Miscellaneous Paper CERC-95-4
June 1995

US Army Corps of Engineers
Waterways Experiment Station

Coastal Engineering Data Retrieval System (CEDRS)

by Danielle S. McAneny

Prepared for Headquarters, U.S. Army Corps of Engineers

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Final report

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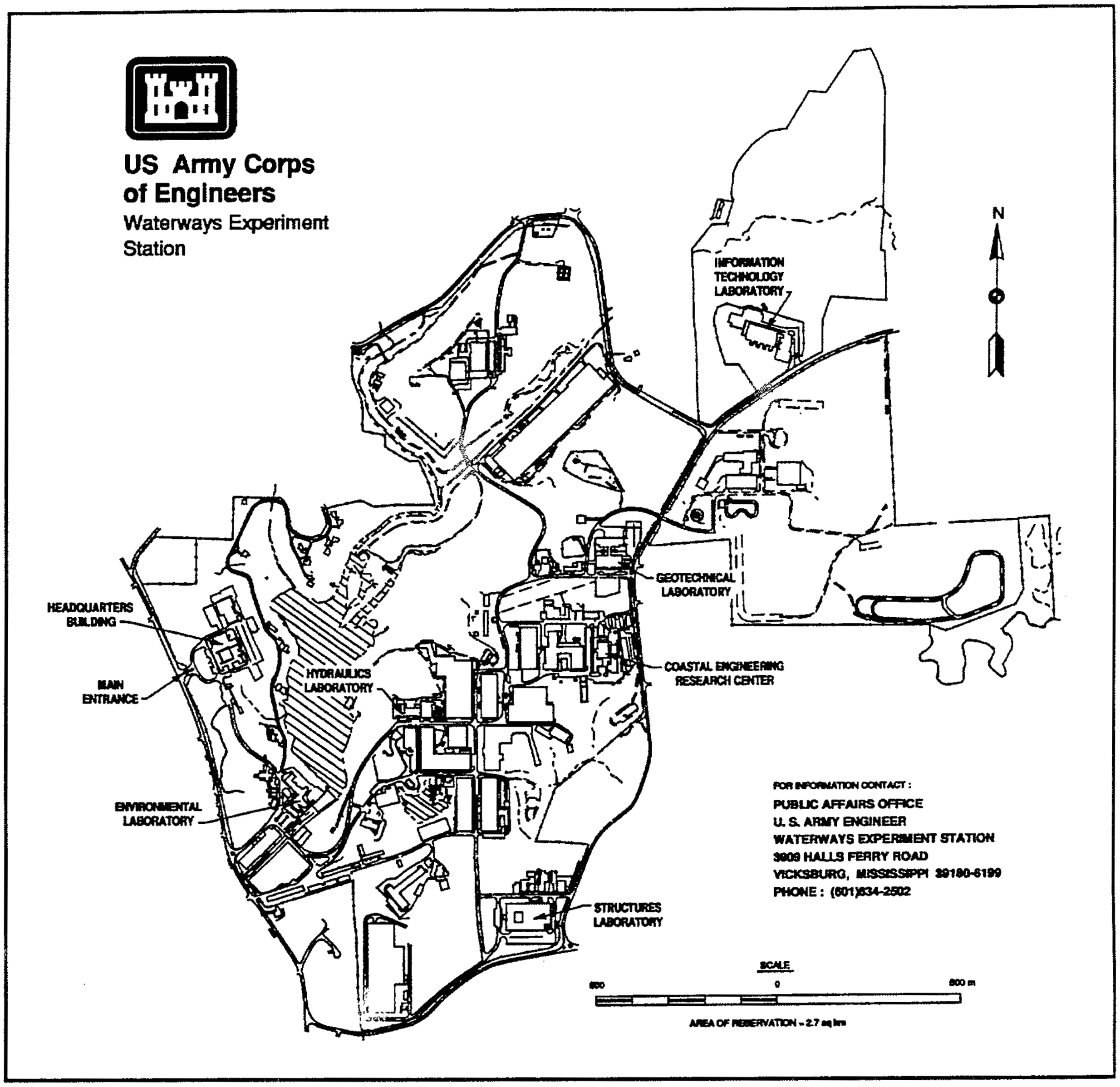

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Contents

Preface

The Coastal Engineering Data Retrieval System (CEDRS) documented herein was developed under the Coastal Engineering Management Information System (CEMIS) work unit of the Coastal Field Data Collection Program (CFDCP) by the CEMIS Group, Coastal Oceanography Branch (COB), Research Division (RD), Coastal Engineering Research Center (CERC), U.S. Army Engineer Waterways Experiment Station (WES). Messrs. John H. Lockhart and John G. Housley were the Technical Monitors for this program at Headquarters, U.S. Army Corps of Engineers.

Development of the system was performed by Mr. Doyle L. Jones and Mrs. Danielle S. McAneny, Principal Investigator of the CEMIS. The work was performed under the direction of Dr. James R. Houston, Director, CERC; Mr. Charles C. Calhoun, Jr., Assistant Director, CERC; Mr. J. Michael Hemsley and Ms. Carolyn M. Holmes, Program Managers, CFDCP; and Mr. H. Lee Butler, Chief, RD. Direct supervision was provided by Dr. Martin C. Miller, Chief, COB, in coordination with Dr. Jon M. Hubertz, Principal Investigator, Wave Information Study, and Mr. David A. Leenknecht, Principal Investigator, Automated Coastal Engineering System.

At the time of publication of this report, Director of WES was Dr. Robert W. Whalin. Commander was COL Bruce K. Howard, EN.

