on adequate water quality, the purpose of the Tidal Creek Project was to develop recommendations for the proper management of these important habitats.

Specific objectives of the Tidal Creek Project were to:

- characterize and define the ecological values and services of tidal creek systems
- identify pollution threats to the ecological values and services of tidal creeks resulting from human development
- develop environmental quality criteria for sustaining tidal creek nursery functions

The Tidal Creek Project was a joint effort by two research centers. One research team included Dr. A. Frederick Holland, George Riekirk, Scott B. Lerberg, Lynn E. Zimmerman, and Denise M. Sanger of the Marine Resources Research Institute, which is part of the Marine Resources Division of the SC Department of Natural Resources. The NOAA, National Ocean Services, Coastal Center for Environmental Health and Biomolecular Research at Charleston was a co-participant in the project. There, the researchers were Dr. Geoffrey Scott, Dr. Michael Fulton, Brian C. Thompson, James W. Daugomah, John C. DeVane, Kevin M. Beck, Aaron R. Diaz, Scott Siverbe, Erich Strozio, and Dan Bearden.

The Tidal Creek Project encompassed twenty-four creeks in the Harbor Project study area. The creeks were chosen to represent typical land use patterns: undeveloped, suburban, urban, and industrial. The physical, chemical, and biological characteristics of these creeks were measured and compared.

Findings:

- Pristine small tidal creeks are naturally stressful environments where salinity, temperature, and oxygen supply fluctuate widely, forcing fish and shrimp to survive near the limits of their tolerance during extreme summer conditions. The small size and physiology of larvae and juveniles of many prey species may allow them to survive in areas where larger predators cannot.
- As nearby land is converted to residential, commercial, or industrial uses, conditions in tidal creeks change markedly. The creeks environments become even more highly stressed for the creatures living there, and less suitable as nursery grounds. Salinity levels vary more erratically, there is more toxic contamination in sediments, and the health and vigor of individual animals decline.
- Small tidal creeks act as conduits for carrying upland pollutants into the estuary. The intensity of land use, reflected by the amount of impervious surfaces (paved roads, roofs, etc.), increases stormwater runoff into small tidal creeks, changing the water chemistry of the creeks and increasing contamination. Researchers discovered that this process introduces additional environmental variability and can increase stresses to the point that even the resilient juvenile creatures in the small tidal creeks cannot survive. Researchers found that there are more species of creek-dwelling creatures in forested creeks than in those near urban/suburban areas. This correlated with the amount of impervious surface surrounding the creeks, with the most marked changes occurring when impervious surfaces cover 30+% of the drainage area.
- Chemical Contaminants included polychyclic aromatic hydrocarbons (from road runoff), Chlordane (termiticide), DDT, and several trace metals (Cr. Hg, Cu) primarily associated with industrial development.

Related work on the variability of estuarine creeks was carried out by Dr. Phil Dustan of the University of Charleston, Dr. Hank McKellar from the University of South Carolina, and others. Their work was designed to arrive at a better understanding of the coupling between land and creek by monitoring fine scale changes in water quality. Creeks in developed areas were compared to creeks near pristine watersheds. They found that stormwater runoff entered the urbanized estuary quickly, causing sharp changes in water salinity and other parameters. Rainfall and runoff in the less developed watersheds had a much less drastic effect on conditions in creeks.

The Tidal Creek Project improved scientific understanding of the intimate relationship between land use and the biological health of the estuarine environment. Plans are already underway to continue tidal creek research, enlarge monitoring programs, and develop new techniques for the protection and preservation of these environments through the cooperative efforts of federal, state, and local managers.

THE BELLE HALL PLANTATION CHARRETTE

The Belle Hall Plantation Charrette investigated the environmental impact of different development designs for a 583-acre tract of land, named Belle Hall Plantation, in the Town of Mount Pleasant. The urban design firm of Dover, Kohl & Partners led a three-day exercise, or charrette, in which the participants designed two development scenarios, one based on typical urban sprawl patterns and one based on traditional town, or neotraditional, development. Charrette participants included planners from the Town of Mount Pleasant and Charleston County, DHEC/OCRM staff, private sector engineers, architects, developers, ecologists, researchers from the Jones Ecological Research Center, and graduate students from Clemson University.

Design alternatives had to be feasible in terms of land planning (existing regulations/ standard practices) and business planning (financing and scheduling, market demand, etc.). Three scenarios were evaluated: Undeveloped, Town, and Sprawl. The Sprawl scenario was based on several existing developments in the area, containing mostly single family detached homes with some higher density housing, large lots and wide streets, cul de sacs, and a separate "power center" commercial area that would consist of a large retail outlet and a grocery store. Design principles for the Town scenario were based on examples from Savannah, Downtown Charleston, and the Old Village in Mount Pleasant. The amount of residential, office, commercial, and industrial space are the same as in the Sprawl scenario, but the land uses have been organized differently: 1.The lots are smaller and residential densities are higher. 2. There are more mixed-use areas with residential and commercial land uses blended together. For example, some of the commercial areas are two-story buildings with a store on the bottom and a residence on the second floor. 3. This scenario leaves most of the land in its natural state and conserves open space. Preservation of open space in the Town scenario also provided much greater opportunities for the protection of biological habitat and such amenities as walkways and viewscapes.

A detailed spatial model (the Agricultural Nonpoint Source 3.65 model) was used to compare the impacts of the Sprawl and Town designs on pollutant loading from Belle Hall. With the amounts and locations of retention and detention ponds for both scenarios, researchers determined that both development scenarios would likely be in compliance with the necessary stormwater regulations.

When compared with the "Undeveloped" scenario, land development was found to increase the amount of surface runoff, sediment loading, and nutrient loading into the receiving waterbody and increase the resultant chemical oxygen demand (COD) in the water. However, water flowing from the project area to the nearby creeks and marshes would be far less polluted under the Town scenario than the Sprawl pattern because the Town pattern provided more open space between the development and the receiving waterbody. The placement and overall reduction of impervious surfaces (roofs, streets, sidewalks) in the Town scenario meant that rainwater would be more likely to infiltrate into the grass and soil and less likely to move across the land as runoff, carrying oil, chemicals, or other pollutants into the creeks and ponds.

Other results of the modeling:

> The Sprawl scenario had eight times greater runoff than the undeveloped watershed and 43% more than the Town scenario. The differences in runoff were conservative estimates because they did not include the application of fertilizers, which would make the differences between the Town and Sprawl developments even larger.

> The Sprawl scenario had three times greater sediment loads than the Town scenario and ten times greater sediment loads than the undeveloped watershed.

> Surface waters that were routed through detention ponds and flowed across vegetated areas (e.g. buffers and undeveloped land) had lower flows and reduced sediment loads.

The study determined that when considering a "town center" design for stormwater management, careful attention must be paid to its location relative to receiving waters. The town center had the most dense and impervious areas of development, so open space between a development and the water body must be preserved to trap sediments, nitrogen, and phosphorus before these loadings enter surface waters.

An analysis was also conducted of the development costs associated with the two scenarios. The Sprawl scenario would contain 19,750 linear feet of streets vs only 9,850 for the Town scenario. Infrastructure (pavement, curb and gutter, sidewalk, sewer, and waterline) costs for the average Sprawl scenario lot were found to be double that of the average Town scenario lot: $7,000 vs $3,500. Local government services such as fire protection and garbage collection would also be less expensive in the Town since less area would be serviced.

METROPOLITAN CHARLESTON 1990-2015

The Harbor Project took part in a two-year study of development trends and projections in Metropolitan Charleston, called the *Metro Charleston 1990-2015* project. The lead agency for the study was the Berkeley-Charleston-Dorchester Council of Governments (COG). The South Carolina departments of Transportation and Commerce also participated. The work incorporated the collective experience of planners from three counties and eleven cities and towns, as well as officials from school systems, public utilities and special service districts.

In 1990, there were more than half a million people living in the tri-county region. It was the fastest-growing major metropolitan area in South Carolina between 1980 and 1990 accounting for one-fifth of the total population growth in the state. Demographers and economic developers agreed that the region would continue to be a growth center into the twenty-first century.

The *Metro Charleston 1990-2015* project was designed to apply planning methodologies to the problem of understanding urban change. The work involved constructing complex computer files of subdivision plans, business locations, wetlands, vacant land, schools, demographic characteristics, and other factors. Region-wide planning in the tri-county area is vast and diverse, and must necessarily proceed with attention to how it will affect life in the neighborhoods and localities that, taken together, form the whole. More than 500 small areas were used in the project as geographic building blocks to derive regional trends and projections. Planners used computer mapping programs to gain new understandings of the relationships between economic centers.

This project created a future land use model of the metro area using geographic information system (GIS) technology. It also developed a detailed spatial analysis of retail sales patterns; compiled a full inventory of local, state, and federal employment by location; mapped the sites of some 13,000 business locations by type of business and number of employees; and created a regional map of more than 400 current or planned residential development and commercial/industrial sites.

The results of this work, combined with the detailed representation of vacant, developable parcels of land from aerial photography, form the basis for location-specific watershed planning, including mitigation banks, greenspacing, habitat corridors, and conservation areas. The findings of Metro Charleston 1990-2015 were used in the long-range Capital Improvement planning of the SC Department of Transportation, in the Section 208 Regional Water Quality Management Plan, and planning processes carried out by local school districts and library systems.

THE WATER QUALITY MODEL

One of the focal points of the CHP was the development of a wasteload allocation water quality model for the Charleston Harbor watershed. Wasteload allocation models allow planners and decision makers to manage point source discharges and other potential water quality impacts on surface waters. These mathematical simulation models are among the best tools for analyzing water quality issues. They are economical, allow the representation of detailed hydrologic systems, permit the incorporation of spatially distributed information, represent detailed physical and biological processes, and require modest empirical data gathering for calibration and validation.

The CHP water quality modeling project was developed by the task forces to fulfill a community need for an improved model for water quality management and planning. Many NPDES permit holders, academic experts, and citizens agreed that an improvement over the existing, steady-state, one dimensional DHEC model was needed.

Several agencies and institutions took part in data collection, analysis, model design, and calibration work. The CHP formed a multi-disciplinary team of individuals from within the state who possesed nationally recognized expertise. The modeling project offered the CHP the opportunity to develop and operate this important water quality management tool locally. The CHP decided to have the end user of the model, DHEC-Bureau of Water, intimately involved from the beginning to maximize the technical transfer of the study. Data collection took place from 1992 through 1995, and model development lasted through 1998.

It was decided early in the process that model development should focus on models readily available to and usable by water-resource managers. In order to meet this requirement, attempts were made to modify several models already in use. Initially, the modeling effort was designed around three existing models, which were to be linked to obtain results for the entire system. The original study plan proposed that one-dimensional models be used for the Ashley, Cooper, and Wando rivers and a three dimensional model be used for the lower reaches of the tributary rivers and the harbor. Unfortunately, the linkage between the various models proved to be unsatisfactory, and it was decided to scale back and concentrate on the three river systems, leaving the harbor section for later model development. In the end, the team delivered an operational water quality model representing the Cooper and Wando rivers, and later a separate model for the Ashley.

While there is no one overreaching model that explains the complex interactions of the three river systems and the harbor in a three-dimensional format, these models are a significant improvement over the existing models used to allocate wastewater loads. They have been accepted by DHEC-BOW and are being used to evaluate future wastewater allocations. Model development can never be considered “finished”, and as our knowledge of the natural systems involved increases and computer technology improves, the models will also improve.

RECOMMENDATIONS

Over several months, twelve task forces, totaling more than 200 individuals, met and discussed issues of importance to the well being of the Charleston Harbor estuary. From these discussions,they identified central issues and designed and funded research to address specific concerns. Focus groups of researchers and selected task force and Management Committee members then synthesized the information from the research into discrete recommendations for action. The Management Committee further refined these into the following recommendations. These recommendations represent much work by many individuals, both in and out of government, and form the basis for action to protect the natural and cultural resources of the Charleston Harbor Estuary.

Each recommendation details, the action needed to accomplish a specific task and gives the background or reasoning behind a particular action item. Each recommendation also includes measurable goals, which both outline steps to be followed in accomplishing the action and can be used to measure success.The agencies or organizations that will play a central role in accomplishing the tasks are also identified. Staff members of DHEC/OCRM will be assigned oversight of each of the action items and made responsible for seeing that they move forward.

STATE OF THE HARBOR PROGRAM

Establish a State of the Harbor program

ACTION:

Establish a State of the Harbor program to ensure that the process of assessing, monitoring, and implementing environmental protection techniques within the Charleston Harbor watershed is an ongoing process.

BACKGROUND:

The Charleston Harbor project was initiated to better manage watershed resources and to minimize resource degradation caused by population growth. It was recognized that one of the main hindrances to achieving this goal was the lack of coordination in overall resource protection. Existing regulatory programs were not established or equipped to deal with problems caused by growth. Resource protection was fragmented among a variety of agencies, with local governments not being aware of their role through their control of land use. As has happened in other areas, the result was a piecemeal degradation of resources, with no mechanism to deal with cumulative impacts.

The CHP has identified the threats to the resources of the watershed and has conducted research to identify solutions to the threats. There is now the need for an organization to oversee and coordinate the various activities and recommendations which have come from this effort. A State of the Harbor report to the community will serve to focus attention on a broad agenda of concerted action. Since local government officials play a crucial role in watershed management decisions, the State of the Harbor Report will examine issues and developments from the standpoint of cities, counties, and districts, as well as the long-established purview of state and federal agencies. The State of the Harbor Program will provide administrative support for long-

term cooperative watershed planning, periodic special reports, and the publication of the full State of the Harbor report every five years.

MEASURABLE GOALS:

Develop a five year plan with specific measurable goals.

Develop ways to measure the effectiveness of resource management policies.

Establish the Management Committee of the CHP as the manager of the State of the Harbor Program.

Produce a yearly report on progress.

Develop an applied research program, in coordination with existing efforts, supported by computer mapping, archiving, and database management, to determine the impacts of urbanization on water quality. As part of this it will be necessary to;

a) Identify and catalog existing research programs and projects.

b) Establish a task force to evaluate and make recommendations on the appropriate mechanisms to conduct the applied research program. Members should include Sea Grant, DHEC, DNR, the state's colleges, USGS, NOAA-National Ocean Service (NOS) and representatives from private groups and local governments.

c) Develop a list of specific research needs related to the water and sediment quality impacts of urbanization.

d) Identify funding sources for implementation of the recommendations and goals of the task force and develop a grant proposal to begin such an effort.

f) Conduct a literature review of research on the impacts of urbanization on water and sediment quality.

Evaluate current research and encourage new research on the impacts of pollutants associated with runoff, contaminated sediments, and the physical effects of water flow on marine fauna.

IMPLEMENTATION:

DHEC/OCRM, Sea Grant

Cooperate with other agencies' planning cycles

ACTION:

Cooperate with other agencies in the context of parallel planning cycles to insure that maximum coordination can take place.

BACKGROUND:

Existing resource protection is fragmented among a variety of federal and state agencies, and local governments; all of which have some sort of planning process to achieve their goals. For example, both DHEC and DNR develop strategic plans for environmental protection every five years, and the Berkeley-Charleston-Dorchester Council of Governments is required by law to update tri-county transportation and wastewater facilities plans at five-year intervals. Many of the key factors for watershed management are contained in these planning programs. Currently there is little coordination among these various governmental entities in developing planning goals, writing plans, or scheduling projects. By synchronizing the planning cycles, related public

policies can be reviewed and renewed as parts of a connected whole. Cooperation among the various groups would greatly improve efficiency and avoid duplication and even instances of government entities working at cross purposes. The proposed State of the Harbor Program would be in a unique position to help to coordinate this endeavor.

