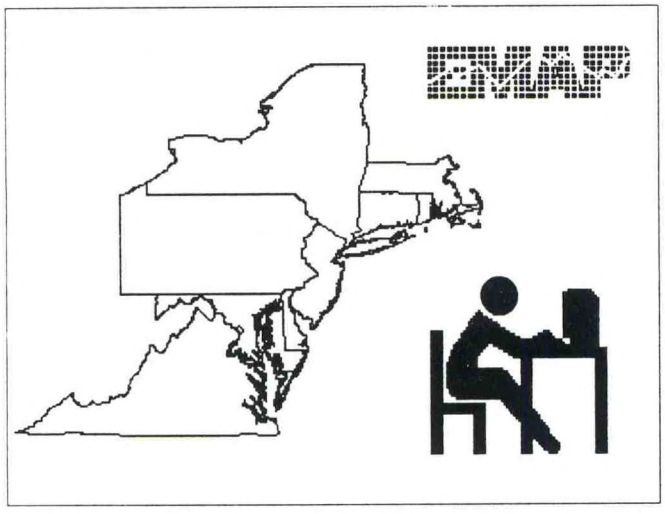
Project Description

A Desktop Information and Mapping System for Near Coastal Areas of the Mid-Atlantic United States

Supporting EPA's
Environmental Monitoring and
Assessment Program



National Oceanic and Atmospheric Administration
U.S. Department of Commerce

Office of Research and Development
United States Environmental Protection Agency

Joint NOAA/EPA Monitoring and Assessment Programs

NOAA and EPA have agreed to work together on the Near Coastal Component of the Environmental Monitoring and Assessment Program. This is the most recent in a series of joint activities undertaken to enhance both information and capabilities in coastal and estuarine resource management. Collaborative efforts to date include: 1) formal interagency agreements through which EPA has supported NOAA activities in areas of joint interest; 2) specific projects enlisting NOAA data and/or services for specific EPA policy or program needs; 3) NOAA participation on EPA technical committees and working groups; and 4) coordination of exhibits and presentations at conferences and symposia. Informal ongoing activities include staff exchanges between NOAA and EPA offices, and training of EPA staff and contractor personnel.

To date, products of these joint efforts include two atlases in NOAA's National Estuarine Inventory Data Atlas series and reports on topics such as estuarine nutrient susceptibility, regional environmental assessment, estuarine salinity characterization, pesticide use in coastal areas, and coastal pollutant discharges. NOAA has also provided data sets and custom software applications to support EPA regulatory responsibilities related to the Clean Water Act. In the coming year, several additional joint products will be developed, including a digital data base of shellfish closure areas which will accompany NOAA's 1990 National Shellfish Register, an extension of the National Eutrophication Project to focus on estuaries in EPA's National Estuary Program, and a simple spreadsheet system to enable screening-level analyses of nutrient enrichment in Gulf of Mexico estuaries.

Offices Responsible for the Mid-Atlantic Desktop Information and Mapping System

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National Ocean Service
National Oceanic and Atmospheric Administration
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Rockville, MD 29852

Environmental Monitoring and Assessment Program
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A Desktop Information and Mapping System for Near Coastal Areas of the Mid-Atlantic United States

NOAA's Strategic Environmental Assessments (SEA) Division and EPA's Office of Research and Development have initiated a cooperative project to develop a prototype desktop, microcomputer-based information system to display, map, and organize data for the Virginian Province (Mid-Atlantic states) demonstration project of the Environmental Monitoring and Assessment Program's (EMAP) Near Coastal Component. When completed, the system will include data sets on environmental monitoring, pollution characterization, habitats, and biological resources.

Introduction

The desktop prototype of the Mid-Atlantic Information and Mapping System is intended for distribution to Federal, State, and regional institutions active in EMAP, and to other selected institutions in the government, academic, public, and private sectors. This paper describes the objectives, initial specifications, and development schedule for the system.

An Evolving Partnership. Two years ago, EPA initiated EMAP to assess the effectiveness of pollutant control strategies throughout the coastal and interior regions of the United States. A principle thrust of EMAP has been monitoring and sampling activities followed by synthesis and assessment to characterize the Nation's environmental and ecological resources. The program's Near Coastal Component, initiated with a demonstration project for the Virginian Province, specifically targets coastal land and water areas—especially estuaries—for extensive studies.