1 Introduction

In 1978, a computer hindcast project to produce a wave climate for U.S. coastal waters was initiated at the U.S. Army Engineer Waterways Experiment Station (WES) (Corson, Resio, and Vincent 1980). Under authority of Headquarters, U.S. Army Corps of Engineers, and as a function of the Coastal Field Data Collection Program, the Wave Information Study (WIS) group of the WES Hydraulics Laboratory was formed to carry out this work.

The first data set resulting from this project was a 20-year time series of climatological data for locations along the Atlantic coast of the United States (Brooks and Corson 1984). Additional hindcasts for the Great Lakes, Gulf of Mexico, and Pacific coasts of the United States followed. As Corps engineers and scientists began to use this large data set for support of projects such as design of coastal structures, study of shoreline erosion, and beach enrichment, the need soon became apparent for a system to allow users direct access to the data.

In 1983 the first coastal database for Corps of Engineers Districts was developed (Ragsdale 1983; McAneny 1986). The purpose of that database was to provide users direct access to the data produced by the WIS hindcasts. That system, the Sea-State Engineering Analysis System (SEAS), was developed for the computer hardware (Honeywell DPS-8) and data storage media (magnetic tapes) available to WES at that time. SEAS was designed to operate in a combined interactive (time-sharing) and remote batch mode. This mode of operation allowed users the convenience of conversational system interaction for choosing from available data and output products, while the time-consuming processing tasks were performed in the batch environment for efficiency.

The vast quantities of hindcast data were stored on magnetic tape. A single 20-year time series for one location is approximately 60,000 records; and the first WIS hindcast produced data for 73 locations along the Atlantic coast—a total of more than 131 MB of data.

Basic operation of SEAS allowed the user to extract a data set for a chosen location and time period to be copied to disk storage. The user could then choose from a number of plots and statistical procedures to process the data and display results at his terminal.

SEAS was made available to all Corps of Engineers offices via long-distance telephone dial-up to the WES computer. Any Corps user with a terminal and modem was only a telephone call away from the SEAS database on the WES Honeywell computer.

Even though SEAS was a friendly, relatively easy-to-access system, users at remote Corps offices did not make use of the system in large numbers. Many Corps offices had problems with basic system communication via long-distance telephone; but the primary problem with SEAS was that most users needed, not data subsets, but entire 20-year data sets to be used as model input. With communications line speeds available at that time, it was not practical to transmit an entire 60,000-line data set to a remote office. Most users preferred to have their SEAS processing done at WES and final output mailed to them, rather than contending with the frustrations of communications and data sets too large for transmission. For a number of years SEAS served as one of the primary data-distribution media for WIS hindcast data; the only alternative was shipment of magnetic tapes to requesting users.

2 Regional Database Concept

In the late 1980's, with the popularity of personal computers (PC's) growing in Corps offices, a new means of distributing data was envisioned—a microcomputer database conveniently located in the engineer's office. From this vision the Coastal Engineering Data Retrieval System (CEDRS) was born—an interactive microcomputer-resident database system to provide not only hindcast data, but also measured wind and wave data, for use in the field of coastal engineering. CEDRS was designed from a regional approach to allow handling of the massive amount of available data in the microcomputer environment; a total of 21 CEDRS database sites were defined (Figure 1), for regions approximately following the boundaries of coastal Corps of Engineers Districts.

CEDRS Pilot System

In 1989 a pilot version of CEDRS was developed for the Gulf of Mexico coast of Florida for the U.S. Army Engineer District, Jacksonville. This initial system was composed of an interactive FORTRAN module and a series of data files, stored in ASCII format, containing the following:

a. Nineteen WIS hindcast stations.

b. Two University of Florida Coastal Data Network stations.

c. One Littoral Environment Observation (LEO) Retrieval System station.

d. Two National Data Buoy Center (NDBC) stations.

A number of references are provided in the Bibliography at the end of this report which give detailed descriptions of all of the data types included in CEDRS, their sources, and their method of collection (or computer generation).