MEASURABLE GOALS:

Identify other agencies' relevant plans, their associated schedules, and their key contacts and establish a coordination process as a component part of the five year plan.

IMPLEMENTATION:

DHEC-OCRM

Provide technical assistance to local governments and government agencies

ACTION:

Provide local governments and government agencies with research findings and expert advice for the application of science-based management techniques in the development of policies affecting Charleston Harbor resources and water quality.

BACKGROUND:

Often, governments are faced with resource management issues with which they have no in-house technical expertise. It should be the role of the coastal zone management agency, along with Sea Grant and DNR, to coordinate research on questions of resource management and distribute the technical data and provide expertise to those agencies that need it. Local governments in particular are in need of this service. Traditionally they have not recognized their role in resource protection, believing it to be the role of federal and state agencies. In truth, they make the land use decisions which fundamentally affect the development patterns for the coastal zone. However, they are not staffed or otherwise equipped to deal with resource management issues and must have technical help if they are to make wise land use decisions that incorporate resource protection techniques.

MEASURABLE GOALS:

Identify effective land use policies for protecting area waterways and wetlands.

Provide assistance in producing appropriate elements of the comprehensive plans of five local communities each year.

Develop a framework for other public agencies to provide expertise and technical advice to local governments.

Establish a clearinghouse to facilitate information exchange.

Develop a web page to disseminate information to the public.

Convert technical information into layman's terms that are easily comprehended by the public to be readily accessible.

IMPLEMENTATION:

DHEC-OCRM&BOW, Sea Grant

PUBLIC OUTREACH

Conduct educational campaigns

ACTION:

Conduct educational campaigns on the importance of the Charleston Harbor Watershed

BACKGROUND:

Citizen involvement is important to any effort to protect the resources of Charleston Harbor. In order to maximize citizen input, it is necessary to educate the public about the existing resources, their value and sensitivity. The more people understand about the harbor's environment, the more support there will be for its protection. This understanding is particularly important for the more than 100,000 students in the study area because these students will become the decision makers of tomorrow.

MEASURABLE GOALS:

Develop and implement an educational campaign that would include:

Use of the shellfish resources of the Charleston harbor watershed

A brochure on cull-in-place harvesting methods for oysters and recommended harvesting methods for clams.

Guidelines and a brochure for best development practices for distribution to stakeholders that include information detailing the impacts associated with human development of the landscape.

Identify and develop a steering committee.

Make the education campaign a component of the OCRM web page.

Develop a campaign to educate the public on the use of the fishery resources of the Charleston Harbor watershed.

Design and conduct one workshop a year to educate engineers, developers, advocacy groups, and municipal officials on new development models and techniques that minimize the impacts of growth on watershed resources.

Use recreational facilities and programs to educate the public to the benefits and values of natural ecological systems, and to direct the public from over-used facilities to under-used sites. Existing kiosks at boat ramps are one method to do this. The goal should be to decrease use at over-utilized facilities by 20%, and increase use at underutilized facilities by 25%.

Encourage activities in particular areas based on the best uses of a waterbody, such as its value for fishing, canoeing, water skiing, etc.

Develop education materials on the importance of green space to foster public discussion on green space issues.

IMPLEMENTATION:

DHEC-OCRM, Sea Grant, DNR, CCPW,NERRs, College of Charleston Science Hub, Charleston Aquarium

Create interpretative program for historic sites

ACTION:

Create interpretative and educational programs for identified historic properties, including significant submerged and archeological sites, buildings, districts, landscapes, and vistas.

BACKGROUND:

The CHP area contains some of the most significant historic and archeological sites in the United States. The area's economy is heavily influenced by its cultural resources and their preservation and interpretation are important factors in the overall "quality of life" of the regional community. While scenic views, and beach and ocean recreation are important attractions, historic resources differentiate Charleston from other coastal cities. In the CHP area, programs to study, preserve, and interpret historic resources therefore have a necessary sense of urgency. The CHP area has a large number of institutions and organizations that contribute to the preservation and interpretation of cultural resources. Support for cultural resource protection comes from an informed citizen base. As development threatens these resources, management decisions become increasingly complex and important. Education of the general public will lead to more informed and better decisions regarding cultural resources by managers and political leaders.

MEASURABLE GOALS:

Work with local governments, SHPO, local historic societies, PRC, developers, and interested parties to coordinate appropriate programs for sites.

Conduct workshops to pull participants together.

IMPLEMENTATION:

SHPO, PRT, CCPRC, DHEC-OCRM, Local Historic Societies, Heritage Trust, Charleston Downtown Group, Local School Districts, Heritage Trust.

BIOLOGICAL RESOURCES

Characterize small tidal creeks

ACTION

Categorize small tidal creeks according to physical and biological characteristics of the creek to ensure proper management.

BACKGROUND

Coastal marshes are among the most productive ecosystems in the world, in part because salt marshes are major producers of detritus (broken down plant material) which supports productivity in adjacent estuaries as much or more than phytoplankton-based production. Meandering shallow tidal creeks that branch from larger creeks and rivers in the Charleston Harbor estuary are vital to the ecology of the estuary because they provide nursery habitat for numerous species of fish, crab, and shrimp.

The assumption that main channel dissolved oxygen (DO) levels are representative of small creek DO is inaccurate. Small tidal creeks (less than 3 ft MLW) are a special category of estuarine habitat. Primary and smaller creeks off the main stem of rivers exhibit water quality dynamics that differ from larger rivers (different flushing rates, depths, and relative amounts of stormwater loading). Due to lower flushing rates, smaller tidal creeks are more susceptible than main rivers to human induced changes in water quality, including more frequent extreme fluctuations in salinity, changes in bottom sediments, and alterations in dissolved oxygen dynamics.

Since small tidal creeks are more susceptible to eutrophication than adjacent rivers, they require more specific management criteria. These creeks are the primary nursery areas in the estuary. It has been theorized that the highly variable physical conditions (salinity, temperature, and dissolved oxygen) in these creeks cannot be tolerated by predators but can be tolerated by small juvenile organisms. However, even these creatures approach their physiological limit in these highly productive habitats under pristine conditions. Additional stresses to these habitats from nutrients and contaminants in stormwater runoff from upland development can move conditions in the water beyond the tolerance of the juvenile organisms and degrade nursery functions. Impacts are due, in large part, to changes in hydrology related to increases in impervious surfaces in the adjacent upland. These hydrologic changes are reflected in increased runoff entering the headwaters and are largely irreversible, although even the most heavily developed industrial creeks studied by CHP researchers provided some nursery function.

MEASURABLE GOALS

Establish a Tidal Creek task force which would:

- Develop a tidal creek characterization method
- Develop an inventory of small tidal creeks
- Define management criteria specific to small tidal creeks.
  - A) establish nutrient criteria
  - B) identify chlorophyll action levels
  - C) identify eutrophication potential

IMPLEMENTATION: DHEC, DNR

Develop a rice field succession plan for Upper Cooper River

ACTION:

Develop a basin-level plan to address rice field succession in the upper Cooper River.

BACKGROUND:

The upper Cooper River has been greatly altered over the last 300 years. The tidally influenced, freshwater marshes and swamps were modified in the 18th and 19th centuries for the cultivation of rice, with dikes and ditches controlling water levels. It is generally believed this rice cultivation technology and skills were brought to the lowcounty from the Gold Coast of Africa. Africans had been growing rice under similar conditions for more than a thousand years. As slaves, they modified the landscapes and cultivated the rice, often in the absence of the white plantation owner. This productive labor supply was lost with the Civil War. Storms and mechanization elsewhere contributed to the end of the rice cultivation in the lowcountry in the 1920'sThe rice fields were largely abandoned and breaches in the dikes allowed renewed tidal flow which initiated aquatic succession.

In 1941, further manmade alterations came to this system when the United States Army Corps of Engineers completed the Santee-Cooper Hydroelectric Project. This diverted the flow of the Santee River into the Cooper, transforming the Cooper from a tidal slough with an average monthly flow of 417 cubic feet per second to a riverine system with a flow of 17,513 cubic feet per second . This project, more than any other human-related or natural change, has had the greatest long-term effect on the Charleston Harbor Estuary.

When it was concluded that, instead of reducing siltation in Charleston Harbor as planned the Santee-Cooper Project actually increased siltation, approximately 70% of the Santee-Cooper drainage water was directed back into the Santee. This was called the Cooper River Rediversion Project, and was completed in 1985. Water flow into the Cooper was reduced to approximately 4518 cubic feet per second, and caused a drop in water levels of about 5.9 inches in the upper Cooper River, relative to post 1941 elevations.

All of these changes have had a significant effect on the wetlands bordering the Cooper River. As a result of differences in cultivation history, management practices, time since abandonment, water depth and duration of inundation, salinity, and potentially other factors, the old rice fields are nowin a variety of successional states. Research, some funded by the CHP, found that lowering of the water levels has accelerated vegetational succession in the remnant rice fields of the upper Cooper River. Marsh and shallow open water areas are changing to a tree cover climax ecosystem, so functions and values associated with river swamp will increase while other functions associated with earlier successional stages will be lost. Functions being lost may be critical to the health and value of the Cooper River drainage basin. Overall, succession in the rice fields may result in a loss of habitat diversity to the watershed.

MEASURABLE GOALS:

Establish a Ricefield Committee.

Develop a basin plan to address rice field succession in the upper Cooper River.

IMPLEMENTATION:

DHEC-OCRM, Sea Grant

Develop molluscan shellfish management plans for the CHP watershed

ACTION:

Develop molluscan shellfish management plans (SMP) for the CHP area to ensure that shellfish resources are restored and sustained at levels that balance maintenance of water quality, estuarine nursery functions, and human uses.

BACKGROUND:

Oysters, clams and whelks are the three species of molluscan shellfish of major economic and recreational importance found in the Charleston Harbor Estuary. Since 1986, commercial oyster landings have risen steadily, peaking during the 1993/94 season, with estimated recreational harvests equaling about 43% of the commercial landings. Commercial landings of wild clams has remained relatively stable since 1986, while clam mariculture has dramatically increased. Whelk production has remained stable for the last six years, with the landings in Charleston far exceeding landings in other parts of the state.

Although shellfish are abundant throughout Charleston Harbor, an oyster survey conducted by the federal government over one hundred years ago (1890-1891) reveals that the resource was once significantly more prevalent. Being sedentary filter feeders, mollusks are more vulnerable to water pollution than other marine animals. Because of this, much of the estuary is closed to harvesting due to either high fecal coliform counts or administrative closures around activities deemed to have the potential for contamination (i.e. marinas, and wastewater and industrial discharges). Threats to the shellfish resources of the Charleston Harbor Estuary include, dredging, heavy boat traffic, urban pollutants, sedimentation, overfishing, diseases, and highly variable, short-term fluctuations in salinity caused by upland stormwater runoff.

Both DHEC and DNR have responsibility for the shellfish resource, but, currently, there is no overall management plan. DHEC is concerned with the public health aspects of shellfish consumption and marketing, and, through the OCRM program, the physical disruption of shellfish beds. DNR has traditionally focused on the permitting of commercial harvesters, the regulation of recreational users, and designating between public and commercial shellfish grounds. There have also been some attempts to relocate stock from areas closed to shellfish harvesting to areas which are open, but this program has never been adequately funded. DHEC and DNR are evaluating shellfish restoration priorities, but there is no concerted effort to restore areas now closed, , reduce user conflicts, or recycle used shell for cultch (bedding or substrate) material.

MEASURABLE GOALS:

Develop a protocol to determine when over-harvesting has occurred.

Establish appropriate management options for over-harvesting areas including moratoria on harvesting, harvest-effort limitations, stock enhancement, etc.

Evaluate the benefits and disadvantages of limited entry into recreational and commercial fisheries, and periodic bed closures as tools for ensuring that shellfish populations are not over-harvested.

Determine if the uses of oyster shell can and should be limited to replanting as cultch for restoration of oyster populations.

Develop an incentive program to encourage the public and restaurants to recycle oyster shell.

Conduct a survey to assess the public's knowledge and use of shellfish resources of Charleston Harbor.

Develop species profiles and assessments on *Busycon* and other shellfish species that are periodically harvested or are ecologically important.

Work with existing DHEC and DNR shellfish restoration committee to develop plans and identify candidate sites for shellfish restoration.

IMPLEMENTATION:

DNR, DHEC

Stabilize Cooper River waterflows

ACTION:

Stabilize Cooper River flows to the highest degree possible and increase water levels as much as is reasonable, particularly during the months of January through May, and in consideration of impacts on siltation rates.

BACKGROUND:

The Cooper River serves as a spawning/nursery habitat and provides a migratory route for many important marine and aquatic fauna. Under current agreement, the water released into the Cooper River at the Pinopolis Dam must average about 4,500 cubic feet per second (cfs) for the week. Actual flow, however, on a given day may be over twice the required average (not to exceed 10,000 cfs) or near zero. Additionally, flow rates can be highly variable within a day. This irregular flow pattern creates an unnaturally high variation in water level that frequently creates a hostile environment for aquatic biota in the river.

Anadromous species such as Atlantic sturgeon and the endangered shortnose sturgeon occur in the Cooper River. Both species of sturgeon are known to spawn directly below the dam. Sturgeon begin spawning in January and continue through April with a peak appearing to occur in March. It also appears that shortnose sturgeon spawn earlier in the season than do Atlantic sturgeon. Relatively little is known about sturgeon spawning behavior and specific spawning habitat. However, it appears that clean, flowing water that is well oxygenated is very important. The eggs are demersal and adhesive, meaning they stick to structure or the bottom. Reduced flow rates soon after spawning could result in increased siltation which could smother eggs or cause dissolved oxygen levels to fall.

American shad, Hickory shad, and blueback herring are species common to the Cooper River, and by all indications, they are less abundant since water flows were reduced with rediversion. Numbers of fish, primarily herring, passing through the fish lift declined by 75% or more in the years following rediversion. A thriving commercial herring fishery in the Cooper River has disappeared and relocated in the Santee River tailrace because of decreased catch rates in the Cooper. Shad catch rates in the recreational hook and line fishery also declined substantially after flow rates were reduced, but a valuable hook and line shad fishery still thrives in the tailrace canal below Pinopolis Dam. Shad, like sturgeon, require clean, flowing water for optimal spawning habitat and survival of eggs, larvae and juveniles. Herring eggs are adhesive and spawning generally occurs in shallow water near plants, rocks, or other substrates. Good water quality is required for optimal survival of all growth stages of herring. Studies in the Connecticut River have shown that year class strength of both shad and herring is largely

determined by survival rates of larvae and juveniles, and survival is positively correlated to stable river flows during spring and summer.

Fishes that spawn in shallow, near-shore waters are vulnerable to variable flow rates that cause drastic water level fluctuations. Mortality of eggs and fry following draw-down has been documented for many species, including several locally important sunfish species. Falling water levels result in a loss of available habitat and can cause direct mortality of eggs. Rapidly receding waters may lead to nest desertion, disrupt normal spawning behavior, strand larvae and juveniles, or sweep them downriver. Nest desertion permits predation on unprotected eggs and larvae and usually results in complete failure of the nest. Additionally, fluctuating water levels prior to spawning may cause reabsorption of eggs by the female. Optimal conditions include relatively high, stable water levels, particularly during spring, thus providing shallow habitats in old rice fields and along river banks.

Forage fish and invertebrates also thrive when the amplitude of water level fluctuations is reduced. It has been observed that important food for shad were higher in abundance and more persistent when river discharge rates were more stable. Erratic fluctuations in river flow during spring have been found to disrupt patch formation of riverine zooplankton-important food for juvenile fishes. In addition, irregular river flow can reduce water transparency, which retards phytoplankton, the primary food source for herbivorous zooplankton.