For many years NOAA has been actively involved in programs to characterize the Nation's nearshore environment, including the National Status and Trends (NS&T) Program, the National Estuarine Inventory (NEI), the National Coastal Pollutant Discharge Inventory (NCPDI) and others. During this time, EPA, NOAA, and other agencies charged with scientific and/or management responsibilities for the Nation's coasts, have been evolving toward a unified Federal effort to assess and manage these important resources. EMAP provides an excellent vehicle to further this cooperative evolution.

In September 1990, EPA and NOAA staff began a series of discussions to identify activities through which NOAA's scientific and technical expertise could be applied to EMAP. Besides development of the Mid-Atlantic Information and Mapping System, other activities include: 1) management of the Carolinian Province Monitoring and Assessment Survey; 2) expansion of the NS&T Quality Assurance Program for EMAP chemical sampling; and 3) a synthesis assessment of pollutant contamination, including sources and effects, for the Virginian Province.

What are Desktop Information Systems?

Recent developments in microcomputer technology have made it possible to bring a wide range of information and capabilities to the desk of the researcher or manager. Desktop informaton systems take advantage of these expanding capabilities by combining data and information with analytical functions in simple, easy-to-use computer environments.

Desktop systems are generally easier to learn than their mainframe or workstation counterparts, thus broadening the number of potential users. Although the gap between mainframe and desktop systems continues to close, desktop systems remain more limited in the types of questions they can address. Still, knowledgeable desktop system users are able to answer numerous questions quickly, perform a variety of screening-level type analyses, and develop high-quality reports and other paper products with relative ease.

Why Develop a Desktop System? The EMAP Virginian Province demonstration project is the first of a series of projects designed to characterize estuarine and coastal areas of the U.S. through sampling, monitoring, assessment, and synthesis. Over the next several years, the project will develop considerable new data across a wide range of environmental parameters. These data will supplement the substantial information which already exists for the region.

The raw data developed in the project will be voluminous and complex, and analysis, interpretation, and summary will require highly trained specialists with large, sophisticated computer systems. Still, the distribution of summary data is best done through a desktop system. Such systems are excellent ve-

hicles for organizing, synthesizing, and distributing information because their simple format imposes a strong discipline on the structure, quality control, and documentation of the data. The user-friendly capabilities of desktop systems widen the access of researchers and resource managers to information. Also, the desktop system development process will allow EPA and NOAA staff to examine the types of analytical capabilities and data structures most suitable for similar summary data developed in other near coastal provinces.

EMAP

EMAP is a long-term, national effort designed to assess and document the status and trends in the condition of the Nation's forests, wetlands, estuaries, coastal waters, lakes, rivers and streams, Great Lakes, agricultural lands, and arid lands on an integrated and continuing basis (Holland, A.F. ed., 1990). The program is an ambitious effort involving numerous Federal agencies, and includes major land- and water-based monitoring and data-gathering programs, combined with assessment activities for "earlier detection of problems and improved identification of their extent, magnitude, and likely causes" and "more cost-effective regulatory and remedial actions" (Holland, A.F. ed., 1990).

The Near Coastal Component. EMAP's Near Coastal Component focuses on the ecological resources of the Nation's estuarine and coastal environments. The program divides the Nation into 13 provinces, each of which will be the subject of intensive study. The Virginian Province, which includes coastal and oceanic waters from Massachusetts through Virginia (Figure 1), has been chosen for the demonstration project primarily because of its rich and varied estuarine systems. Estuaries are the initial focus of the Near Coastal Component because they function as repositories of land-based pollutant discharges, serve as important reproductive habitat for many marine species, and are often indicators of watershed-wide conditions.

The Near Coastal Component proposes a set of environmental indicators to determine the ecological health of large regions of the Nation's coastal waters. Early data-gathering activities are centered on four types of indicators: 1) response (e.g., benthic and fish community composition, abundance, pathology, and histopathology); 2) exposure (e.g., dissolved oxygen concentrations, sediment toxicity, and contaminant concentrations); 3) habitat (e.g., sediment characteristics, and salinity); and 4) stressor (e.g., pollutant loadings, land use, and climatic fluctuations). The sampling strategy, a stratified random sample using a systematic grid, is designed to allow regional-level generalizations of environmental status and trends after four years of individual station sampling. Intensive sampling of numerous parameters will be undertaken during the time window (index period) in which the indicators are expected to show the greatest response to pollutant stress (for further details, see Holland, A.F. ed., 1990).