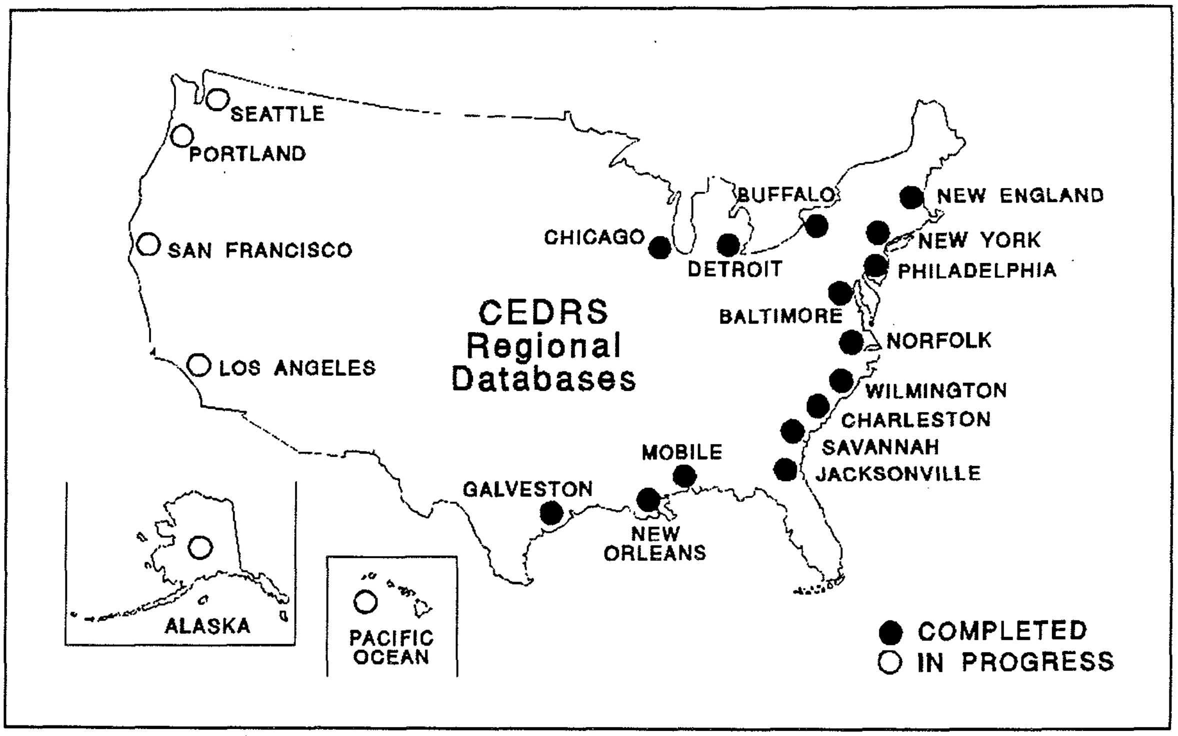

Figure 1. Map showing CEDRS database sites for Corps of Engineers coastal Districts

The system was stored on an external optical disk drive connected to one of the District's standard AT-type microcomputers. The storage medium used was an IBM 3363 optical disk drive with 200-MB removable cartridges. One of these cartridges provided adequate space for data-storage requirements with additional space for growth.

Basic CEDRS functions are shown in Figure 2, a replica of the CEDRS Master Menu. Figure 3 shows one of the regional maps, which in conjunction with tables of location data, are used for defining available data. An example of one of the various types of data plots is shown in Figure 4. Figure 5 illustrates one of the hurricane products; and Figures 6 and 7 illustrate several of the CEDRS statistical tables. Probably the most important CEDRS function allows extraction of user-defined data subsets for import into other software modules (i.e., spreadsheets, graphics, and various Corps engineering models). Figure 8 describes the contents of a typical CEDRS extract file for WIS hindcast data. A sample CEDRS user's guide is attached as Appendix A.

The pilot CEDRS system was well received by District users, even though data access was relatively slow by today's standards. Availability of this comprehensive data set in the engineer's office was a major improvement in data accessibility.

Data-access speed in the pilot CEDRS system was restricted not only by the slow access time of the optical-disk hardware, but also by the sequential

```
Coastal Engineering Data Retrieval System
CEDRS

MASTER MENU

1. Regional Map
2. Available Information for Region
3. Extract of Data Subjects
4. Plot Data
5. Precomputed Statistical Reports
6. Hurricane Statistics
7. Exit to DOS

0 = HELP    SELECT (0 or 1 - 7)  [1]
```

Figure 2. CEDRS Master Menu showing basic system functions

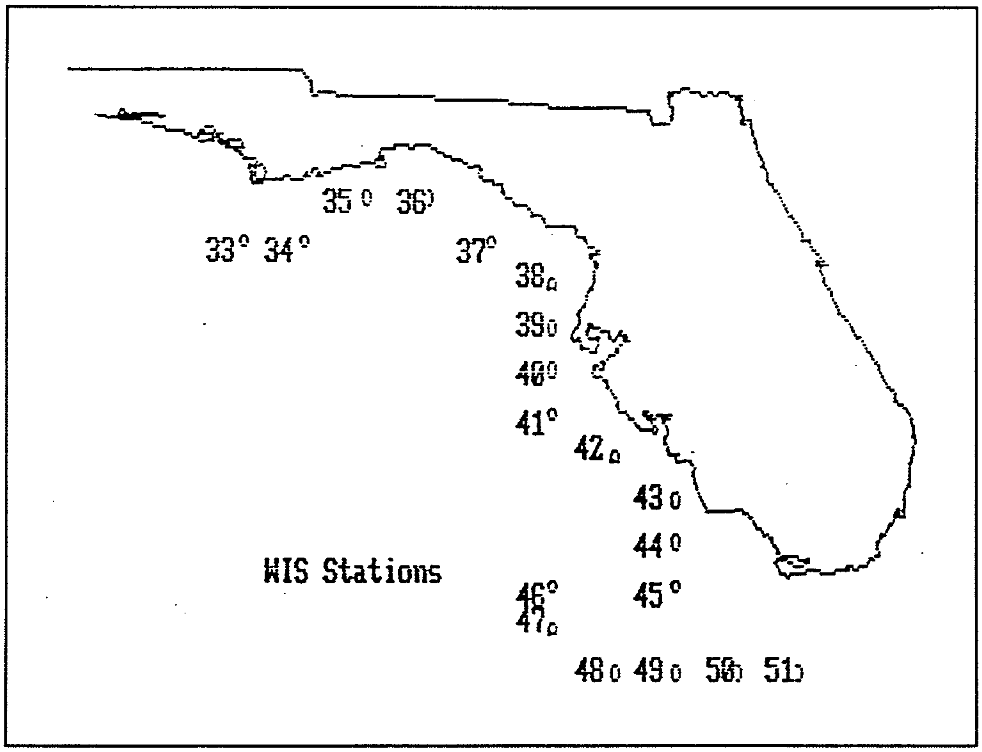

Figure 3. Map showing locations of WIS stations from the 1988 Gulf of Mexico hindcast