MEASURABLE GOALS:

Establish a committee of affected parties to negotiate a new agreement regulating water flows.

Establish a new flow management regime with the next FERC permit renewal.

Evaluate the need to enhance upstream and downstream passage for anadromous species.

Evaluate impacts of flow on water quality, particularly NPDES permits and loading models for the harbor.

IMPLEMENTATION:

DNR, DHEC, COE, NMFS, SPA, SANTEE-COOPER

Establish GAPC designation for sensitive fish habitats

ACTION:

Identify and designate unique and sensitive estuarine fish habitats as Geographic Areas of Particular Concern (GAPC's) and establish management policies to protect them.

BACKGROUND:

All creeks function as nursery grounds, with finfish being the most abundant in the brackish creeks. Spot, Atlantic croaker, red drum, spotted seatrout, flounder, and catfish inhabit the estuary and are recreationally important. Declines in the populations of some commercially and recreationally important inshore and offshore finfish species may be related to habitat degradation within the estuary.

In order to preserve sensitive fish habitats, they must first be identified. Some work on this has been done. Research has shown that large aggregations of seatrout are seasonally found around structures exposed to high velocity currents, and that "The Grillage" area near the Charleston jetties is a spawning area for red drum. Sound detection equipment has also

documented concentrations of seatrout in main shipping channels within the harbor. Dredging and other types of disruptive activities could either be directed away from these areas, or restricted as to season.

MEASURABLE GOALS:

Identify and map all unique and sensitive estuarine fish habitats.
Designate these areas as GAPCs under the SC Coastal Zone Management program.
Develop appropriate management measures for protection of these habitats.

IMPLEMENTATION:

DNR, DHEC-OCRM, NMFS

Develop and promote measures to protect colonial waterbirds

ACTION:

Implement measures to protect colonial waterbirds

BACKGROUND:

Colonial waterbirds are a conspicuous and important component of coastal wetland ecosystems. Because of their diverse foraging and nesting requirements, waterbirds serve as valuable indicators of the health of South Carolina's wetlands.

Thirteen species of wading birds, eleven species of seabirds, and four species of shorebirds have been documented nesting in the CHP area. During a statewide survey of waterbird colonies in 1994, DNR located 59 wading bird and 29 seabird colonies in Charleston and Berkeley counties, containing totals of 11,520 and 19,800 nests, respectively. Although the Charleston Harbor Estuary still supports substantial waterbird populations, recent surveys suggest that population size has been reduced from historic levels.

Seabirds and shorebirds nest primarily on the ground on offshore sandbars, barrier island beaches, man-made dredge spoil islands, and shell banks. However, Least Terns also nest on large flat rooftops located near foraging sites. Wading birds are more versatile, building nests in vegetation on sandbars and man-made spoil islands, as well as in emergent aquatic shrubs and trees in swamps, ponds, and man-made impoundments. In addition, Great Blue Herons nest singly or in small groups in mature pines on small hammocks or along the marsh-upland edge.

Colonial waterbirds exhibit a large range of habitat and prey preferences. Wading birds generally forage by standing in shallow water along creek, river, and bay shorelines. By contrast, seabirds feed primarily on the wing, often diving into the water or skimming across the surface to catch their prey.

Although there are numerous threats to the health of waterbird populations, the greatest overall threat is the reduction in the quantity and quality of habitat. The reduction in nesting, roosting and foraging habitats limits the number of waterbirds that can be sustained within the study area. Wetlands are being altered or destroyed due to increasing residential, commercial, and industrial development, as well as changing forestry practices. Shrub habitat on pond or impoundment edges is often eliminated for aesthetic reasons. In addition to the direct loss of nesting sites, tree and shrub-nesting wading birds are forced to abandon nesting sites when the hydrology is altered. Beach nourishment activity has altered longshore currents and eroded an

important sand island used as a rookery by pelicans, gulls, and terns. Other nesting sites on sand islands have been impacted by human trespassers into the rookery.

Avian mortality has also been documented due to powerline collisions and entanglements with gill nets, fishing line, and various forms of plastics. Wood storks and other large wading birds are particularly vulnerable to collisions at power line crossings, but when yellow aviation spheres are located on lines, fewer collisions occur.

MEASURABLE GOALS:

Promote buffers to protect colonial water bird nesting and roosting sites. A setback of 300 feet for arboreal nesting sites and 600 feet for ground nesting sites is recommended during the nesting season.

Maintain a buffer of 100 feet around roosting sites. Within these buffers keep the clearing of understory trees and shrubs to a minimum, and protect mature trees and dead snags.

. Do not permit putresible waste landfills within 2 miles of nesting sites to prevent concentrating predators.

Minimize alterations to natural hydrologic patterns in river swamps at colony sites. Restrict timber harvesting to high elevation areas away from deep-water channels.

Encourage impoundment managers, developers, and homeowners associations to manage for colonial water birds.

Promote measures to reduce bird mortality in gill nets and from collisions with power lines.

Work with SCFC to add the management measures to the SC forestry BMP manual.

Produce and distribute a methods manual targeting impoundment managers to aid them in managing for colonial wading birds.

Hold a workshop for impoundment managers on managing for colonial water birds.

Publish and distribute guidelines for designing island bird habitat.

Develop incentives to encourage developers to construct small island habitats.

Develop a GIS data layer showing colony roosting and nesting sites with appropriate setbacks delineated, including a 2 mile radius buffer for landfills.

Distribute a map for each local municipality showing locations of colony roosting and nesting sites and setbacks.

Develop model ordinances to protect colony roosting and nesting sites.

Work with local governments to implement the management measures and get the ordinances adopted.

Reduce gill netting activity that results in high mortality of sea birds.

Sign a MOA with power companies to reduce bird mortality from power lines.

Establish a citizen Bird Watch program similar to the Turtle Watch program.

Map areas to be annexed by local jurisdictions so they can police impacts to bird nesting areas.

Sign MOAs with local governments to establish marine patrols during nesting season.

IMPLEMENTATION:

DNR, DHEC, LOCAL GOVERNMENTS

Develop measures to protect diamondback terrapins

ACTION:

Develop measures to protect aquatic and land-based turtles.

BACKGROUND:

The diamondback terrapin is the only species of turtle in North America that inhabits brackish coastal habitats exclusively. Although hunting made them scarce in the early part of this century, today the diamondback is common. It is widely found in the marshes and marsh tidal creeks of the Charleston Harbor Estuary.

Drowning in crab traps is a common form of mortality that was first observed in the 1940s, but only acknowledged as causing an impact on terrapin populations in the late 1970s. Recent evidence suggests that recreational crabbing activities that result in abandoned or lost traps are responsible for the greatest number of drownings. Solutions for excluding terrapins from crab traps, similar to the turtle excluder devices used by the commercial shrimp industry, acould minimize mortalities.

MEASURABLE GOALS:

Require the use of crab traps that exclude terrapins by developing and distributing a flyer and providing information to local marine educators.

IMPLEMENTATION:

DNR

Protect hydrology of key plant habitats

ACTION:

Adopt policies that prohibit alterations of hydrology of key plant habitats.

BACKGROUND:

A CHP research study produced an inventory of significant botanical natural areas in the tri-county area that may be affected by human activities in the Charleston Harbor estuary. It provides one of the more important habitat descriptions of the regions natural areas and identified eighty significant botanical natural area sites. Significance was based on the following criteria;

Plants listed as endangered by the U. S. Fish and Wildlife Service(USFWS)-Two plants listed as endangered species are known to occur in the study area-*Schwalbea americana L*, (American chaffseed) and *Lindera melissifolia (Walter) Blume* (pondberry).

Plants listed as Category 2 species-These are plants for which information now in possession of the USFWS indicates that proposing to list as endangered or threatened is possibly appropriate, but for which sufficient data on biological vulnerability or threats are not currently available to support proposed rules. There are 13 Category 2 species in the CHP area.

Rare plant communities-Certain plant communities, such as marl forests and longleaf pine savannas, are rare in the study area and the state. This results from either natural

rareness or loss of habitats due to human activities. Preservation of these rare communities is critical to preserve natural diversity.
Significant wetlands-The tri-county area harbors many wetland habitats that are important to the existence of several plant species.
Wilderness Areas-Four wilderness areas occur in the study area. All are found in the Francis Marion National Forest.
Significant sites from the rice culture era of South Carolina-Sites considered to have historical value in preserving the botanical history of the rice industry are identified.
Pristine sites of unusual natural beauty-The study area in the tri-county area is laced with sites of unusual natural beauty that should be preserved for future generations to enjoy.

MEASURABLE GOALS:

Publish the inventory of key plant habitats produced by Richard D. Porcher, Ph.D.
Develop policies to protect these habitats.
Educate local governments about these habitats.
Work to have Penny and Euchaw Creeks designated as scenic rivers.

IMPLEMENTATION:

DHEC-OCRM, DNR, local governments

WATER QUALITY

Determine sources of bacterial contamination in area waters

ACTION:

Use techniques, such as antibiotic resistance, developed by Harbor Project researchers to determine sources of bacterial contamination in area waters.

BACKGROUND:

Several studies conducted by the Harbor Project evaluated the impact of nonpoint source pollution on water quality and aquatic resources. The human utilization of shellfishis particularly sensitive to the impacts of nonpoint source pollution.. Because they can be eaten raw, the waters where they live have to meet the most stringent water quality standards. Levels of bacteria contained in urban runoff are orders of magnitude greater than what can be allowed in shellfish harvesting waters. Unfortunately, current technologies and best management practices for treating runoff are relatively ineffective at reducing bacteria loads to an acceptable level. It is therefore critically important that sources of bacterial contamination be identified and eliminated, or substantially reduced, because this is the only reliable means of treatment. Bacteria in runoff can come from humans, domestic animals or wildlife. Only by determining what the primary source is, can appropriate management actions can be taken.

Local scientists with NOAA-NOS have evaluated several different ways to determine the sources of bacteria in runoff. Currently, the most promising and practical method is one called Multiple Antibiotic Resistance. Bacteria from runoff are exposed to ten different antibiotics. Generally, bacteria from humans are very resistant to most of the antibiotics. Domestic animals' bacteria are resistant to a few of the antibiotics that are commonly prescribed by veterinarians. Wildlife, however, are rarely exposed to antibiotics and therefore bacteria from that source are very sensitive. More work is required before this method can be widely used, but it should give managers a much needed tool for determining where to focus limited resources and management actions.

MEASURABLE GOALS:

Evaluate the need for future research to make this technology useable by DHEC laboratories.

Evaluate the feasibility of Transfering technology to DHEC labs.

Develop and implement a protocol for using the technology in NPS impaired waters.

IMPLEMENTATION:

DHEC, NOAA-NOS

Adopt sediment contaminant criteria

ACTION:

Adopt sediment contaminant criteria.

BACKGROUND:

The estuary contains several "hot spots" where heavy metals and organic compounds in the sediments exceed the low range for toxic effects on estuarine organisms. Many of the chemical contaminants that occur in potentially toxic concentrations in the CHP area are "contaminants of antiquity", such as DDT, PCB's and alpha chlordane which have been present for decades. These chemicals were once used quite heavily, and although they are now banned or highly regulated, concentrations from past usage can still be found at area sites. The primary chemical contaminants from industrial pollution include chromium, copper, lead, and nickel. The most pervasive contemporary source in the Charleston Harbor Project area of industrial pollution appears to be centered in the Shipyard Creek watershed, with sediment concentrations of chromium representing some of the highest concentrations reported anywhere in the world. Other highly impacted sites include Diesel, Brickyard, and Shem creeks, as well as areas adjacent to large roadways and high density urban developments. Chemical contaminants from suburban sources appear to be primarily polycyclic hydrocarbons (PAHs), chlordane, PCBs, and copper.

Spatial comparisons between small tidal creeks, rivers and lower/upper reaches of the Charleston Harbor watershed indicate that the locations of the greatest chemical contamination are the small tidal creek regions, which are also nursery grounds for finfish, crustaceans, and shellfish. Analyses of spatial distribution of contaminant concentrations indicate migration of some chemical contaminants from land-based sources to the mouths of tidal creeks and eventually into larger water channels.

Toxicological analyses of sediments in the CHP area found that almost 22% of harbor sites tested and 16% of sites in upper reaches of the smaller tidal creeks reached levels of contamination which would be considered degraded. Additional toxicity tests found significant reductions in reproductive success of copepods, although no significant adult mortality from industrial or municipal outfall sites was observed. These findings suggest that most toxicity associated with sediment contamination in Charleston Harbor appears to cause chronic problems affecting reproduction. This effect on reproductive success can have serious consequences for the overall abundance and health of the fauna of the CHP ecosystem.

The scientific literature includes numerous different criteria for establishing sediment pollutant standards, and EPA has established sediment criteria for only a few pollutants. Currently there is no method for addressing this problem when contaminated sediments are found. Although there are established criteria for water pollution, with numerical limits dictating when water is considered safe for certain uses, there are only a few for sediment contamination. In the absence of limits for most contaminants, regulators have no tools for requiring cleanup, or effectively and consistently regulating the manipulation of existing sediments. Currently regulators must rely on guidelines which are not universally accepted, and have questionable legal status.

MEASURABLE GOALS:

Conduct a literature review of other state approaches to sediment contaminant criteria, produce a state of the knowledge report on sediment criteria, and apply these findings to Charleston Harbor.

Establish a committee and schedule for developing a state criteria.

Recommend adoption of criteria.

IMPLEMENTATION:

DHEC, DNR, NOS

MONITORING:

Revise water quality and habitat monitoring programs

ACTION:

Maintain and coordinate a coastal water quality and habitat monitoring program with increased emphasis on smaller streams and creeks.

BACKGROUND:

Existing monitoring efforts for the Cooper River and open areas of Charleston Harbor appear to be adequate to document spatial patterns and long-term trends. However, main tributaries and sub-basins, such as the Ashley River and Goose Creek, are characterized by lower rates of estuarine flushing, complex inputs of point sources and nonpoint runoff, and periodic or episodic contraventions of water quality standards. More intensive monitoring is necessary in these systems, especially during the summer months.

A large fraction of the total surface area of the Charleston Harbor Estuary is composed of smaller tidal creeks and inter-tidal wetlands. These areas represent an important habitat for estuarine organisms. Considering the sensitivity of smaller tributaries and tidal creeks to eutrophication and oxygen depletion, these areas require more intensive monitoring, especially during the warm months when freshwater discharge is limited and flushing is reduced. There is an assumption that main channel dissolved oxygen (DO) levels are representative of small creek DO which is inaccurate. Lower flushing rates make the smaller tidal creeks more susceptible to human induced changes in water quality, including more frequent extreme fluctuations in salinity, changes in bottom sediments, and alterations in DO dynamics. The changes in DO levels are of particular concern because the vast majority of the creeks studied by CHP researchers, failed to meet 1996 state DO standards (4mg/l). Creeks draining relatively developed watersheds showed significantly more frequent violations of existing DO standards and appeared to have the greatest exposure to low DO conditions.

Increases in duration and severity of exposure to low DO can result in adverse ecological changes ranging from direct mortalities to shifts in the kinds and abundance of organisms present in the ecosystem. However, existing DO standards for aquatic environments do not appear to be meaningful for small tidal creek habitats, since even undisturbed tidal creeks often are in violation of these standards. It is possible that moderately low DO levels in tidal creeks may serve as a barrier that protects the low DO tolerant juvenile fish and shrimp from their predators. Further research is needed to verify this hypothesis.

At present, current regulatory processes used to establish biological and chemical oxygen demand limits for point and nonpoint source dischargers do not include estimates of the DO needed to preserve and maintain the ecological services provided by tidal creeks and associated salt marshes. We currently do not know if the observed alterations in DO dynamics in developed tidal creeks are associated with increased loading of oxygen consuming material, increased loadings of nutrients (nitrogen and phosphorous) that stimulate excessive growth of primary producers, and/or some other unidentified causes, or whether they are to a large extent natural.