SEA Division's Desktop Information Systems

For several years, NOAA's Strategic Environmental Assessments Division has developed desktop information systems for specific topics concerning ocean and coastal resources. The SEA Division's electronic products are distributed to government, academic, and private- sector organizations.

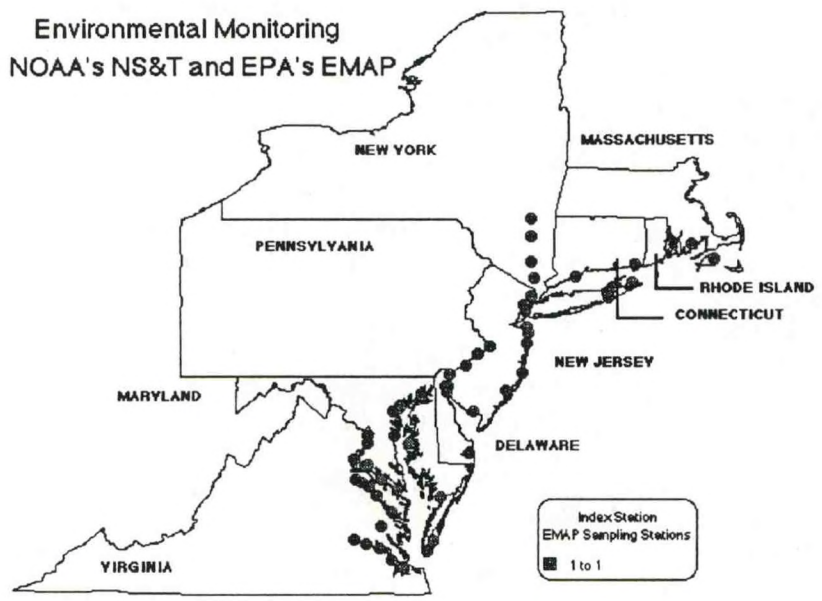
Completed products include: ***The Gulf of Mexico Shrimp Harvest Desktop Information System*** (SAB, 1989a); ***The West Coast of North America Colonial Seabirds Desktop Information System*** (SAB, 1990); ***The Bering, Chukchi, and Beaufort Seas Biogeography Desktop Information System*** (SAB, 1989b).

A new product, the ***Coastal Ocean Management Planning, and Assessment System*** (COMPAS), has been designed to assist state-level resource managers (SAB, 1989c). A COMPAS system for the State of Texas is in the final stages of development; work on the second state, Florida, has been initiated. Additional SEA Division prototype desktop demonstration systems include: 1) Gulf of Mexico pollutant discharges; 2) SEAMAP groundfish trawl survey data; and 3) the Mid-Atlantic Information and Mapping System, the subject of this document.

The Demonstration System

In the fall of 1990 NOAA developed a demonstration desktop system to illustrate the feasibility of the proposed project. Consistent with the objective of focusing on information content, the demonstration system included numerous data sets on pollutant discharges, regional sampling programs, coastal characterization, and coastal and marine habitats. Since the system contained complete data sets and functioning software, it provided a solid base on which to build the final system. Over the past several months, NOAA and EPA have previewed the demonstration system at numerous institutions working on the Virginian Province project.

Figure 1. *The Virginian Province study area, showing sites of the Near Coastal Component's index stations.*



Macintosh or PC applications for specialized analysis.

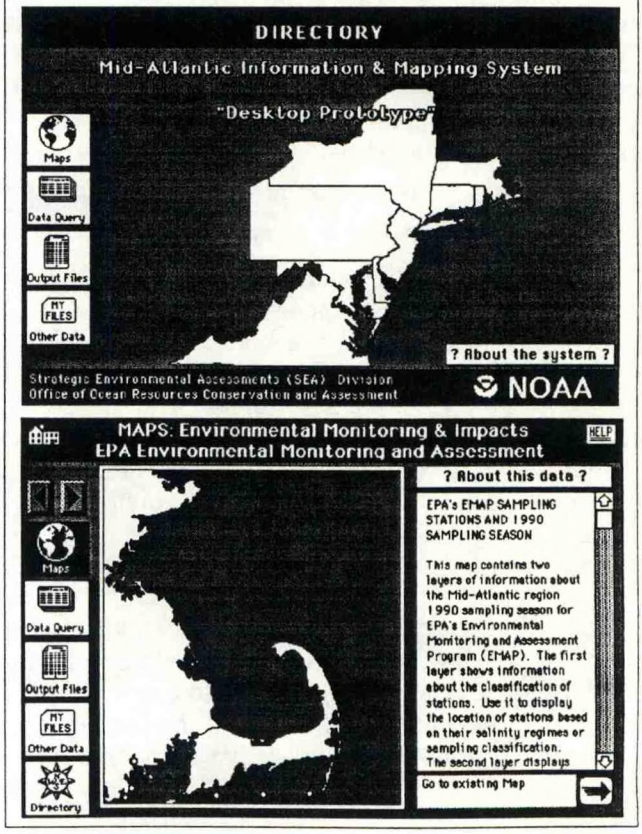
It is anticipated that users will want to incorporate their own data sets, to take advantage of the system's capabilities and to view and/or analyze their data within the context of the information within the system. In the demonstration system, this capability has been provided through a general utility called "StackMaker," which takes any spreadsheet-type file (with a few simple formatting conventions), and converts it to a data set equivalent to all other data sets in the system. Once in the system, all mapping, data management, and data analysis operations become available for use with the data set.