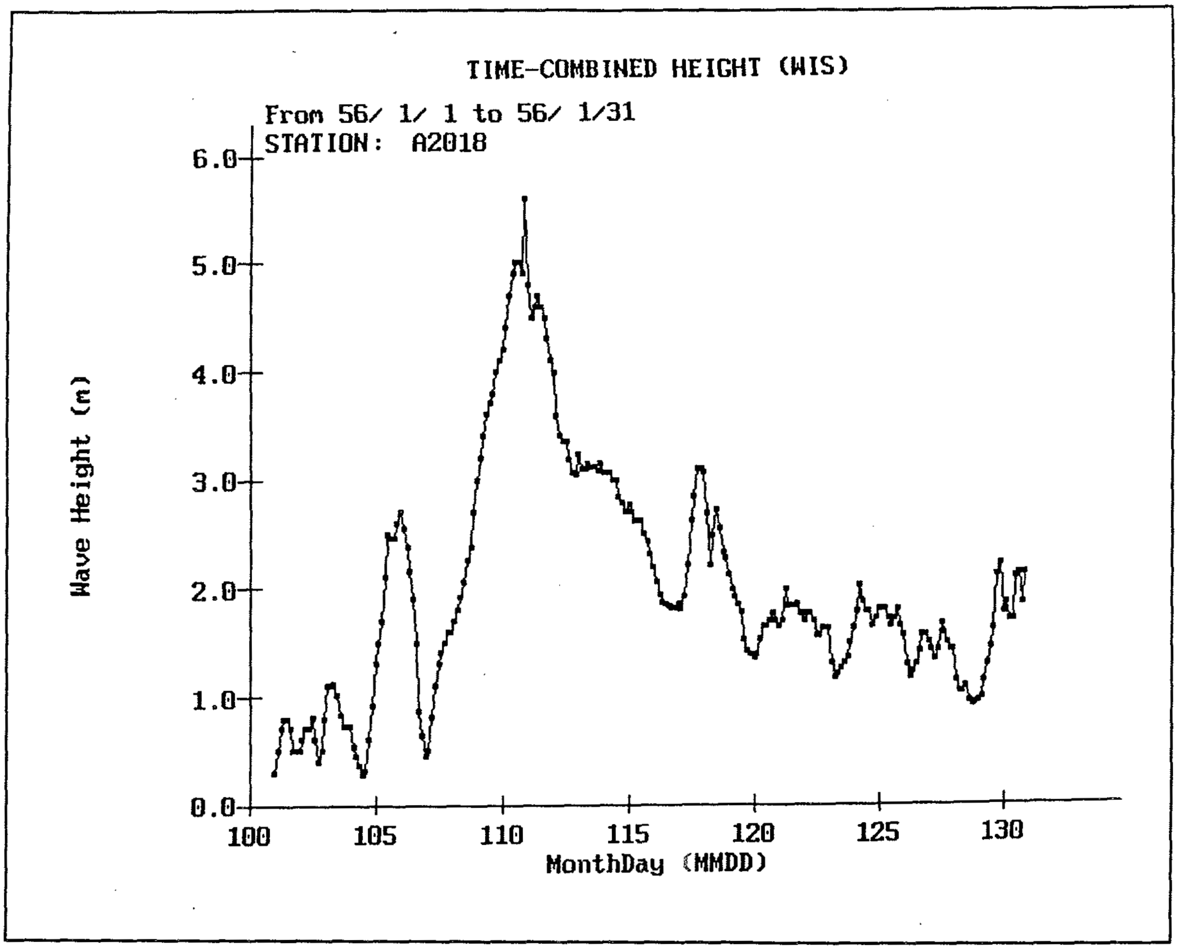

Figure 4. Plot of WIS wave height for Atlantic Station 18 for the month of January 1956

structure of the data files. With sequential files, every record must be read until the desired record is reached. Measured data sets were not large enough to cause significant data-access delays; but for the WIS hindcast data, even though subdivided into 20 yearly files, read time for records near the end of a yearly file was quite lengthy.

Introduction of RDBMS Techniques

Investigation of alternative data-storage techniques was the obvious next step. Since Relational DataBase Management System (RDBMS) techniques seemed to offer the most potential for speeding up data access, a study was made of RDBMS software available for the microcomputer environment. Project researchers were aware that the CEDRS data did not need the relational capabilities of this technique, but hoped that increased speed of data access would offset any disadvantage produced by the overhead introduced by the RDBMS technique. After months of study and software testing, RDBMS software package was chosen for CEDRS which met the following requirements:

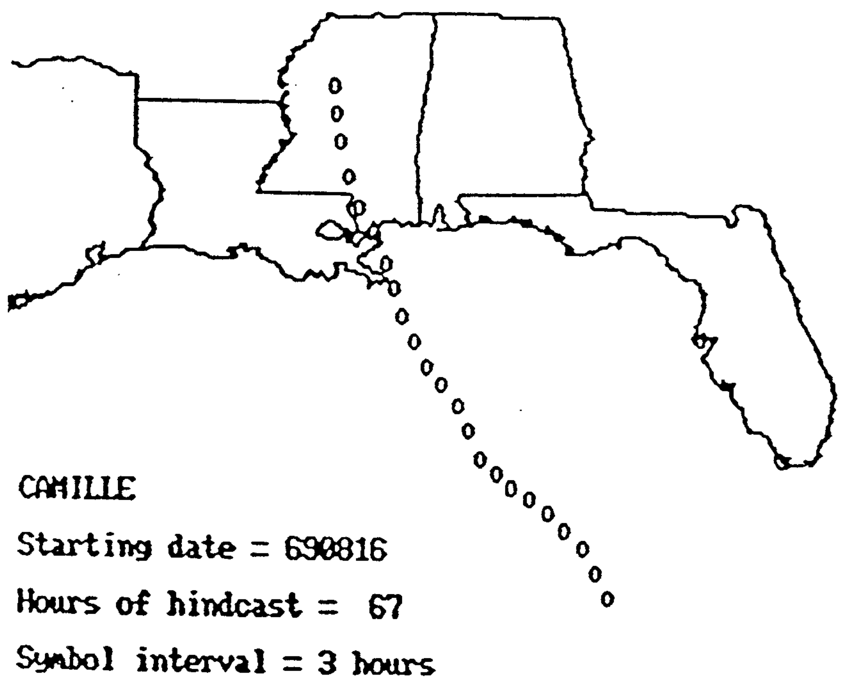

Figure 5. Map depicting storm track of 1969 Hurricane Camille

STATION A2028 (30.75N, 81.25W) DEPTH: 11 Meters

	RETURN PERIOD (Years)					
	2	5	10	20	25	50
TYPE I	3.52	3.81	4.01	4.20	4.26	4.44
TYPE II	3.54	3.87	4.12	4.38	4.47	4.74

NOTE: Return periods calculated using ACES code for Extremal Significant Wave Height Analysis--Goda Method, Fisher-Tippett Type I and II probability distributions. (Leenknecht, 1990).

Figure 6. Example of statistical table showing return period of extremal wave heights for WIS hindcast data

a. Availability of Structured Query Language (SQL) access to allow the CEDRS database to be directly accessible by users outside of CEDRS. This was an important factor since a major CEDRS goal was to maintain compatibility with the Automated Coastal Engineering System (ACES), a library of coastal engineering computer programs which require CEDRS data for input (Leenknecht and Szuwalski 1992).

PERCENT OCCURRENCE (X1000) OF HEIGHT AND PERIOD
FOR ALL DIRECTIONS

STATION: A2001 (24.5N, 81.2W / 183.0M) NO. CASES: 58440
% OF TOTAL: 100.0

HEIGHT IN METERS	PEAK PERIOD (IN SECONDS) <4.0	4.0-4.9	5.0-5.9	6.0-6.9	7.0-7.9	8.0-8.9	9.0-9.9	10.0-10.9	11.0-11.9	12.0-LONGER	TOTAL
0.00-0.99	41457	26806	7790	492	313	343	362	251	207	270	78291
1.00-1.99	.	4199	5821	6160	2770	480	6	.	.	.	19436
2.00-2.99	.	.	27	138	817	800	246	47	1	.	2076
3.00-3.99	.	.	.	.	6	51	87	20	3	.	167
4.00-4.99	.	.	.	.	.	3	10	.	.	.	13
5.00-5.99	.	.	.	.	.	.	.	.	.	.	0
6.00-6.99	.	.	.	.	.	.	.	.	.	.	0
7.00-7.99	.	.	.	.	.	.	.	.	.	.	0
8.00-8.99	.	.	.	.	.	.	.	.	.	.	0
9.00-9.99	.	.	.	.	.	.	.	.	.	.	0
10.00+	.	.	.	.	.	.	.	.	.	.	0
TOTAL	41457	31005	13638	6790	3906	1677	711	318	211	270	

MEAN Hmo(M) = 0.7 LARGEST Hmo(M) = 4.3 MEAN TP(SEC) = 4.1

Figure 7. Excerpt from percent occurrence table showing distribution of wave heights and periods. Separate tables for 16 direction bands and a composite table for all directions are available

b. Capability of handling large databases. Many of the popular RDBMS software packages marketed for the microcomputer environment are not capable of handling a database of the size needed for CEDRS.

c. Availability of training and technical support. Since project personnel had no prior training in use of RDBMS techniques, considerable initial training was required. Training classes were readily available in this geographic area; and technical support for other large RDBMS projects was already available onsite at WES.

The RDBMS chosen for CEDRS was ORACLE Corporation's ORACLE for MS-DOS. Their ORACLE Pro-FORTRAN interface was also included to allow more flexibility in the design of user interaction functions. CEDRS screens and built-in information files eliminated the requirement for users learning how to use the RDBMS software.

The basic approach to development of a new RDBMS-based CEDRS involved retaining the basic input and output data functions of the FORTRAN-based pilot system, and linking this module to the new ORACLE database via the Pro-FORTRAN interface which converted SQL necessary for accessing the RDBMS database to standard FORTRAN. The reason for choosing this approach was to retain the user-friendly look popular with Corps users of the ACES library (and preserved in the pilot CEDRS system), and eliminate the

```
Header line 1 -- Station identification information

   Data type (WIS)
   Station name/number
   Start date (year/month/day/hour)
   End date (year/month/day/hour)
   Total number of records available
   Latitude
   Longitude
   Water depth

Detail lines 2 thru n -- Time series of wind/wave parameters

   Station name/number
   Date/time (year/month/day/hour)
   Spectrally-based significant wave height (Hmo)
   Peak wave period
   Peak wave direction
   Mean wave period
   Mean wave direction
   First wave component (sea) height/period/direction
   Second wave component (swell) height/period/direction
   Wind speed
   Wind direction
```

Figure 8.   Typical CEDRS data record contents for WIS hindcast data

requirement for learning the RDBMS "language." It was also felt that this approach would simplify system development—the database need only be converted to RDBMS format and linked to the FORTRAN program module.

Conversion of the pilot CEDRS system to the new RDBMS format proved to be a lengthy and painful process. Even after the basic training suggested for system developers in the use of the RDBMS package, months of "trial-and-error" were still required to build the new database and link the FORTRAN module. Most of the training offered for RDBMS system developers was directed toward mainframe computer users, with very little specific training or information available for the microcomputer environment.

The first major obstacle encountered was in use of the optical-disk storage media. After purchase of the ORACLE RDBMS software, months of training, and embarking on initial system development, it was discovered that ORACLE did not support use of "write-once" optical-disk media. Obviously, all of the right questions had not been asked to be sure the system met anticipated needs.