MEASURABLE GOALS:

Amend DHEC's monitoring program. (already completed)
Amend DNR's monitoring program. (already completed)
Monitor small tidal creeks. (underway)
Develop a voluntary program to get local governments, private industry, nonprofits and homeowner's associations to 'adopt-a-creek' and fund additional tidal creek monitoring sites.
Expand the state's small tidal creek monitoring program by 25% by the year 2001.
Establish a 'State of the Creek' section in the State of the Harbor report to publish findings.
Identify outside funding sources to set up monitoring stations.
Research and Develop a DO budget for tidal creeks.
Identify the factors contributing to extremely low DO levels in developed tidal creeks.

IMPLEMENTATION:
DHEC, DNR, LOCAL GOVERNMENTS

Monitor for chlorophyll-a

ACTION:
Implement a regular monitoring network for chlorophyll-a throughout the Charleston Harbor Estuary.

BACKGROUND:
Eutrophication, or overenrichment of nutrients in estuarine waters, is becoming a serious problem nationwide. Nutrients are chemicals essential for plant growth, but during the eutrophication process the fertilizing effect of nutrients in waters causes an overabundance of plant growth. The plants reproduce and grow rapidly, producinge very high levels of oxygen during daylight. During darkness, or periods of reduced light due to cloud cover, the profusion of plants consume more oxygen than they produce, and their respiration, along with that of the animals, drives DO levels lower than normal. Eutrophication fundamentally changes the aquatic environment, which can result in nuisance algae blooms, fish kills, and a variety of other detrimental changes in biological community structure. As human populations impact adjacent waters through nutrient inputs from sewage discharges, nonpoint source runoff, and air pollution, natural nutrient levels are altered.
High algae biomass (chlorophyll-a concentrations) represents an obvious consequence of excessive nutrient loading in sensitive areas. DHEC already uses chlorophyll-a concentrations to monitor trophic conditions in lakes but additional chlorophyll-a monitoring is needed in the estuarine and coastal areas. A chlorophyll-a standard to indicate the need for nutrient loading is also needed.

MEASURABLE GOALS:
Implement DHEC's updated monitoring plan which includes chlorophyll-a sampling in the estuaries.
Identify a funding source to implement the plan.
Apply findings to better management of water quality issues in Charleston Harbor.
IMPLEMENTATION:

DHEC

Require organic nitrogen monitoring on NPDES permits

ACTION:

Require organic nitrogen monitoring on NPDES permits to allow managers to develop estimates of oxygen demand for organic nitrogen.

BACKGROUND:

Point source discharges, permitted under the National Pollution Discharge Elimination System (NPDES), are monitored by the discharger. Monthly water quality data are provided to the South Carolina Department of Health and Environmental Control (DHEC). DHEC reviews these monitoring data to determine compliance with NPDES permitted limits and applies enforcement policies as needed. The NPDES permitting system is designed to control overall pollutant loadings to prevent adverse effects to human health and the environment.

Organic nitrogen is nitrogen that is bound to carbon atoms and is the product of biological activity. Plants and animals bind nitrogen and carbon into large complex molecules. These molecules are typically less reactive and the nitrogen is less biologically available than the inorganic forms of nitrogen. Therefore, organic nitrogen may not be a major contributor to BOD, but more information on the form of organic nitrogen in the system is needed. Water quality modeling efforts for wasteload allocations assume that a certain percentage of organic nitrogen is directly converted to ammonia. More specific data on organic nitrogen forms in the system would help improve modeling accuracy.Although organic nitrogen sources arise from both point and nonpoint source discharges,the high level of organic nitrogen in the Cooper is thought to be from the large wetlands and erodible soils.

Some contribution of organic nitrogen is attributable to sewage discharges, but dischargers do not monitor organic nitrogen and consequently the proportions can not be determined. In order to develop an overall Harbor nutrient budget, , point source data on organic nitrogen is needed.

MEASURABLE GOALS:

Revise permitting or certification requirements for NPDES permits in coastal zone to require monitoring of various forms of organic nitrogen.

Begin modeling organic nitrogen with accumulated data.

IMPLEMENTATION:

DHEC, Universities

Establish a national atmospheric deposition pollution sampling site(s)

ACTION:

Seek funding to establish and maintain a National Atmospheric Deposition pollution sampling sites(s) in Charleston to collect wet and dry inputs of pollutants from atmospheric sources.

BACKGROUND:

The emphasis of non-point source pollution is usually ground-based. Often ignored in this discussion is the contribution of atmospheric deposition. This is despite the fact that tons of pollutants are released into the air everyday around the Charleston Harbor watershed by industry, automobiles and other sources. Atmospheric aerosols and particulates absorb trace metals and nutrients that then act as cloud condensation nuclei. These nuclei continue to grow and eventually fall to the earth as rain, carrying the contaminants earthward.

The CHP conducted basic research on the impact of atmospheric deposition, but the contribution of air pollutants to surface water pollution is still not clearly understood. Additional monitoring is necessary to document the significance of atmospheric pollution on surface waters.

MEASURABLE GOALS:

Research available literature on atmospheric deposition sampling.

Establish a committee to design a limited sampling program to determine whether atmospheric deposition is a significant contributor of pollutant loads to the Harbor.

Identify potential funding sources and conduct the sampling program.

Evaluate the sampling results and make recommendations regarding the need for long-term monitoring.

Install and maintain NADP sites to evaluate;

1. Nitrogen series (~$10,000 per installation, $5,000 annually to monitor)
2. Mercury (~$20,000 per installation, $8,000 annually to monitor)

IMPLEMENTATION:

DHEC EPA

Increase monitoring in waters classified for swimming

ACTION:

Seek funding for increased monitoring in estuarine waters that are classified for primary contact recreation (swimming) to ensure public health is protected.

BACKGROUND:

As the region grows, appropriate local and state agencies should monitor the degradation of water resources and share the information with those agencies responsible for providing recreational services and facilities. Demand is increasing for outdoor recreation, but recreational sites are limited. Degradation of the resource from pollution will diminish recreational opportunities. It is important to monitor water quality at these sites to insure problems are discovered promptly.

MEASURABLE GOALS:

Identify the most heavily used swimming waters in the area.

Develop a proposal and budget for monitoring these areas as required to evaluate the water quality standards for swimming .

Fund and monitor the identified areas.

Evaluate public notification process and information needs of the public.

Produce a map showing swimming areas.

IMPLEMENTATION:

DHEC, local governments

NONPOINT SOURCE:

Quantify nonpoint source loads

ACTION:

Quantify and project nonpoint source (NPS) loads for inclusion in wasteload allocation models and TMDL development.

BACKGROUND:

Stormwater runoff from agricultural and urban areas is often characterized by high concentrations of biological oxygen demand (BOD), fecal coliform bacteria, nutrients, and toxic substances. As part of CHP research, two simulation models were developed to predict NPS inputs of water and nutrients based on drainage area and land-use patterns. These studies found that the degree of nonpoint source runoff from urban areas is a result of both the extent and type of urban land use and the watershed soils, highlighting the fact that care should be taken in making predictions based only on land use changes.

Current wasteload allocation models distinguish between the "background" load of pollutants and the load associated with permitted point source discharges. The background load therefore includes contributions from natural, nonpoint and air sources. With a growing population, both the air and nonpoint loads will likely increase. These increases need to be figured into wasteload allocation models to insure water quality standards are met in the future.

MEASURABLE GOALS:

Conduct a literature review and gather existing manuals and information from other states on quantification of nonpoint source loads to receiving waters.

Use NPS models to extrapolate the effects of future land use changes on the total loading of nutrients and BOD to the Charleston Harbor system.

IMPLEMENTATION:

DHEC-OCRM & BOW

Improve Stormwater BMP Design

ACTION:

Develop a stormwater BMP manual that quantifies the pollution reduction capabilities of various BMP's and provides design guidance for meeting pollutant reduction goals.

BACKGROUND:

Current state regulations and stormwate management system design guidance focus on removal of sediment. As various CHP studies have shown, other pollutants such as nutients and fecal coliform bacteria are contained in urban runoff and contribute to water quality problems. Methods exist to estimate the removal of specific pollutants, such as nitrogen, phosphorus, sediment and bacteria, from BMP's such as wet ponds, swales and constructed wetlands. These methods rely on data gathered from regional monitoring studies, which document the pollutant loads exiting specific types of BMP's. A region's rainfall and soils characteristics also impact removal efficiencies. Design manuals have been produced that include engineering aids that simplify the calculations necessary to determine if a particular BMP or set of BMP's will meet specific pollutant load goals.

MEASURABLE GOALS:

Develop a BMP manual that quantifies NPS pollutant load reductions associated with specific BMP's and provides how-to guidance for design engineers.

Conduct three workshops on the use of the manual and the pollutant load reduction design methodology.

Require the use of the pollutant load reduction design methodology where necessary to meet water quality standards.

Reduce pulses of stormwater into tidal creeks

ACTION:

Establish stormwater management plans for new development, and for retrofitting of old developments that minimize "pulses" of stormwater flow into tidal creeks and rivers.

BACKGROUND:

The shallow tidal creeks of South Carolina's estuaries provide nursery habitat for numerous species of economically important fish, crab, and shrimp but also serve as conduits through which pollutants enter the estuary, while creek sediments serve as repositories for these potentially toxic materials. There is a growing body of evidence that the process of urbanization dramatically increases the transfer rate of terrestrial materials to coastal estuaries.

Small tidal creeks are important nursery areas, at least in part, because of the naturally occurring environmental stresses they provide. The highly variable physical conditions (salinity, temperature, and dissolved oxygen) cannot be tolerated by large aquatic predators, but can be tolerated by juvenile organisms. Even juveniles reach the limit of their tolerance at times under natural conditions. When the natural forested watershed of pristine creeks is changed by upland development, the nutrients and contaminants in the runoff from impervious surfaces can increase the stress levels of natural nursery areas beyond the tolerance of juvenile organisms.

Research conducted by CHP researchers found that salinity fluctuated over greater ranges and was generally more variable in developed creeks than in undeveloped reference creeks. Sediments in developed creeks were composed of more sand and had larger site-to-site variation in physical characteristics than reference creeks. Dissolved oxygen is always a limiting factor in small tidal creeks, but research found that organisms inhabiting developed creeks are exposed to low dissolved oxygen events more frequently than those in reference creeks. Trace metal concentrations, pesticides, polychlorinated biphels, and polycyclic aromatic hydrocarbons (PAH)

were found to be higher in developed creeks than in pristine creeks. All of these factors show the importance of reducing pulses of stormwater into tidal creeks.

MEASURABLE GOALS:

Research available engineering, design, and regulatory options to implement this recommendation.

Research/inventory needs for Charleston Harbor and seek funding for retrofits.

Identify areas for possible demonstration project.

Set goal for pulse reduction.

Develop a design manual for engineers.

IMPLEMENTATION:

DHEC-OCRM, LOCAL GOVERNMENTS

Ensure compliance with stormwater management plans

ACTION:

Compliance with stormwater management plans should be enforced.

BACKGROUND:

The development of stormwater management plans is a complex process involving site level engineering. In order for the resultant plan to be effective, it must be followed from the beginning of construction, and provisions made to maintain the stormwater system. Too often there is a breakdown in communication between the engineer and the construction personnel during the actual construction phase, resulting in unnecessary releases of sediments into the surrounding wetlands. Better communications need to be established with the construction industry, and more stormwater inspection personnel need to be employed.

MEASURABLE GOALS:

Evaluate and report on the current inspection capability of DHEC for both NPDES permits and state stormwater permits.

Evaluate enforcement options available to DHEC and layout procedures for noncompliance with management plans.

Evaluate delegation of inspections for stormwater management and sediment reduction permits to local governments.

Develop and submit a budget proposal to adequately fund an inspection program.

IMPLEMENTATION:

DHEC-OCRM

ONSITE WASTEWATER DISPOSAL SYSTEMS:

Develop an inspection and maintenance program for Onsite Wastewater Disposal Systems (OSDS)

ACTION:

Develop an inspection program to prevent the discharge of pollutants to the surface and groundwater. Inspect OSDS at a frequency adequate to ascertain whether they are failing. In addition, for all OSDS permits issued in the coastal zone include a recommended pump-out schedule, conduct periodic surveys of OSDS permit holders and send reminders regarding routine maintenance.

BACKGROUND:

Onsite wastewater disposal systems (OSDS), also known as septic tank systems, are commonly used in the CHP area. Recent data indicate that approximately 35% of the homes in Charleston County are currently using OSDS for wastewater disposal. Records for the eight county coastal zone show that between 1986 and 1999 a total of 43,918 OSDS was installed.

DHEC is the lead agency that administers the OSDS program for the State. It provides the coordination and support to the county health departments (Health Authority) that are responsible for program implementation, including site investigations, system installation inspections, permitting, and enforcement. The Division of Onsite Wastewater Management periodically conducts quality control surveys as a follow up to field activities and permitting.

Poorly designed or improperly operating systems can cause surface ponding of partially treated sewage that can reach surface waters through runoff. In addition to containing oxygen-demanding organics and nutrients, these sources contain bacteria and viruses that present potential human health hazards. Routine maintenance of existing OSDS plays a key role in protecting coastal waters from this source of nonpoint pollution. Most OSDS tanks need to be pumped out every three to five years to remove the accumulated layers of sludge and scum.

Routine maintenance inspections are not required by state regulations. Inspections are generally conducted as a follow-up to citizen complaints regarding individual OSDS or when homeowners request assistance.

Just as inspections and maintenance of OSDS are integral to protecting coastal waters, the repair, modification, or replacement of failing OSDS is also a key componentThe Health Authority is authorized to require a permit for the repair, extension, or alteration of an OSDS, as deemed necessary, and may authorize the best possible method of repair to improve system operation, regardless of site conditions.

MEASURABLE GOALS:

Develop a system failure analysis protocol to define procedures applicable to the inspection, analysis, and repair of failing systems.

Identify potential resources, technical and financial, which may be developed to establish programs for routine maintenance and repairs of onsite systems.

Provide training programs in failure analysis and repair for DHEC staff and contractors.

Institutionalize the inspection program within DHEC by writing regulations governing its procedures.

Educate the public as to the importance of maintaining OSDS.

Develop a prototype inspection program for local governments to adopt.

Request that the Onsite Program include a pump-out recommendation in all new permits.

Determine the costs associated with establishing a database and mailing reminders to permit holders.

Refine maintenance recommendations to reflect varying coastal uses.

Determine availability of federal grants and other assistance for homeowners to fix OSDS problems, particularly low income and minority communities.

IMPLEMENTATION:

DHEC, LOCAL GOVERNMENTS

Encourage connection to sewer service where available

ACTION:

Encourage homeowners to connect to a centralized treatment system where sewer service is available and where septic systems are shown to contribute to groundwater and surface water pollution.