The demonstration system has two basic components: 1) data and associated data-management, query, and manipulation; and 2) a "Mapping Toolkit" which provides a broad range of mapping capabilities. These components are organized within a single application written in HyperCard, an "index card" browsing environment provided with all Apple Macintosh computers.

The system's focal point is "The Directory," a navigational tool which allows users to move quickly between various parts of the system, for example, from a specific data base to a data-rich map. The Directory includes an introductory card for each system component, which provides a "visual clue," a brief explanation, and access to specific on-line data documentation (Figure 2).

Data and Data Management. Each data set in the system is structured within a HyperCard-based data management application written by NOAA. These applications have a standard set of functions including: 1) simple browsing; 2) sorting; 3) multivariable data searching and data extraction; 4) simple graphing; 5) direct data overlay to a base map; 6) development of linear data value combinations; 7) simple reporting; and 8) exporting of data sets or subsets as simple ASCII files (Figure 3). Exported ASCII files can be read with any standard word processing or spreadsheet application, and/or exported to other

Figure 2. *The Directory card for the demonstration system, and introductory card for the EMAP sampling station map.*



The Mapping Toolkit. Mapping will be one of the external analytical tools used in EMAP's Near Coastal Component, and will be a major function of the desktop product (Figure 4). Although desktop systems cannot provide the full range of functions available in large Geographic Information Systems (such as ARC/INFO™) they do provide considerable mapping and assessment tools. The Mid-Atlantic system includes a robust set of mapping functions including base maps, pre-loaded multilayered maps for selected data sets, the ability to place any data set or subset on a base map, the ability to create new maps with a variety of geographic features (e.g., counties, rivers etc.), and more. The mapping component is provided through a combination of Atlas*Mapmaker™, a commercial product of Strategic Mapping Incorporated, and specialized software written by NOAA.

With the Mapping Toolkit, NOAA provides a range of digital geographies from its own libraries (at a 1:2,000,000 scale) including state boundaries, counties, hydrologic cataloging units, estuarine and coastal drainage areas, rivers, water bodies, and offshore bathymetry. Selected coastline geographies at a 1:250,000 scale are being developed for the final system.

Lessons of the Demonstration. Experience with the demonstration system indicates that the primary focus and most resource-intensive aspect of building the final system will be organizing, editing, and aggregating the data. Defining suitable data types and structures must be carefully planned in the beginning stages of the design process.