To get around this obstacle, a new storage medium was chosen—a standard external disk drive with a capacity of 600 MB. The much larger 600-MB-capacity disk (optical-disk cartridges were 200 MB each) was chosen because it was already known from experience that the ORACLE system itself required considerable storage and that our database files were at least 20 percent larger than the ASCII originals with the added overhead of RDBMS indexing.

An external disk drive which used the Small Computer Systems Interface (SCSI) was chosen, because investigation seemed to indicate that this type of drive could more easily be added to PC's whose internal disk controllers used other interfaces. This was a fortunate choice which allowed for maximum compatibility with the various PC's provided by Corps offices for installation of the CEDRS systems. Installation on a PC with other than an SCSI interface for its internal hard-disk drives requires a controller board for interfacing the CEDRS disk drive. PC's with SCSI interfaces for their internal hard disks do not require an added controller board; the PC's internal controller accepts the CEDRS disk as an additional drive.

A multitude of additional general hardware and software incompatibilities plagued disk installations on the many different brands of computers used for CEDRS systems. Conflicting addresses and interrupts were corrected and major conflicts with network and other software installed on the CEDRS PC's were resolved. Each CEDRS installation provided a new challenge in hardware and software compatibility.

Development of CEDRS systems for the Great Lakes brought to light a new problem—much more data was available than for any of the previous CEDRS regions along the Atlantic and gulf coasts. The Detroit District is responsible for parts of four of the Great Lakes, a total of more than 1,800 MB of data in RDBMS format. The largest disk capacity available at the time was 1.2 GB (1,200 MB)—only about one-half of the needed capacity. A major hardware challenge was again faced in attaching multiple disk drives to a single PC. Technical specifications for the disk drives and controllers in use at that time claimed that "daisy chaining" up to seven disks together was possible; i.e., connection of multiple disks to each other with a single controller for all disks. It was possible to do so, but again, not without a great deal of "trial and error." The final solution to the problem was the addition of a chip to the controller board and an appropriate cable for connecting the PC's.

3 Conclusions

At this stage in the life of the CEDRS project—with hardware, software, and system design choices firmly in place and all of the initially planned systems installed—the initial goal has been met. Each coastal Corps of Engineers District has its own regional CEDRS database accessible on a microcomputer.

With today's rapidly advancing computer technology, the vastly more powerful "workstation" is replacing the PC as the computer of choice for many Corps engineers. The challenge of a complete conversion of the WES system to a new computer environment is again being faced—an environment not nearly as standardized as that of microcomputers. Already study and testing are underway to provide a much expanded coastal database (i.e., water levels, currents, bathymetry and other parameters required by the more sophisticated computer models now being developed). This next generation of CEDRS will not only target the workstation environment but will take advantage of networking capabilities now commonly available to give Corps engineers and scientists more convenient access to an even larger coastal database to support their project needs.

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Appendix A
Sample CEDRS User's Guide

CERC Wave Information Study (WIS)

Time Series. Data for this region are from the 1992 WIS Atlantic Level 2 hindcast (see WIS Report 30) and cover a continuous 20-year span from January 1956 through December 1975 (at 3-hr intervals). Data are available for Atlantic Level 2 Stations A2056 through A2064. See Regional Map (Figure A-1) and Table A-1 for station locations. Note that water depths shown in table and extract file header lines were taken from bathemetric charts and are furnished only as general location information. These hindcasts assumed deep water conditions; therefore calculated wave heights are not dependent on water depth.

Example A-1 -- WIS Extract File for Atlantic Stations

Output files for WIS data are named using 8 characters as follows:

```
     characters 1      W
     characters 2-6    station name/number
     character  7      - (dash)
     character  8      file number 0-9 (user selected)
     extension         .DAT
```

Example for Atlantic Station 28 as output file 1 to drive A:

```
          A:WA2028-1.DAT
```

Header line 1 contains the following identification information: data type, station name, start date, end date, number of records, latitude, longitude, water depth.

```
       DTYPE = 'WIS '
       WRITE(*,3102) DTYPE,STATION,ISTART,IEND,NREC,RLAT,RLON,IDEP
  3102 FORMAT(1X,A4,1X,A5,2I10,I7,F7.2,F8.2,I8)
```

Lines 2 thru n contain station, date/time, spectrally-based significant wave height (Hmo), peak period, peak direction, mean period, mean direction, first component (sea) height/period/direction, second component (swell) height/period/direction, wind speed, and wind direction.

```
       WRITE(*,3110)ISTA,IDTIM,HMO,PTP,PDIR,MTP,MDIR,HT1,TP1,DIR1,
      &             HT2,TP2,DIR2,IWS,IWD
  3110 FORMAT(I4,I9,F5.1,2(F4.0,F5.0),2(F6.2,F4.0,F5.0),2I4)
```

```
 WIS  A2028  56010100  56013100    248  45.48   85.30      27
  28 56010100  0.8  3.  25.  3.  25.  0.80  3.  25.  0.00  0.   0.   9  25
  28 56010103  0.8  3.  25.  3.  25.  0.80  3.  25.  0.00  0.   0.   9  25
  28 56010106  1.0  4.  26.  4.  26.  1.00  4.  27.  0.00  0.   0.   9  30
  28 56010109  1.2  5.  30.  5.  30.  1.20  5.  29.  0.00  0.   0.   9  35
  28 56010112  1.2  5.  33.  5.  33.  1.20  5.  34.  0.00  0.   0.   9  40
```