BACKGROUND:

Although a recent survey of septic systems in South Carolina showed that the state has a lower failure rate (as defined by effluent surfacing on the ground or backing up in the home) than other states, it is estimated that OSDS are responsible for between 23 and 39% of all shellfish closures in the southern United States. Approximately 32% of shellfishing waters in SC are closed to harvesting, even though some only after heavy rainfalls due to NPS runoff. Over 10% of the permanent closures are administrative, therefore approximately 22% are closed at some time due to water quality problems. Some of these closures are near areas served by OSDS. While groundwater contamination from toxic substances is more often life-threatening, the majority of groundwater-related health complaints are associated with pathogens from OSDS. In addition, a 1980 DHEC study on the hydro-geology of the shallow aquifers of the lower coastal plain of South Carolina and the impacts of land disposal sites on the shallow groundwater found that the highest degree of ground water contamination was found near tile field systems located in very permeable sediments with shallow water tables. The greatest volume of contaminants entering groundwater is from tile field effluent contributed by subdivisions and trailer parks. It is important to note that the potential for groundwater contamination is greater on those sites where OSDS were installed prior to current standards and under conditions which today would be considered unacceptable. South Carolina residents who consume groundwater from shallow aquifers that are associated with an OSDS, especially from wells that are less than 50 feet from a septic tank, and/or swim in estuarine waters, in areas drained by septic tanks are at increased risk of contracting bacterial enteritis.

MEASURABLE GOALS:

Determine availability of GIS data on location of onsite disposal systems and examine correlations with water quality data.

Determine feasibility of developing a data base for such information.

Based on above findings, present information to local governments and encourage adoption of ordinances requiring connection to central sewer service for areas with failing OSDS.

Inventory areas where people are on septic tanks, and have sewer available.

Work to resolve state and county conflicts over septic tanks/sewer requirements and regulations.

Identify incentives to encourage homeowners to connect to existing sewer service systems.

IMPLEMENTATION:

DHEC, COG, local governments

Change septic tank standards adjacent to estuarine waters

ACTION:

Encourage more stringent state and local regulations for septic tank systems adjacent to estuarine waters, including requiring systems to be designed or modified to reduce total nitrogen loadings in the effluent.

BACKGROUND:

Although the state no longer uses minimum lot size guidelines, some counties and municipalities have adopted the state's former guidelines. The state does stipulate minimum setback distances that, in effect, establish the minimum lot size for OSDS installed statewide. The setbacks require that no part of the system be within 50 feet of the mean high water elevation in tidal waters or ordinary high water elevation of an impounded or natural body of water, including streams and canals, within 10 feet of an upslope or 25 feet of a downslope interceptor drain; or within 25 feet of a drainage ditch, or within 15 feet of the top of the slope of embankments or cuts of 2 feet or more vertical height when the soil absorption trench is to be placed higher in elevation than the invert of a cut, ditch, or gully. Additional setbacks are also required for experimental and ultra shallow placement systems , many of which must have a minimum setback of 150 feet from environmentally sensitive waters (waters classified as outstanding resource and shellfish harvesting areas).

The current regulations are the same for all areas of the state, and do not recognize unique and sensitive areas of the coastal zone. The coastal zone has different characteristics from the rest of the state such as soil types, amount of surface waters, greater eutrophication potential, and slopes. For instance, since mean high water is often in the marsh and not at the edge of highground, technically it is possible to place a system below the critical area line. A system is unlikely to be permitted in this area because of subsurface drainage problems associated with placing a system in wetlands, but represents an inconsistency in the regulations that should be clarified. Also, porous Lowcountry soils often do not allow sufficient residence time before releasing effluent into groundwater and subsequently surrounding waterbodies. This can result in contamination of ground and surface waters, and closure of shellfish grounds. These different conditions warrant more stringent OSDS requirements.

MEASURABLE GOALS:

Participate in the rule-making process as a stakeholder for proposed rule changes to individual onsite systems.

Revise SOP for certification of large-scale onsite systems and subdivisions in close proximity to nitrogen-sensitive surface waters. Coordinate with the Bureau of Environmental Health in light of new evaluation procedures in subdivision regulations.

IMPLEMENTATION:

DHEC, , LOCAL GOVERNMENTS

Work with COG technical advisory committee (TAC)

ACTION:

Work with the Berkeley-Charleston-Dorchester Council of Governments (COG) Technical Advisory Committee (TAC) to evaluate land use, industrial expansion plans, and new growth forecasts to appropriately evaluate water quality.

Establish procedures for early notification of the TAC regarding inquiries or negotiations for new industrial facilities or major facility expansions.

Ensure recommendations from the TAC are considered as proposed amendments to the 208 Water Quality Management Plan and subject to public review and comment.

BACKGROUND:

In cooperation with the CHP and the Institute of Public Affairs and Policy Studies at the University of Charleston, the COG held a series of workshops in 1995 to obtain input from dischargers and other users of the Ashley and Cooper rivers regarding discharge permit policies and procedures. Dischargers and other interested parties that participated in the workshops expressed a strong interest in taking a more active role in water quality planning and management for the Cooper and Ashley Rivers. They expressed support for the establishment of a technical advisory committee that would assist the COG in determining the allocation of total maximum daily loads (TMDLs) developed by DHEC's Bureau of Water, and provide input on other aspects of water quality planning. This recommendation was approved by the COG's board of directors and a TAC for water quality planning was formed.

Two policy options that received support at the workshops were the creation of an assimilative capacity growth reserve and the development of contingency plans for responding to water quality problems caused by continued growth, drought or other factors. There is some indication that sections of the upper Cooper River still have sufficient unallocated capacity to accept new growth. Even in those sections of the Cooper, Wando or Ashley rivers where the total permissible loads have been fully allocated, several options may exist to allow continued growth. However, the consensus of participants was that significant additional planning and detailed, site specific information is needed before establishing an appropriate growth reserve, creating a contingency plan, or otherwise reallocating existing permitted loads in the Cooper and Ashley River basins.

MEASURABLE GOALS:

Compare assimilative capacities, actual loads and current projected permitted loads along the length of the Cooper, Wando, and Ashley rivers.

Provide a menu of policy and technical options, along with a recommended action, for accommodating new growth that address ecological and economic conditions at different points

along each river. Where the total permissible loads have been fully allocated, options should include;

a. Requiring new industrial dischargers to connect to public sewer systems where excess capacity exists.

b. Directing certain types of industries to river stretches with unallocated biological oxygen demand (BOD) capacity.

c. Wasteload reallocation to include allowing new dischargers to develop discharger specific contingency plans or reallocation policies for those river stretches that cannot easily accommodate new growth. General guidelines for the reallocation of permitted loads should include consideration of the following;

a. The relevant contributions of specific dischargers to excess loadings in any river segment.

b. Pollution control options available to the discharger requesting the new or expanded permit, including more advanced wastewater treatment.

c. Availability of unused permitted loads of existing dischargers in the affected area.

d. An evaluation of past pollution control efforts by the affected dischargers.

e. An evaluation of the costs of further load reductions to each discharger.

f. The degree to which these costs can or would be passed on to consumers or local residents.

Using the available modeling tools, run modeling scenarios for the Cooper, Ashley, and Wando rivers.

Develop policy guidance for accommodating new growth.

Develop a map showing areas that can be feasibly served by public sewer systems with excess capacity.

Evaluate whether requiring new industrial dischargers to connect to the systems with excess capacity is feasible.

Develop a map showing river stretches with unallocated BOD capacity.

Develop an incentive package to direct industries to preferred locations.

Make zoning changes as necessary, in cooperation with local governments, to encourage industries to locate in the identified river stretches.

Evaluate the feasibility of establishing a BOD 'trading' program for each of the three rivers.

If feasible, develop guidance for operating a BOD trading program.

Map river stretches that cannot easily accommodate new growth.

Develop rules for formally adopting TAC recommendations and providing mechanisms for public review and comment.

IMPLEMENTATION:

COG, DHEC

Revise management decisions to include impacts to small tidal creeks

ACTION:

Include an analysis of how permitted wasteloads affect small tidal creek eutrophication, BOD, and DO levels when deciding permit limits.

BACKGROUND:

The assumption that main channel dissolved oxygen (DO) levels are representative of small creek DO is inaccurate. Small tidal creeks (creeks less than three feet at mean low water) are a special category of estuarine habitat. Primary and smaller creeks off the main stem of rivers exhibit water quality dynamics that differ from larger rivers (different flushing rates, depths, and relative amounts of stormwater loading). Due to lower volumes of freshwater discharge and flushing, smaller tidal creeks are more susceptible than main rivers to human induced changes in water quality, including more frequent extreme fluctuations in salinity, changes in bottom sediments, and alterations in dissolved oxygen dynamics. Creeks studied by CHP researchers that drain relatively developed watersheds appeared to have the greatest exposure to low DO conditions. Since small tidal creeks are more susceptible to eutrophication than adjacent rivers, they require more specific management criteria.

Water quality managers currently focus on worst case scenarios when allocating waste disposal permits into surface waters. This worst case is early morning during late summer, when DOs are at their lowest. The rationale is that if DO conditions meet the 4-5 parts per million threshold in the main channel of the harbor during these critical times, water quality managers can safely assume that waters are being protected for living organisms at all times. This approach has worked to protect water quality in the main channel, but does not take into account the much lower DO situation in small tidal creeks.

MEASURABLE GOALS:

Develop or obtain a modeling algorithm that can be linked to wasteload allocation models to provide analysis of impacts to small tidal creeks from various wasteload allocation scenarios.

IMPLEMENTATION:

DHEC

Refine estimates of CHP nitrogen budget

ACTION:

Refine the estimates of the CHP watershed nitrogen budget and incorporate them into ongoing regulatory actions.

BACKGROUND:

Water quality in urbanized estuaries is affected by a variety of inputs from human development including municipal and industrial wastewater discharges, as well as nonpoint source urban runoff. These factors interact with a complex set of natural estuarine processes including freshwater runoff, tidal movements, and ecological functions in the water, sediments, and wetlands. The combination of these influences must be understood for effective, long-term water quality management.

A study conducted by CHP researchers showed that the effects of wastewater discharge and stormwater runoff into the Goose Creek estuary were mitigated by extensive tidal wetlands which removed and transformed nutrients during tidal inundation. There were consistent trends of nitrogen uptake by tidal marshes which removed 20-34% of the nitrate flowing across the marsh during each tidal cycle. Therefore the removal of dissolved inorganic nitrogen by the tidal marshes needs to be included in nutrient loading considerations and wasteload allocations.

MEASURABLE GOALS:

Prepare a summary paper describing the CHP watershed nitrogen budget estimates and the information necessary to refine those estimates.

Develop a strategic plan for refining the nitrogen budget.

Develop a strategy for funding the development of the nitrogen budget.

Fund and implement the plan.

Incorporate the findings into the TMDL's developed for the rivers of the Charleston harbor system.

IMPLEMENTATION:

DHEC, DNR, USC

MODELING:

Improve wasteload allocation model

ACTION:

Continue to refine and improve the computer simulation model that is used to determine wasteload allocations. Impacts to small tidal creeks should be taken into account during the modeling process, as well as longer modeling runs to consider eutrophication in coastal waters. Nonpoint source loading and wetland nutrient exchange rates, or percentage of loads in the nutrient budget, should be input directly into simulation models to develop TMDLs.

BACKGROUND:

One of the focal points of the Charleston Harbor Project has been the development of a wasteload allocation water quality model for the Charleston Harbor watershed. The models that were developed, one for the Cooper and Wando Rivers and one for the Ashley River, are significant improvements over previously available models. These models simulate the water-level, streamflow, mass transport, and water quality of the river systems.

Key management questions can be addressed with models such as maximum daily loads that can be assimilated and the most appropriate location of new discharges if assimilative capacity is still available. They can also provide guidance for the development of policies and growth management strategies that allow for continued economic development while still ensuring that water quality standards are maintained.

The interaction of total nutrient loads from point source discharges in the river sloshing up into smaller creeks coupled with the impacts of nonpoint source nutrients running off the upland and down into the harbor must be understood by managers charged with protecting water quality and fishery resources. An improved model is necessary to gain this understanding.

MEASURABLE GOALS:

Develop a strategic plan for improving the modeling capability of DHEC.
Determine the costs and identify the funding needed to implement the plan.
Implement the plan.
Establish a State Modeling Advisory Committee.
Develop methods to evaluate longer-term affects of nutrient enrichment.
Adopt procedures to directly account for NPS loading in TMDL analyses.
Adopt procedures to directly account for wetland nutrient exchange in TMDL analyses.
Identify potential funding sources.
Develop the model and evaluate.
Model runs should be conducted to evaluate water quality given actual as well as permitted point source discharges. The analysis of DO levels should be conducted for both 24-hour and seven-day averages.
Water quality scenarios should be developed that can help identify the effects of growth on water resources, and which include projections of municipal and industrial loads through 2015.
The modeling effort should address the following questions;
What are the predicted patterns of water quality distribution and where are the critical zones of oxygen depletion given current and projected future loads?
Are projected increases in population and economic growth compatible with current limitations on the assimilative capacity of the Charleston Harbor system?
How much more wasteload can be assimilated (TMDL) and where are the most feasible regions for discharge?
Will there need to be more advanced wastewater treatment to accommodate future growth?
The model should also be used to test the sensitivity of water quality distributions to the major point source dischargers and to variable fresh water flows from Pinopolis Dam on Lake Moultrie.

IMPLEMENTATION:

DHEC, SEA GRANT, COG

Use Non-Point Source model to determine effects of development on water quality

ACTION:

The nonpoint source (NPS) model should be used to extrapolate the effects of proposed future land use changes on the total loading of nutrients and resulting biological oxygen demand (BOD) on the Charleston Harbor system.

BACKGROUND:

Urban and suburban land uses contribute significantly to the estimated loadings of nitrogen (N). The higher percentage of impervious surfaces in urbanized areas reduces infiltration and subsurface transport of precipitation. However, NPS models indicate that the degree of nonpoint source runoff from urban areas is a result of the extent and type of urban land use *and* the watershed soil composition. In other words, it is expected as urbanization increases within the watersheds, the importance of nonpoint source runoff will increase, but the rate of increase will vary depending on the soils within a given watershed. Therefore caution should be taken in making predictions based only on land use changes.

Two models were developed to predict NPS inputs of water and nutrients to Charleston Harbor based on drainage and land-use patterns. According to these models, 28% of the total N input into Charleston Harbor comes from precipitation, and the NPS input is approximately 15% of the total annual N load to the estuary, with the remaining 85% contained in municipal and industrial point source discharges. The relative importance of point source and nonpoint source varies in each sub-basin. In the Wando River basin, there are very few point sources of dissolved inorganic nitrogen (DIN), with *non*point sources accounting for virtually all of the total input. In the Ashley River, DIN from nonpoint sources is approximately 19%, with point sources accounting for 81%. In the Cooper River watershed, point source loads are approximately 89% of total nitrogen loads, nonpoint sources accounting for 11%.

MEASURABLE GOALS:

As part of the TAC efforts, ensure future land use changes are included in the evaluation of BOD and nutrient capacity in the Harbor system.

Insure future land use changes are evaluated as part of the development of the watershed nitrogen budget.

IMPLEMENTATION:

DHEC

Adopt a nutrient standard for estuarine waters

ACTION:

Adopt a nutrient standard for estuarine waters..

BACKGROUND:

As noted in previous recommendations, the level of nutrients significantly impacts overall water quality. Nutrient elements such as nitrogen (N) and phosphorus (P) are considered major limiting factors for the production of aquatic plants. High concentrations of these nutrients can result from municipal and industrial wastewater discharge or nonpoint runoff from urban or agricultural areas. Excessive concentrations can cause nuisance blooms of algae, which may degrade water quality, deplete oxygen, and cause fish kills. Managing nutrients, therefore, is necessary to insure the multiple uses of area waters are maintained.

One key management tool is water quality standards. These standards set levels for various water quality parameters necessary to ensure water uses are protected. The standards in combination with waterbody specific hydrologic information are then used to determine assimilative capacity and wasteload allocations. There are no specific water quality standards for N and P in South Carolina. Currently, nutrients are indirectly regulated because their presence

affects the level of dissolved oxygen, which has a specific standard. However, the presence of nutrients affects more than the level of dissolved oxygen as has been discussed in previous recommendations. EPA is currently supporting an effort to identify appropriate nutrient standards for estuarine waters. By establishing nutrient standards, managers will have a direct mechanism for monitoring nutrient levels and requiring management actions.