Building the System

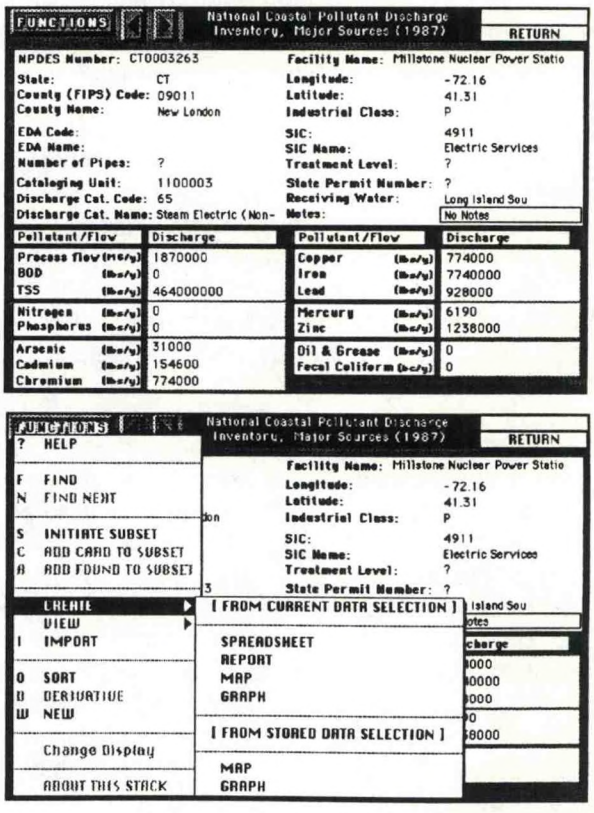
Based on the advantages and limitations of desktop systems, the guiding design principle will be the development of a rich information base to examine a wide variety of data themes relating to the health of estuarine and coastal waters. While EMAP near-coastal sampling data will be a major component of the system, these data will be complemented by numerous other themes to assist in interpretation, and in achieving EMAP's goal of environmental characterization.

Additional design concepts include: 1) system openness, i.e., allowing individual users to easily add their own data sets to the system or to extract (export) any subset of data; 2) simplicity, i.e., an emphasis on a limited number of basic operations common to all data sets to reduce the time needed to learn the system; 3) documentation, i.e., complete for each data set, both within the system and in a reference manual; and 4) low cost, i.e., available at a reasonable total cost for the institutions in the target user group.

Data Sets. Considerable attention will be given to equipping the system with a wide variety of information to enable characterization of the region's environmental resources. Supplementary material will be incorporated to improve data interpretation and analysis. Although priority will be given to the EMAP near-coastal sampling data, this will be supplemented by information from national and State programs, such as NOAA's NS&T and NEI. This information is readily available, and will be easily incorporated into the system. EPA has also developed data sets for a number of important regional characteristics (e.g., toxics release sites, drinking water supplies, etc.).

It must be noted, however, that the desktop system will not be a "data warehouse." Such warehousing is

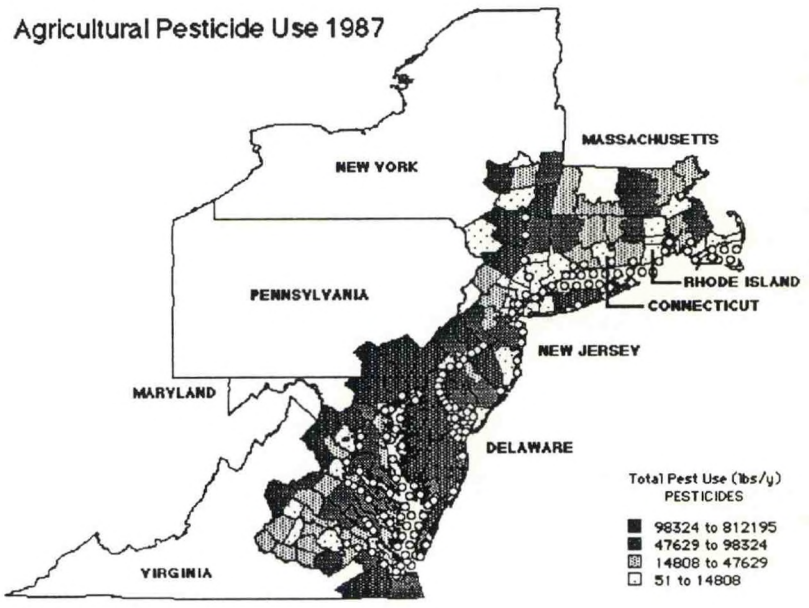
Figure 3. *An example data card on point sources of pollution, and a card showing analytical functions of the system's data management component.*



an appropriate function for archival mainframe systems. All of the data sets to be included in the Mid-Atlantic system will undergo a carefully designed synthesis and aggregation process to extract the most relevant information.

EPA and NOAA are presently reviewing the types of data sets to be incorporated (Table 1). The following criteria will be applied to the selection process: 1) importance to the objectives of the Near Coastal Component (especially the emphasis on estuaries); 2) areal coverage (data bases should cover all, or a large portion, of the study area); and 3) data quality (unedited, poorly documented data sets with obvious errors will be excluded).