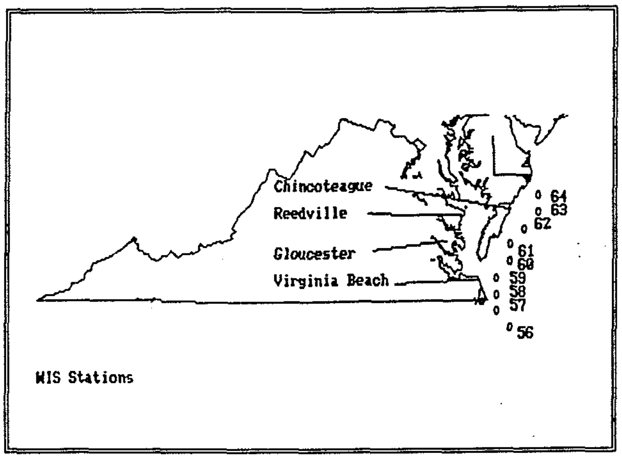

Figure A-1. CEDRS Region 11
WIS Stations - 1992 Hindcast

SOURCE	STATION	LATITUDE/LONGITUDE		WATER DEPTH (m)	(ft)	INCLUSIVE DATES
W	A2056	36.25	75.50	27	89	1956-1975
W	A2057	36.50	75.75	18	59	1956-1975
W	A2058	36.75	75.75	11	36	1956-1975
W	A2059	37.00	75.75	14	46	1956-1975
W	A2060	37.25	75.50	24	79	1956-1975
W	A2061	37.50	75.50	18	59	1956-1975
W	A2062	37.75	75.25	18	59	1956-1975
W	A2063	38.00	75.00	18	59	1956-1975
W	A2064	38.25	75.00	16	53	1956-1975

W = WIS

Table A-1. WIS Station Descriptions - 1992 Hindcast

Recorded Units:

time	GMT
wave height	meters
wave period	seconds
wave direction	meteorological convention--degrees from true north (from which)
wind speed	meters per second (12 minutes averaged at 19.5 meters)
wind direction	meteorological convention--degrees from true north (from which)
water depth	meters
latitude	degrees North = +, South = -
longitude	degrees West = +, East = -

Precomputed Reports. Statistical tables calculated from the 20-year WIS time series for stations A2055 through A2066 are also included in this regional database. Statistics available are:

a. Percent Occurrence of Wave Height and Period by Direction.

b. Summary Statistics (mean and maximum wave height, peak period, average direction, etc.

c. Return Periods.

Examples of these reports are shown below.

PERCENT OCCURRENCE (X1000) OF HEIGHT AND PERIOD
FOR ALL DIRECTIONS

STATION: A2001 (24.5N, 81.2W / 183.0M) NO. CASES: 58440

% OF TOTAL: 100.0

HEIGHT IN METERS	PEAK PERIOD (IN SECONDS) <4.0	4.0-4.9	5.0-5.9	6.0-6.9	7.0-7.9	8.0-8.9	9.0-9.9	10.0-10.9	11.0-11.9	12.0-LONGER	TOTAL
0.00-0.99	41457	26806	7790	492	313	343	362	251	207	270	78291
1.00-1.99	.	4199	5821	6160	2770	480	6	.	.	.	19436
2.00-2.99	.	.	27	138	817	800	246	47	1	.	2076
3.00-3.99	.	.	.	.	6	51	87	20	3	.	167
4.00-4.99	.	.	.	.	.	3	10	.	.	.	13
5.00-5.99	.	.	.	.	.	.	.	.	.	.	0
6.00-6.99	.	.	.	.	.	.	.	.	.	.	0
7.00-7.99	.	.	.	.	.	.	.	.	.	.	0
8.00-8.99	.	.	.	.	.	.	.	.	.	.	0
9.00-9.99	.	.	.	.	.	.	.	.	.	.	0
10.00+	.	.	.	.	.	.	.	.	.	.	0
TOTAL	41457	31005	13638	6790	3906	1677	711	318	211	270	

MEAN Hmo(M) = 0.7 LARGEST Hmo(M) = 4.3 MEAN TP(SEC) = 4.1

Figure A-2. Excerpt from Percent Occurrence Table.

MEAN WAVE HEIGHT (IN METERS) BY MONTH AND YEAR

STATION: A2001 (24.50N/ 81.25W / 183.0M)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
1956	0.7	0.8	0.7	0.6	0.7	0.4	0.5	0.3	0.6	0.7	1.0	0.8	0.7
1957	0.7	0.8	0.6	0.9	0.5	0.4	0.2	0.4	0.6	0.7	0.8	1.1	0.6
1958	1.0	0.8	0.6	0.6	0.8	0.6	0.7	0.3	0.6	0.8	0.7	0.8	0.7
.													
.													
.													
1975	1.0	0.6	0.7	0.7	0.4	0.3	0.4	0.7	0.7	0.8	1.4	1.2	0.7
MEAN	0.8	0.8	0.7	0.7	0.6	0.5	0.5	0.5	0.5	0.7	0.9	0.9	

LARGEST WAVE HEIGHT (IN METERS) BY MONTH AND YEAR

STATION: A2001 (24.50N/ 81.25W / 183.0M)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1956	1.9	2.0	1.6	1.6	1.6	1.6	1.6	0.9	1.2	2.2	2.4	1.8
1957	3.1	1.8	1.8	2.2	1.9	1.4	0.6	1.2	1.3	3.0	2.7	2.3
1958	2.5	2.2	1.9	1.9	1.8	1.7	1.7	0.9	2.2	2.7	2.2	2.4
.												
.												
.												
1975	2.4	1.2	2.2	2.6	1.1	1.1	1.2	1.7	2.2	2.3	3.1	3.5

20-YEAR STATISTICS

STATION: A2001 (24.50N/ 81.25W / 183.0M)