MEASURABLE GOALS:

Actively participate in EPA development of regional nutrient standards.
Once EPA standards are established, incorporate them into the state standards.
Evaluate the need for identifying criteria for "Nutrient Sensitive Waters".
Work to speed EPA schedule for development of regional nutrient criteria.
Identify "Nutrient Sensitive Waters" as a specific classification for water quality management

IMPLEMENTATION:

DHEC

GROWTH MANAGEMENT

Integrate ecosystem-level planning for wetlands

ACTION:

Integrate ecosystem level planning into the current wetland management policy structure.

BACKGROUND:

Wetlands constitute only about 5% of the land area in the United States, yet approximately 50% of the animal species listed in the United States as threatened or endangered are dependent on wetlands. Wetlands comprise a major portion of the total area of the CHP region. Until the 1970's, wetlands were poorly understood and therefore undervalued. It has since been proven that wetlands regulate water quantity and water quality, reduce flood damage, and store excess water.

South Carolina has been relatively successful in protecting its wetland resources, and has retained approximately 73% of historic levels. Although tidal wetlands have been relatively well protected, significant losses have occurred in freshwater non-tidal areas. The US Army Corps of Engineers, through the Clean Water Act, has direct authority over all US waters and their adjacent wetlands. DHEC-OCRM, through the state's coastal zone management act, is responsible for managing wetlands in the coastal zone,and the DHEC-BOW, through section 401 of the Clean Water Act has certification authority over all federal permitting decisions relating to wetlands. Additionally other state and federal agencies, such as the Department of Natural Resources and the US Fish and Wildlife Service, have management roles regarding wetland resources. Upland areas adjacent to wetlands are directly subject to local land use regulations. Existing regulations are designed to protect water quality functions, wetland habitats and associated wildlife. However, the current practice of parcel-level review does not provide managers with the opportunity for large-scale and long-term ecosystem management. State and federal regulations set certain parameters for environmental protection, but local decisions regarding land use, zoning, and infrastructure ultimately determine an area's future environmental condition. A more comprehensive ecosystem approach, including representation from all levels of government, is needed to ensure proper management is done in the most effective and efficient manner.

MEASURABLE GOALS:

Revise wetland permitting and mitigation review to incorporate ecosystem considerations using the method developed for the Broad and New River watershed project, including whole system evaluation of socio-ecological characteristics such as water quality functions, hydrologic integrity, and anthropogenic impacts on freshwater wetlands.

IMPLEMENTATION:

DHEC-OCRM, USACOE, USEPA, USFWS, DHEC-EQC, DNR, USNMF, USNOAA/NOS, local governments

Refine the wetland master planning process

ACTION:

Refine the wetland master planning process to address management of wetlands smaller than one acre.

BACKGROUND:

In the CHP area many small isolated wetlands, especially cypress ponds, swamp tupelo ponds, and borrow pits, are less than one acre in size. These small wetlands are particularly prone to loss or modification. Current policy allows wetlands of one acre or less to be filled for development, while requiring mitigation in larger wetland systems. This policy protects many highly valued wetland dependent resources, but it diminishes protection for some rare habitats that provide unique conditions not found in larger wetlands. CHP researchers found that at least ten frog species and five salamander species of the southeastern Coastal Plain of South Carolina are exclusively or primarily dependent on small, isolated wetlands as breeding sites, while six other amphibians and two reptiles also use small isolated wetlands in addition to other aquatic habitats. These small wetlands protect these species by excluding aquatic predators. Small isolated wetlands were found to make up approximately 15% of the freshwater wetlands of the watershed.

These small wetlands are not adequately protected under current policies. As their habitats are lost, rare species become endangered species, and Federal law requires protective measures. Unfortunately, these measures are considered a serious obstacle to economic development in a community. Refining the wetland master planning process can enhance management of rare species by keeping them off the endangered species list and reducing the need for more restrictive regulations which could effect economic recruitment.

MEASURABLE GOALS:

Adopt revised wetland master planning guidance.

Develop an inventory of wetlands within the watershed.

Investigate and propose wetland land banks that would include small isolated wetlands.

IMPLEMENTATION:

DHEC-OCRM, MBRT

Work with local governments to protect water quality

ACTION:

Make local planning commissions aware of the impacts of zoning decisions on stream use, habitat and water quality and develop guidelines for using desired water quality characteristics to influence zoning decisions.

BACKGROUND:

Tidal creeks are conduits for upland runoff from adjacent land uses. Their ecological integrity is directly dependent on the type and amount of land uses in the drainage basin. Being nearer the source creeks accumulate sediment contaminants at a higher rate than other portions of

estuary. Urbanization, agriculture, and deforestation dramatically increase the rates of transfer of sediment pollutants to coastal estuaries. Runoff enters the urbanized estuary more rapidly resulting in sharp changes in salinity, pH, and dissolved oxygen. Smaller tidal creeks are more susceptible than main rivers to human induced changes in water quality, including more frequent extreme fluctuations in salinity, changes in bottom sediments, and alterations in dissolved oxygen dynamics.

Local governments have direct control over land use through land use planning, zoning, and infrastructure decisions. Environmental protection has been largely seen as a state and Federal concern, but in fact it is the decisions made at the local level that will dictate the area's future environmental condition. The 1994 Comprehensive Planning Enabling Act requires local government to consider natural and cultural resources as elements of their plans. The state has an obligation to provide data and technical assistance to local governments in order to develop a process for effective resource management.

MEASURABLE GOALS:

Work with the COG to implement Land Use Training Workshops for Municipal Officials.

Evaluate (NEMO) program for implementation of continuing nonpoint source education in this area.

If NEMO is not appropriate, develop another outreach program to educate local planning commissions.

Implement the chosen outreach program.

Develop guidelines for using desired water quality and biological characteristics to make zoning decisions.

Develop a brief slide presentation for civic clubs and city/county councils.

IMPLEMENTATION:

DHEC-OCRM & EQC, DNR, BCDCOG, SC Sea Grant Consortium

Encourage land acquisition policies

ACTION:

Encourage governments to develop mechanisms to allow collection of funds to acquire areas for public recreation and resource conservation.

BACKGROUND:

Increasing urbanization is placing greater demands on our resources to meet water based recreation and resource management objectives. Acquiring uplands adjacent to water bodies can help achieve these objectives by providing habitat for songbirds, who depend on scrub areas for roost-site habitats. Scrub/shrub areas currently have no regulatory protection from encroachment. A 100 foot buffer around a site, protecting mature trees and dead snags while minimizing the clearing of understory trees and shrubs, can protect this biologically important habitat. Acquisition of land around water bodies can also provide water-based and passive recreation opportunities to the public such as canoe and kayak throw-in areas and small community parks. Acquisition of prime habitat and park areas, combined with clustering development to protect open space and habitats while allowing for development, can meet

multiple demands while allowing needed development to take place. The establishment of local, regional, and state programs for the identification, creation, and protection of greenways can help maximize the benefits of open space protection.

Interest in the establishment of greenways has risen during the past decade. Greenways serve multiple recreation and habitat protection purposes, including jogging, biking, and bird watching. Some actions have been taken to establish greenways in several areas within the watershed, however there has been no coordination of a greenway system. Coordination would ensure a system that would maximize the benefits and uses of greenways.

MEASURABLE GOALS:

Work with local governments to develop mechanisms to allow collection of funds to acquire areas for public recreation and resource conservation.

Acquire and preserve scrub habitats for nearctic migrants.

Develop a map showing prime habitat for nearctic migrants and make this information available to affected local governments, PRC, and local conservation organizations.

Use acquisition programs to meet the need for more publicly accessible docks and fishing piers by placing a high priority on acquiring waterfront properties.

Research and develop technical assistance materials for local governments on mechanisms to finance acquisition programs.

Provide technical assistance to local governments interested in developing acquisition programs.

Conduct surveys to assess need and public opinion on the issues.

Draft state legislation to encourage development of local and regional acquisition programs by providing tax credits and other incentives.

Investigate development of green "infrastructure" from PCF reports, PRT trails, utility right of way, railroad right of way, etc.

Inventory and map potential sites-should attempt to form practical linkages between greenways and focus on the benefits of recreation and resource protection.

IMPLEMENTATION:

DHEC-OCRM, SCPRT, LOLT, SCCCL, CCPRC, Local Governments, Utilities

DEVELOPMENT COORDINATION:

Establish an economic development liaison

ACTION:

Work with the Charleston Regional Development Alliance to create an economic development liaison office for environmental permitting and natural resource issues to expedite communication between developers and permitting agencies.

BACKGROUND:

There is a great amount of pressure on local governments to accept most types of economic investment that will create jobs for the community without full realization of their impact upon natural systems. The region's economy depends greatly on its surrounding biological and water resources, not only for wastewater assimilation but also for recreational and quality of life purposes. If the critical balance in shallow tidal creeks, with their oyster reefs and mud flatsis disturbed, it will impact the recreational harvest of such species as spotted sea trout, red drum, white shrimp, and others. In addition, commercial fishermen will see impacts on brown shrimp, white shrimp, blue crab and other species. Economic development agencies should target industries that are environmentally compatible with the area and have a past record of environmental regulatory compliance. The ultimate costs of dealing with industries that generate large volumes of air and water pollution, or create significant infrastructure problems, may not be worth the short-term benefits to the area.

Infrastructure capacity in the greater Charleston region is adequate, although the assimilative capacity of the rivers and estuary may be a concern to large water users who wish to perform their own treatment. The availability of both CSX and Norfolk Southern railroad systems to service the region lowers costs to local industries. Of considerable note is the short-line rail owned by the S.C. Rail Commission. The ability of the state to recruit rail-dependent firms by providing an economic rate structure is a strength that is unique to the region. The Port of Charleston, considered one of the best ports on the East Coast, enhances these services.

State economic development agencies play an important role in industrial recruitment withover two-thirds of industrial prospects contacting the state first. Usually, the state has been asked to respond promptly to an inquiry, and the relative success of any one community will rest on its ability to respond quickly and thoroughly to the requests. For this reason, it is critical to maintain close working relations with the state economic development authorities, the Charleston Regional Development Alliance, and local government economic development offices.

Coordination and communication between the regulatory and the business communities is critical to an effective and efficient process for attracting economic development. Including an environmental permitting liaison for new or existing industries requiring applications, approvals, modeling, etc., could expedite communication between developers and permitting agencies. A liaison could identify options that benefit the community and natural resources while improving and streamlining the permitting process.

MEASURABLE GOALS:

Identify a CRDA employee as the environmental permitting liaison.
Identify contacts in each of the environmental and natural resource agencies.
Educate this liaison on environmental and cultural resources permitting issues.

IMPLEMENTATION:

CRDA, DHEC, USFWS, DNR, USACOE, SHPO

Establish an advanced coordination program for development sites

ACTION:

Work with local economic development offices to evaluate the suitability of their prime sites for future development and establish a pre-development coordination program.

BACKGROUND:

Open communication between the economic development and the regulatory community can keep uncertainty to a minimum. Currently, DHEC has a liaison who consults with the industrial development community during the permitting process. There is also an informal interagency review committee, comprised of DHEC-, DNR, the US Army Corps of Engineers, US Fish and Wildlife Service, and others, that meets with potential applicants to discuss concerns that are likely to arise during the permitting process. This kind of communication should be expanded to include developers of all types of properties and representatives from all permitting authorities including the municipal and county governments within the watershed.

In recent years attention has been focused on streamlining the permitting process. While some steps, such as the consolidation of state agencies, have moved toward a one-stop application process, each section, within these larger consolidated agencies, still has the same regulatory procedures to follow during the permitting process. A more proactive approach to permitting could make the process more efficient. Identifying wetland locations and critical habitats is important for making the permitting process more efficient. Combining this information with cultural resource data could reduce the uncertainty for developers and assist resource managers in properly managing watershed resources. The continued maintenance of prime industrial sites in the CHP area can facilitate the economic development process. Development could be focused toward areas more conducive to those activities while resource-sensitive areas could be avoided.

MEASURABLE GOALS:

Work with COG, local governments, DOC using INSITE program to identify sites appropriate for different types of development. This should be coordinated by the CRDA liaison.

Make a top ten list of developable sites available.

IMPLEMENTATION:

DHEC, COG, LOCAL GOVERNMENTS, CRDA, SHPO,COE

Develop user-friendly format for data on resources

ACTION:

Provide data regarding natural and cultural resources (wetland, habitats, and historic and archaeological sites) in an accessible, user-friendly format to decision makers at all levels of government.

BACKGROUND:

The Charleston Harbor watershed contains a multitude of biological resources and some of the nation's most important historic resources. Many of these resources have been mapped by researchers and resource managers through the years. However, the data exist in various formats and is not always available to decision makers at various levels of government. In order to promote effective and efficient resource management this group of data and the expertise that

developed it should be available to decision makers at an appropriate planning scale. Land use decisions could be made to ensure that uses are compatible with resource protection This could apply to transportation networks, industrial recruitment, and residential/commercial development.

MEASURABLE GOALS:

Establish an interagency task force to determine what data will be collected, who will collect the data, who will maintain the data and the scale and format the data will be presented.

IMPLEMENTATION:

DNR, DHEC-OCRM, SHPO SCIAA

Establish local wetland mitigation banks

ACTION:

Establish local wetland mitigation banks to facilitate economic development while protecting water quality and biological habitats.

BACKGROUND:

A wetland mitigation bank is a site where wetlands are restored, created, or preserved expressly for the purpose of providing compensatory mitigation for the unavoidable destruction of other wetlands, thereby maintaining environmental quality while allowing development to proceed. Under the Clean Water Act, anyone wishing to fill a wetland must first demonstrate that the impact is unavoidable or that the result of the filling would be minimal. If so, mitigation is required for this unavoidable impact by replacing the filled wetland with the same or similar type of wetland, either at the impacted site or within the same watershed as the impacted site. A developer who needs to compensate for authorized impacts to wetlands has two options: restore or create new wetlands at the impacted site, or purchase "wetland mitigation credits" from an established mitigation bank located in or near the same watershed. Mitigation banking also allows many isolated or fragmented mitigation projects to be consolidated into larger tracts, where more benefits can be realized.

By establishing a mitigation bank, local governments would benefit by having an inventory of the region's wetlands, which would provide assistance when choosing lands to purchase for mitigation purposes. They would be able to protect valuable resources while improving the economic recruitment process by having credits readily available for potential businesses within their jurisdiction. Local jurisdictions would have economic growth placed in appropriate areas, while protecting resources in areas where development would not be appropriate. Citizens would reap the benefits of local resource protection as opposed to buying mitigation credits in a bank located somewhere outside the watershed. Protecting resources locally helps to preserve open space and may provide passive recreation opportunities.

MEASURABLE GOALS:

Develop and distribute educational material for municipal officials and local developers on local mitigation banks.

Establish a local mitigation bank to serve as an example.

IMPLEMENTATION:

DHEC-OCRM, LOCAL GOVERNMENTS, MBRT

Encourage reuse of existing developments

ACTION:

Develop and propose incentives to encourage the improvement and reuse of older, under-utilized, or abandoned developments.

BACKGROUND:

Redevelopment is becoming an increasingly important issue as the region experiences the effects of increasing urbanization. Many benefits can be realized by redeveloping areas within the urban core. Roads, water, and sewer service are already in place, thereby reducing the cost for additional infrastructure. Additional impervious surface coverage and consequent stormwater impacts on coastal resources are minimized within the watershed because areas to be redeveloped are also generally closer to the existing urban area and do not require as many new roadways. Redevelopment of areas within the urban core can simultaneously address the problems of urban decay and urban sprawl. More land on the fringe of the urban area would also be left in its natural state, protecting habitats and lessening development impacts on natural and cultural resources.