Figure 4. *Map of agricultural pesticide use from the demonstration system, based on data from NOAA's National Coastal Pollutant Dischage Inventory and EMAP sampling stations.*



Working with Users. Because the Mid-Atlantic Information and Mapping System is specialized (focusing on the Near Coastal Sampling Program and supporting characterization data) the initial user community will be a select group of Federal, State, and regional institutions, who are either active in the Virginian Province project, or whose management responsibilities will directly benefit from the information.

Because of limited resources, system development will require the examination of potential trade-offs such as incorporating one data set versus another, the degree to which certain data sets will be aggregated, and adding additional data sets or developing advanced capabilities. To ensure that such decisions incorporate the input of potential users, the project will include several activities designed to elicit user comments.

The project will be directed by a small working group with representatives from NOAA, EMAP's Near Coastal Component, and EPA Region III. Several meetings will be held with a larger group including representatives of State agencies and regional authorities. This extended group will review progress, and will be encouraged to provide suggestions. There will also be site visits to demonstrate the system and to gather additional comments. As the system nears completion, a small number of institutions will be asked to participate in an informal testing program. Upon distribution, NOAA and EPA jointly will host training sessions for interested users.

Microcomputer Platform. The prototype system will be designed for the Apple Macintosh microcomputer. NOAA has considerable experience in designing desktop systems on this platform. The Macintosh is an excellent platform in which to design a fully functional prototype in a relatively short period, and is a highly integrated machine, with an intuitive user interface which complements the desktop system's user-friendly design.

However, with the advent of the PC/Windows operat-

Operating Environment

- Apple Macintosh microcomputer
- Mac II or larger system
- 2.0 MB RAM minimum
- Color monitor
- Removable media hard drive (40 MB)
- System 6.05 or higher

Table 1. Potential data themes for the Mid-Atlantic desktop information and mapping system.

EMAP Near Coastal Sampling Data
- Physical/chemical properties
- Benthic infauna
- Sediment characterization
- Fish and invertebrate surveys

NOAA Data
- Status & Trends monitoring
- Point sources of pollution
- Nonpoint sources of pollution
- Demographics
- Land use
- Wetlands (aggregated)
- Agricutural pesticide use (aggregated)
- National Estuarine Inventory data
- Surficial sediments
- Shellfish area closures
- Fish kill events

Other Data
- CERCLIS sites
- RCRA wastehandler sites
- Toxics release inventory
- Drinking water supplies
- Climate data

ing system, the Macintosh and PC environments are rapidly becoming equally user-friendly. Depending upon the level of user interest, EPA and NOAA may evaluate (upon completion of the Macintosh product) the possibility of converting the Mid-Atlantic system to PC/Windows.

During the project, a significant investment will be made in items unrelated to microcomputer platform, such as data base cleanup, structuring, and synthesis; the development of digital geographies for mapping; and data documentation. So PC users can benefit from this effort, NOAA and EPA can provide requesting institutions with ASCII files for all data sets and digital geographies on PC-readable disks, together with data and geography documentation. All files will have standard formats for immediate transferal to user systems.

Development Schedule

Project development is scheduled for one year, from August 1991 to 1992. The final product will be a fully tested desktop information system which will operate on most Macintosh microcomputers with an accompanying user's guide and data reference manual.

The project will evolve in three phases. Phase 1 (August 1991 to January 1992) will emphasize data base selection and preparation, and software development. The result will be an advanced demonstration system which will include several complete data sets. Phase 2 (February 1992 to May 1992) will focus on structuring the final data sets, and system testing. During Phase 3 (June 1992 to August 1992), documentation will be developed, and any remaining software "bugs" or data errors will be corrected. Distribution of the prototype will begin shortly thereafter.

The desktop product and the development schedule are ambitious, based on optimistic assumptions about data availability and quality, and a system design that, once established, undergoes few changes. Experience indicates, however, that a number of situations may arise which delay and/or change the product considerably. These include problems with data editing and clean-up by the responsible agencies, customized design and/or capabilities for specific data sets, and software changes to incorporate advanced analytical features. Both NOAA and EPA are committed to reducing these possibilities, and to developing a timely, high-quality product.

Concluding Comments

The Mid-Atlantic Information and Mapping System is only one element of a multifaceted NOAA/EPA program to improve coordination and information exchange among the agencies responsible for managing the Nation's coastal resources.

NOAA and EPA are confident that the final product, rich in information and simply designed, will be a useful tool for disseminating information gathered in the Virginian Province demonstration project, and for amplifying the participation and contributions of State and regional institutions in EMAP's Near Coastal Component.

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