This is consistent with the USEPA and DHEC Brownfields initiatives. Brownfields are defined as "abandoned, idled, or under-utilized industrial and commercial facilities where expansion or redevelopment is complicated by real or perceived environmental contamination."

MEASURABLE GOALS:

Develop draft ordinances and tax advantages to encourage reuse of existing developments.

IMPLEMENTATION:

DHEC-OCRM, SCCCL, LOCAL GOVERNMENTS, SC DEPARTMENT OF REVENUE

Develop a cultural resources management plan (CRMP)

ACTION:

Develop a Cultural Resources Management Plan (CRMP) based on similar plans designed and in place for military bases and other federal lands

BACKGROUND:

The Charleston Harbor region's rich history dates back to the Paleoindian, Archaic, Woodland, and Mississippian periods of Native Americans, continues through Spanish exploration in the 1500s, to the English settlement of Charles Towne in 1670. In colonial times Charleston quickly grew to become the largest city of the southern colonies. Numerous cultural resources representing this rich history are present in Charleston, in the surrounding cities, and in rural areas of the watershed. Charleston's cultural resources are attractive to tourists and contribute to the immigration of residents into the area. While scenic views, and beach and

ocean recreation are very important attractions, historic resources differentiate Charleston from other coastal cities.

In some areas preservation programs are effective in maintaining these resources. In other areas these resources are being lost or neglected primarily due to limited knowledge about them. Due in part to the preservation societies, land trusts, and enlightened local governments, preservation efforts have been relatively successful for both land and underwater archeological sites. Bluff and Medway Plantations and the Hunley submarine are notable examples.

There is concern that the region's wealth of cultural resources may impede industrial recruitment to the area. Federal, state, and local laws and regulations require consideration of historic and cultural resources before permits for development or zoning changes may be approved. New industries looking to locate here and existing industries planning to expand must apply for and receive various permits that include consideration of cultural resources. A cultural resource management plan (CRMP) for the Charleston Harbor Watershed would make decision-makers aware of cultural resource concerns in the area, enhancing the ability of city, county, and local agency planners to participate in the preservation of cultural resources. The creation of a cultural resource management plan would improve the efficiency of the permitting process. This kind of information, along with data regarding historic sites and submerged archaeological sites, could assist in locating future industrial parks in an efficient manner while managing resources and providing the region with growth opportunities.

MEASURABLE GOALS:

Designate sensitive areas with the assistance of the Department of Archives and History, and the SC Institute of Archaeology and Anthropology, and make this information available to local governments.

Designate these sensitive areas as GAPCs.

Develop CRMPs for each local jurisdiction as an element of theircomprehensive plans.

Amend zoning and adopt ordinances to implement the plans.

Develop and distribute a cultural resources management requirements brochure, and include this information in OCRM's permit packages.

Publicize information regarding the cultural resource management process for permit applicants in order to ensure a smoother regulatory process.

IMPLEMENTATION:

DHEC-OCRM, COG, SHPO, NPS, LOCAL GOVERNMENTS

Create interpretive program for historic sites

ACTION:

Create interpretive and educational programs for identified historic properties, including significant submerged and archaeological sites, buildings, districts, landscapes, and vistas.

BACKGROUND:

The CHP area contains some of the most significant historic and archeological sites in the United States. The area's economy is heavily influenced by its cultural resources and their preservation and interpretation are important factors in the overall "quality of life" of the regional community. While scenic views, and beach and ocean recreation are very important attractions,

historic resources differentiate Charleston from other coastal cities. In the CHP area programs to study, preserve, and interpret historic resources thus have a necessary sense of urgency. The CHP area has a large number of institutions and organizations that contribute to the preservation and interpretation of cultural resources. Support for cultural resource protection comes from an informed citizen base. As development encroaches on these resources, management decisions become increasingly complex and important. Education of the general public will lead to more informed and better decisions regarding cultural resources by managers and political leaders.

MEASURABLE GOALS:

Work with local governments, SHPO, local historic societies, PRC, interested parties to coordinate appropriate programs for sites.

Conduct workshops to solicit input from proper authorities and interested parties.

IMPLEMENTATION:

SHPO, SCPRT, PRC, DHEC-OCRM, NPS, Local Historic Societies, Heritage Trust for Historic Preservation, Charleston Downtown Group, Local School Districts, SC Heritage Corridor

Develop a regional water-related recreation plan

ACTION:

Coordinate the development of a plan for natural water-related recreational opportunities in the region, allowing input from appropriate officials of all local governments. This plan should include;

1. Encouraging public-private partnerships to help generate the revenues needed to acquire, develop and operate recreation-oriented facilities and programs.
2. Assesing the pollution and habitat degradation potential for recreational uses of areas.

BACKGROUND:

The environment plays a major role in our region's economy through commercial and recreational fishing, sailing, swimming, and other water-related recreational opportunities. Saltwater fishing stamps have generated over $400,000 annually for resource protection. Waterfront property values have been enhanced due to the generally good water quality conditions of our streams and rivers and the wealth of recreational opportunities and aesthetic amenities they provide.

The region abounds with navigable waterways, including the Santee-Cooper Lakes and the Ashley, Cooper, Edisto, Stono, and Wando Rivers, which make boating possible from the Charleston Harbor into tributary creeks, tidal marshes and forested swamps. They afford passage through a spectrum of ecological settings. There are numerous boat landings in the region, primarily in Charleston and Berkeley Counties, which are evenly distributed along the principal rivers and creeks. Amenities, such as picnicking facilities with shade trees, are not available at most sites.

The demands on the resources are heavy, and there are sections of coastline that are restricted and inaccessible to the public. Charleston's beaches are overburdened not only with county residents, but with visitors from inland South Carolina and other states. Berkeley County's lakefront, which is predominantly private, has nearly 52.5 miles of waterfront along Lake Moultrie, and 25 miles along Lake Marion. Private cottages, commercial fish camps, and private recreation areas are the dominant uses along the lakeside. There are also several commercial beaches near Moncks Corner, but no supervised public swimming areas.

Public access to water-related activities has often been taken for granted and assumed to be available in perpetuity. However, as the population has increased, public access has decreased as a result of the gradual change from rural to suburban land use. Thus, the opportunities for recreational use of water resources has diminished, leading to crowding at existing sites and conflict among user groups. In addition, the costs of obtaining and developing appropriate sites will also increase greatly as competing user groups vie for these sites.

MEASURABLE GOALS:

Establish a Taskforce to develop a water-related recreation plan to include a funding analysis.

Encourage recreation agencies to obtain and reserve sites for future recreational development.

Design and operate facilities and programs to provide maximum benefits from existing facilities and avoid conflicts among user groups.

IMPLEMENTATION:

SCPRT, CCPRC, COG, DNR, LOCAL GOVERNMENTS, AND APPROPRIATE INTERESTED PARTIES (Recreation associations)

Encourage utilization of identified dredge disposal sites

ACTION:

To the extent practical, utilize the preferred dredge disposal sites as ranked in CHP research to meet future disposal capacity needs.

BACKGROUND:

The maintenance of navigational channels in the Charleston Harbor Estuary is important to the regional economy. Activities associated with dredging, particularly the disposal of dredged material, may have substantial adverse effects upon natural resources. More than 7.5 million cubic yards of material are removed annually from the channels of the Charleston Harbor Estuary to maintain adequate water depths for Charleston's ship traffic. Construction of planned new port facilities and deepening of the Harbor to support a broader range of vessels will require the initial removal of over 11 million cubic yards of dredged material.

Environmental concerns associated with dredged material disposal sites include:

- physical sediment characteristics, which are important environmental factors controlling distributions of organisms
- impacts on existing environmental quality, water quality, and critical habitat losses,

- impacts on environments adjacent to candidate sites,
- impacts on material cycles, animal migration and movement patterns,
- impacts on groundwater resources,
- impacts on cultural resources,
- impacts on human uses.

Due to the anticipated reduced use of Daniel Island as a dredged material disposal site (construction of the Mark Clark Expressway has made this area accessible for development), a study was conducted to identify alternative sites to Daniel Island which had acceptable economic costs and environmental impacts. Researchers identified twenty potential sites in the CHP area with small cumulative environmental and cultural impacts and disposal capacities ranging from about 1,000,000 to 122,000,000 cubic yards. Collectively, these sites will provide most of the disposal capacity required for the Charleston Harbor area for the next 50 years. Six of the sites were currently in use. Five sites were projected to represent the least threat to natural and cultural resources and were the most acceptable alternatives to Daniel Island.

None of the preferred alternative sites were habitat for threatened or endangered species or blocked migrational routes for recreationally or commercially important species. Existing diked dredged material disposal facilities at Yellow House Creek, Naval Weapons Station, Drum Island, and Clouter Creek were projected to represent the least threat environmentally and were the most acceptable alternatives to Daniel Island. The most acceptable "new" site identified was Upper Thomas Island.

MEASURABLE GOALS:

Publish and distribute the preferred dredge disposal sites to affected parties.
Sign a MOA designating the sites to be used.

IMPLEMENTATION:

SCDHEC-OCRM, SCSPA, USACOE

Develop methods to mitigate problems caused by differences in zoning between jurisdictions

ACTION:

Analyze environmental implications of differences in planning and zoning regulations across the region, particularly at jurisdictional boundaries, and facilitate consideration by each local governments' planning commission of the plans developed by other agencies so that conflicts between jurisdictions can be avoided.

BACKGROUND:

The Charleston Harbor watershed consists of all or parts of 18 municipalities and three counties. Differences in planning and zoning regulations and in standards for development complicate resource management; jurisdictional boundaries follow property lines and not natural features of the landscape, such as creeks, marshes and other biological habitats. When a municipality annexes a subdivision, it may be acquiring lots, roadways, ponds and drainage networks that do not meet its own standards, although they did meet the standards of the

previous jurisdiction. A developer can intentionally avoid compliance (thereby reducing costs) by delaying a request for annexation until development is completed.

By working to eliminate differences in planning and zoning regulations between counties and municipalities, with the ultimate goal of developing regional planning and zoning standards, fewer differences in these regulations would result in fewer conflicts during annexation. This would lead to better resource management throughout the watershed, as well as making the development process easier by fostering consistency between local governments planning and zoning rules.

MEASURABLE GOALS:

Develop and maintain a database of local, state, and federal plans and zoning regulations in the tri-county area.

Make the database available to local governments and the development community.

Devise a process to evaluate the environmental implications of various zoning regulations and plans.

IMPLEMENTATION:

DHEC-OCRM, COG, local governments

Nonpoint Source:

Develop an area-wide runoff management strategy

ACTION:

Develop an area-wide stormwater runoff management strategy to guide decisions on construction permits and minimize the impacts.

Incorporate BMPs which meet specific pollutant load reduction.

Change local ordinances and state laws to require more comprehensive urban stormwater runoff control, including effective maintenance requirements.

BACKGROUND:

Stormwater arises from precipitation that washes runoff from industrial, agricultural, construction, and household sites directly into streams or into drainage systems that flow into streams. Urbanization, agriculture, and deforestation degrade streams, rivers, lakes, and estuaries by greatly increasing the rates of transfer of terrestrial materials (runoff) to these water bodies. Nonpoint source pollutants (pollutants derived from diffuse sources) in runoff include pesticides, heavy metals, excess nutrients, suspended solids, and fecal coliform bacteria. Urbanized, less forested lands retain less water, and buildings, paved roads, and sidewalks provide more direct flows into a receiving water body, which results in sharp changes in salinity, pH, and dissolved oxygen. Urban nonpoint source runoff varies with type of land use (residential, commercial, industrial), percent of impervious area, density of developments, alteration of hydrology, amount of fertilizer application, and degree of management practices used (e.g., impoundments, grass swales).

Historically attempts to control the pollution in stormwater have focused on site-level planning for new development and, to a limited extent, redevelopment. This piecemeal approach is expensive for both the stormwater management agencies and the development community due to its inherent inefficiencies. Planning drainage on the watershed level is more cost effective as well as being more effiecient at controlling pollution.

Best Management Practices (BMPs)

The control of nonpoint pollution in the US is based on the identification and promotion of best management practices, or BMPs, including retention ponds (contain permanent water storage),detention ponds and extended detention ponds (dry out between storms), vegetative filter strips or buffers, and infiltration BMPs, such as infiltration trenches, medians, and swales. Two studies were conducted to investigate the management of urban/suburban nonpoint source pollution in the Charleston Harbor Watershed. One study evaluated the efficiency of detention/retention ponds in improving water quality. This work was part of the evaluation of structural and non-structural best management practices that aid in the reduction of erosion, flooding, and surface water contamination in the Charleston Harbor Estuary. CHP researchers also evaluated the effectiveness of vegetative filter strips for controlling sources of nonpoint pollution of urbanized creeks and waterways.

MEASURABLE GOALS:

Establish a tri-county stormwater committee that would focus on minimizing runoff.

Develop and distribute a 'best' BMPs design manual that addresses both new development and redevelopment, and that encourages the use of natural predevelopment runoff patterns.

Revise ordinances and regulations to encourage use of 'best' BMPs.

Revise DHEC-OCRM stormwater management regulations to more effectively address maintenance.

Revise local ordinances to more effectively address maintenance.

IMPLEMENTATION:

DHEC-OCRM, STORMWATER COMMITTEE, LOCAL GOVERNMENTS, COG, DOT

Limit the impact of Impervious Surfaces

ACTION:

Limit the impact of impervious surfaces by slowing its rate of increase, holding subwatershed imperviousness to less than 30% and placing the highest concentrations of impervious surfaces as far from receiving waters as possible.

BACKGROUND:

Impervious surfaces, such as rooftops, parking lots, and roadways, accelerate runoff and contribute to eutrophication by funneling polluted stormwater runoff directly to receiving water bodies without the benefit of filtration through vegetation or the ground. This is a serious problem for tidal creeks, due to their small size, proximity to uplands, and importance as biological habitats.

The CHP Tidal Creek Project and other research elsewhere in the country indicate that water quality changes begin to appear when a water body's surrounding area contains 10% impervious surface. When the impervious surface surrounding a water body reaches 30% of the total area, the body changes from impacted to degraded and significant changes in water quality and biological habitats can be expected. The critical nursery function of tidal creeks becomes impaired when impervious coverage in the basin exceeds 30%. The CHP Belle Hall Study concluded that the area of highest impervious coverage, the town commercial center, should be placed as far from the receiving waterbody as possible. Therefore, the amount and location of impervious surfaces is an important consideration in zoning and infrastructure decisions, particularly in areas near wetlands and tidal creeks.

MEASURABLE GOALS:

Delineate the region's subwatersheds.

Calculate existing imperviousness in each subwatershed.

Establish target imperviousness levels for each subwatershed.

Develop a package of incentives, ordinances, and other mechanisms local governments can use to meet imperviousness goals and adopt ordinances and other mechanisms to meet the imperviousness goals.

Adopt programs to place impervious surfaces as far from receiving waterbodies as possible.

Sign a resolution to minimize rate of increase of impervious surfaces.

Review existing road codes, and develop new model code for road construction to reduce the amount of impervious surface.

IMPLEMENTATION:

DHEC-OCRM, STORMWATER COMMITTEE, LOCAL GOVERNMENTS, COG, DOT, Sea Grant, and Clemson Extension Service.

Require engineer certification of stormwater pond design depth and a bond for pond maintenance

ACTION:

To ensure stormwater ponds are constructed to proper design depth, require engineer certification prior to final plat approval

Require developers to leave enough open space around a stormwater pond for easy access for maintenance (dredging) equipment.

Require a maintenance bond from developers to be used for a one-time future pond maintenance.

BACKGROUND:

In housing developments, retention ponds are often designed for six to ten feet of depth, but ongoing siltation reduces the holding capacity. Without adequate storage capacity, backups will occur, and drainage upstream will also be compromised. In the Shemwood I subdivision in Mount Pleasant, a marsh area was excavated as a pond in 1952 but the pond has gradually filled to the point of capacity failure and now access to the site for maintenance is difficult.

The need for sufficient siltation capacity often dictates that a pond be designed to depths of ten to thirteen feet to accommodate silt deposits and six to ten feet of water. Unfortunately, construction engineers are often prevented from excavating deeper ponds because they have insufficient space in which to deposit removed material. Once a pond is excavated, housing units are built around it, which often prevents access of dredging equipment to the pond. Property owners also tend to fence their yards as close to the water line as possible.

An engineer certification of proper pond design depth would ensure the pond can perform as designed. When a subdivision is built, developers could be required to place in escrow funds to be used for one-time future pond maintenance at the point of 85% lot development. This will ensure the homeowners have a pond system that can function as designed as opposed to one filled with sediments from constructio of the subdivision. Since pond-side owners receive aesthetic and recreational benefits, subdivision fees could be made higher for these owners.

MEASURABLE GOALS:

Revise DHEC-OCRM stormwater requirements.

Revise local drainage system requirements.

Draft a model ordinance to require a maintenance bond in jurisdictions with no stormwater utility.

Adopt the ordinance.

IMPLEMENTATION:

DHEC-OCRM, LOCAL GOVERNMENTS

Examine potential for stormwater retrofitting of roads and bridges

ACTION:

Examine existing roads and bridges for retrofitting to reduce impacts on natural resources.

BACKGROUND:

Many current stormwater and drainage problems are related to the construction, maintenance, and modification of roadways. In addition, highway runoff from bridges introduces potentially toxic metals and hydrocarbons into surrounding wetlands and uplands. There is an urgent need for a concerted effort to develop creative engineering solutions to existing problems, so that voters and governments can be presented with reasonable retrofit options.

In certain areas, roadside ditches drain directly into surface streams and are, in some cases, tidally influenced. The possibility of unregulated highway runoff, which may contain metals and organic materials discharging right into tidal creeks is an environmental concern. In addition, the use of curb and gutter construction must be balanced with the need to reduce unnecessary increases in the total amounts of impervious surface area in each drainage basin.

MEASURABLE GOALS:

Develop and prioritize an Environmental Restoration Program for existing roads and bridges.

Identify funding sources for implementing the program.
Construct one project a year.

IMPLEMENTATION:
DOT, DHEC, LOCAL GOVERNMENTS

Establish vegetated buffers

ACTION:
Establish naturally vegetated buffers with a minimum average width of fifty feet for all development bordering tidal creeks, and rivers.

BACKGROUND:
Water quality concerns can be addressed, in part, by developing greenways and vegetated buffers to alleviate stormwater runoff problems. Vegetated buffers or filter strips trap sediments and a number of pollutants and are useful for protecting water quality when placed between impervious surfaces and nearby receiving water bodies.

For best results, fifty-foot buffers are the minimum average widths necessary to prevent sedimentation in tidal creeks and wetlands. Fifty-foot buffers can reduce nonpoint source pollution greatly and do not require the constant maintenance needed for smaller buffers. Larger buffers are even better for controlling nonpoint source pollution and providing habitat and should be established, where possible. To a lesser extent than greenways, buffers can be used for passive recreation, cultural resource protection (if the resource is next to a waterbody), and to serve as a wildlife corridor. In general, buffers strips can be a relatively inexpensive means of reducing nonpoint source pollution. However, they are not as reliable and effective as retention ponds and other engineering practices for treating drainage from pavement, so these additional BMPs may also be required.

The Charleston Harbor Project developed a document of buffer guidelines, entitled *Vegetated Riparian Buffers and Buffer Ordinances,* which makes specific recommendations for buffer ordinances for local governments, explains the purpose of buffers, provides information on how to solve problems common to buffer ordinances (such as private property rights), and gives examples of existing buffer ordinances in the United States.

MEASURABLE GOALS:
Promote and distribute DHEC/OCRM's document *Vegetated Riparian Buffers and Buffer Ordinances.*
Encourage establishment of larger buffers (50-100 feet), where possible.
Make buffer ordinances flexible, to address issues of private property rights.
Actively manage and maintain buffers after they are established.
Print buffer boundaries on all development and construction plans, plats, and maps.
Adopt buffer ordinances in South Carolina communities.
Evaluate the effectiveness of buffers in sensitive shellfish harvesting areas.

IMPLEMENTATION:
DHEC-OCRM, LOCAL GOVERNMENTS

RELATED ACTIONS:

Limit the number and conditions for stream buffer crossings (roads, bridges, and utilities)

All footpaths running through a buffer to the water (perpendicular to the buffer) should be covered by nonelevated wooden boardwalks to prevent the channelization of stormwater runoff caused by dirt footpaths.

Encourage environmentally friendly golf course practices

ACTION:

Encourage compliance with the maintenance and design guidelines in the CHP *report 'An Environmentally Friendly Coastal Golf Course'*.

Maintain non-chemically treated vegetative buffer zones of at least fifty feet adjacent to all natural watercourses to assist in filtering nutrients and pesticides in runoff, and to moderate water temperatures.

BACKGROUND:

Golf courses are manipulated environments that require significant energy (chemicals, pesticides and nutrients, and physical labor) to maintain their organization. The challenge to today's golf course architects, developers, superintendents, and managers is to facilitate the coexistence of these high-energy systems with sensitive ecosystems immediately adjacent to the courses. This is especially true along the coast where golf courses are literally designed into beach dunes and through sensitive marsh habitats. The potential environmental effects of golf courses include leaching and runoff of nutrients, soil erosion and sediment losses during construction and degradation of surface waters receiving runoff.

Charleston Harbor Project researchers produced a technical manual to serve as a guide for the design, construction, and maintenance of golf courses in the coastal southeastern United States. Recommendations include avoiding the disturbance of wetland areas and incorporating their features into the design, ensuring an adequate water supply is available for all potable and irrigation needs of the golf facility and neighboring properties, selecting plant species that are best suited to the local climate and require the minimum of inputs, considering on-site retention of stormwater runoff on soils with low infiltration rates, making golf course managers aware of the wildlife species that frequent their courses and the risks incurred upon them by pesticide applications.

MEASURABLE GOALS:

Target a newly planned course to be built in compliance with the design elements in *An Environmentally Friendly Coastal Golf Course* at the beginning and an existing course for possible retrofit.

Award "Green Star" golf course designations for golf courses which comply or make significant improvements.

Distribute copies of "An Environmentally Friendly Coastal Golf Course" to developers, golf course designers and local government zoning and permitting departments.

IMPLEMENTATION:

DHEC-OCRM, LOCAL GOVERNMENTS, USGA

Encourage alternative development patterns

ACTION:

Pass regulations encouraging development patterns, such as neotraditional design, which improve stormwater management, protect open space, and lower infrastructure costs.

BACKGROUND:

Conventional development patterns, with large lot subdivisions and complete separation of residential and commercial uses, contribute to urban sprawl, encourage dependency upon the automobile, and generate additional road and parking requirements. Nationwide, planners and developers are considering "neotraditional" planning, reminiscent of towns and cities designed prior to World War II, for the development of their communities. Areas such as downtown Charleston and the Old Village in Mount Pleasant are good examples of such design, blending residential and commercial uses together in a compact and pedestrian-friendly setting. This compact development protects land resources, improves water quality by reducing impervious surfaces and associated stormwater runoff, and reduces the number and length of car trips required by the average family.

Several neotraditional projects have been built or partially built in the United States and Canada in recent years, with most started in the 1990s. Seaside, Florida, begun in 1981, is considered the first neotraditional community. It is a fifty-four acre semicircular property on the Gulf of Mexico that contains homes built closely together, a commercial/civic center, narrow streets, parks, and mixed land uses (residential property above retail and offices). The design of the development places the needs of the pedestrian above the automobile. Seaside has been a financial success, as property values in the community have increased dramatically since the project's inception. Newpoint in Beaufort and I'on in Mount Pleasant represent two examples of neotraditional developments in the Lowcountry of South Carolina.

The CHP conducted a study to evaluate the effects of neotraditional planning on stormwater runoff amounts in the watershed. Called the Belle Hall Plantation Charrette, this project examined the differences in stormwater runoff between two design scenarios, a typical "urban sprawl" development and a more traditional "town center" design (see page __ for an in depth description). The land saved from development in the Town scenario was left pristine in a large contiguous block, so elements of conservation subdivision design were demonstrated as well. Researchers determined that, if constructed, the sprawl scenario would produce 43% more runoff than the Town scenario and three times greater sediment loads. Infrastructure (pavement, curb and gutter, sidewalk, sewer, and waterline) costs for a typical lot in the sprawl scenario would be double that of a typical Town scenario lot. Local government services such as fire protection and garbage collections would also be less expensive in the Town scenario, since less area would need to be serviced.

Another alternative design form is conservation subdivision design, conceived by Randall Arendt, which also contains small lots, but instead preserves the remaining land as large, contiguous tracts left in their pristine state. Designs for these developments follow guidelines similar to those for golf course communities, but instead of building a golf course the land is left pristine, with footpaths for hiking and nature watching. (Mr. Arendt polled residents of a golf course community and found that 40% of residents did not play golf, they just liked being near the greenspaces.)

MEASURABLE GOALS:

Revise subdivision regulations and zoning ordinances to allow and encourage more environment-friendly development patterns such as conservation subdivision design and neotraditional design.

IMPLEMENTATION:

LOCAL GOVERNMENTS

Encourage utilization of existing wastewater capacity

ACTION:

Direct residential, commercial, and industrial developments to areas with existing wastewater treatment capacity.

BACKGROUND:

Guiding development to areas with existing wastewater capacity saves money and natural resources by making efficient use of existing facilities and by avoiding stretches of area rivers that cannot receive any more wastewater without negatively affecting water quality. The only other option in such overtaxed locations is to increase the level of wastewater treatment. Construction of new wastewater facilities to serve industrial development in these areas would be unnecessary if the projects were instead built where the receiving waterbody can still take extra discharges.

New development in remote areas disturbs more habitat and costs more money to establish and maintain. Either a new wastewater treatment plant must be built to serve the development or many more miles of water and sewer lines must be laid from an existing wastewater plant than would be required for a development built closer to the plant and the urban core.

MEASURABLE GOALS:

Maintain and update maps for each local municipality showing existing wastewater systems and their treatment capacity.

Develop incentives to encourage growth in areas with existing capacity and discourage new service to inappropriate areas.

Adopt incentives.

Inform taxpayers and rate payers and local decision makers about the economic costs of extending wastewater capacity to remote areas.

IMPLEMENTATION:

COG, DHEC-OCRM, LOCAL GOVERNMENTS

Design waterbody restoration efforts

ACTION: Design waterbody restoration programs with local governments in the Charleston Harbor watershed, using the CHP Summerville project as the model for interagency cooperation.

BACKGROUND:

In 1994, the Charleston Harbor Project initiated a wetlands restoration project at the Sawmill Branch Canal in Summerville with funding from the Environmental Protection Agency (EPA). The canal was formed in the 1960s by the Army Corps of Engineers to control flooding by deepening the existing creek and placing the dredge spoil between the creek and adjacent wetlands. Additionally, drainage pipes from the wetlands to the canal were placed too low, draining the wetlands instead of allowing them to retain and filter stormwater. In addition, other stormwater drain pipes from nearby developments bypassed the wetlands altogether and drained directly into the canal, resulting in sedimentation and polluted water in the canal, inadequate water supply to the wetlands, and eroded streambanks.

The restoration project, an effort by CHP, the Town of Summerville, Dorchester County, and other government agencies, solved the problem of the drainage pipes that led directly into the canal by redirecting them into the wetlands. The pipes that led from the wetlands to the canal were raised to allow the wetlands to retain more water. Now the water in the creek is cleaner because the wetlands can again filter it, and the wetlands are much healthier because they again have an adequate supply of water.

Other waterbodies exist in the CHP area, such as Filbin Creek in North Charleston, that would benefit from restoration projects similar to the one undertaken in Summerville. With adequate funding, such projects would have environmental, economic, and recreational benefits.

MEASURABLE GOALS:

Implement the Wetland Restoration Program funded by DHEC as part of the FY99 319 program.

Inventory potential wetland restoration projects in the CHP watershed.

IMPLEMENTATION:

DHEC-OCRM, LOCAL GOVERNMENTS

Encourage mass transit

ACTION:

Support efforts to develop and improve the mass transit system by making it more efficient and appealing to citizens.

BACKGROUND:

Until residents consider mass transportation to be a viable and convenient alternative to using private automobiles, mass transportation systems will continue to operate at less than maximum efficiency. Meanwhile, increased motor vehicle traffic requires more and larger roads (increasing impervious surfaces and rates of stormwater runoff); increases associated oil, grease, engine coolant, and tire wear pollutants; and increases sediments carried by runoff. An economically and functionally efficient mass transportation system reduces daily vehicle traffic, thus reducing needs for more and larger roadways and ultimately, reduces associated pollution.

The existing mass transit system must be made more efficient and appealing to citizens and be redefined to fit the community by making changes such as using smaller buses on certain routes and increasing reliability with more frequent arrivals. Other strategies used by cities in recent years include:

> Giving buses their own lane at traffic lights. The light changes early for the buses to move in front of cars.

> Creating programs for employers to offer financial incentives to their employees for using mass transit.

MEASURABLE GOALS:

Support efforts to educate the public on the benefits of mass transportation by developing and distributing information regarding environmental issues and transportation.

IMPLEMENTATION: LOCAL GOVERNMENTS CHATS and COG and Carta.

Encourage adoption of marina ordinance

ACTION:

Adopt marina ordinances throughout the tri-county area that reflect the CHP model ordinance.

BACKGROUND:

There are over 1,450 marina slips and 730 dry stack storage units in the Charleston Harbor Project area. Several marinas are planning to add additional slips. Marinas are regulated by federal, state, and local guidelines. Consequently the regulatory process is at times uncoordinated, resulting in poor siting decisions. A CHP project attempted to improve coordination among governmental agencies to enhance appropriate and environmentally consistent marina development. A general overview of constraints to marina siting included water quality classifications, water depth, bridges, streets and roads, wetlands and marshes, shellfish areas, existing land uses, and public services and utilities. A finished report provides a model ordinance for the CHP area that would improve marina siting throughout the watershed.

A CHP researcher reviewed the general permitting criteria required for a developer to secure a permit for marina construction within the Charleston Harbor area. It deals specifically with the implications of the need and demand terminology as they relate to the marine industry and marina development. The intent is to present OCRM, a permitting agency, with clarifying information about the need/demand controversy surrounding the permitting of marina development.

The primary issue in marina permitting is how the facility will affect water quality. The test for the effect on water quality has always been whether the facility will close shellfish beds. To protect public health, a shellfish buffer zone is established around marinas to prohibit the gathering of shellfish in potentially polluted areas. Other issues include the potential effects of marinas on navigation, the impacts of boat wakes on surrounding wetlands and upland property, dredging for construction and maintenance of a marina, and the effect of bridge openings on municipalities.

MEASURABLE GOALS:

Target Charleston County and City of Charleston to adopt measures from the CHP model marina ordinance.

IMPLEMENTATION:

DHEC-OCRM, LOCAL GOVERNMENTS SOUTH CAROLINA MARINA ASSOCIATION

APPENDICES

TASK FORCE MEMBERS
RESEARCHER BIOS
ACRONYMS