MEAN SPECTRAL WAVE HEIGHT	(METERS)	0.7
MEAN PEAK WAVE PERIOD	(SECONDS)	4.1
MOST FREQUENT 22.5 DEGREE (CENTER) DIRECTION BAND . .	(DEGREES)	90.0
STANDARD DEVIATION OF WAVE Hmo	(METERS)	0.5
STANDARD DEVIATION OF WAVE TP	(SECONDS)	1.4
LARGEST WAVE Hmo.	(METERS)	4.3
WAVE TP ASSOCIATED WITH LARGEST WAVE Hmo.	(SECONDS)	9.0
PEAK DIRECTION ASSOCIATED WITH LARGEST WAVE HS. . . .	(DEGREES)	115.0
DATE LARGEST Hmo OCCURRED 68060318		

Figure A-3. Excerpts from Summary Statistics Table.

STATION A2028 (30.75N, 81.25W) DEPTH: 11 Meters

	RETURN PERIOD (Years)					
	2	5	10	20	25	50
TYPE I	3.52	3.81	4.01	4.20	4.26	4.44
TYPE II	3.54	3.87	4.12	4.38	4.47	4.74

NOTE: Return periods calculated using ACES code for Extremal Significant Wave Height Analysis--Goda Method, Fisher-Tippett Type I and II probability distributions. (Leenknecht, 1990).

Figure A-4. Atlantic Return Period.

Hurricane Statistics. The WIS hindcast of hurricane generated waves along the Atlantic and Gulf of Mexico coastlines (WIS Report 19, 1989) has not been revised. Thus results for hurricane conditions are located at original WIS stations. A map (Figure A-5) and table (Table A-2) of 1988 WIS Atlantic stations are included for your convenience in determining locations for which hurricane data are available.

Table A-4 provides individual storm descriptions for all hurricanes included in the separate WIS hurricane hindcast for the Atlantic Ocean. See Table A-3 for damage categories used in rating hurricanes. Time period covered (1956-1975) and locations for which statistical information is available are both the same as for the 1988 WIS 20-year time series data.

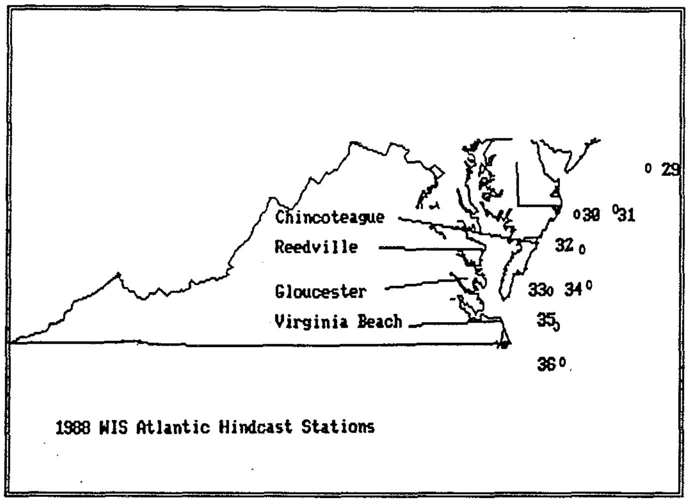

Figure A-5. CEDRS Region 11
1988 WIS Atlantic Hindcast Stations

WIS STATION LOCATIONS FOR HURRICANE STATISTICS
(1988 ATLANTIC HINDCAST)

STATION	LATITUDE	LONGITUDE	WATER DEPTH (m)	(ft)	INCLUSIVE DATES
A2029	39.20N	73.62W	33	108	1956-75
A2030	38.55	74.79	15	49	1956-75
A2031	38.63	74.16	31	102	1956-75
A2032	38.07	74.69	7	23	1956-75
A2033	37.51	75.21	11	36	1956-75
A2034	37.59	74.59	55	180	1956-75
A2035	37.03	75.11	37	121	1956-75
A2036	36.54	75.02	31	102	1956-75

Table A-2. 1988 Atlantic Hindcast (1956-1975).

SAFFIR/SIMPSON DAMAGE CATEGORY SCALE RANGES

Scale Number (category)	Central Pressure (mb)	Winds (mph)	Winds (kph)	Surge (ft)	Surge (m)	Damage
1	=> 980	74-95	119-153	4-5	1.5	Minimal
2	965-979	96-110	154-178	6-8	2-2.5	Moderate
3	945-964	111-130	179-209	9-12	2.6-3.9	Extensive
4	920-944	131-155	211-249	13-18	4-5.5	Extreme
5	< 920	> 155	> 249	> 18	> 5.5	Catastrophic

The Hurricane and Its Impact by Robert H. Simpson and Herbert Riehl, 1981, pp. 366-368.

Table A-3. Saffir/Simpson Damage-Potential Scale.

NO.	STORM YYMM	BEGINNING DATE	TOTAL HOURS	CENTRAL PRESSURE	LARGEST HS(M)	(FT)	DAMAGE CATEGORY	NAME
1	5608	56081312	121	951	12	39.4	3	BETSY
2	5808	58082412	133	935	15	49.2	4	DAISY
3	5809	58092312	145	934	16	52.5	4	HELENE
4	5810	58100612	109	968	10	32.8	2	JANICE
5	5907	59070612	73	991	5	16.4	1	CINDY
6	5909	59092212	181	950	12	39.4	3	GRACIE
7	5929	59092900	145	959	11	36.1	3	HANNAH
8	5910	59101806	49	988	7	23.0	1	JUDITH
9	6008	60081712	79	982	8	26.2	1	CLEO
10	6009	60090900	103	932	12	39.4	4	DONNA
11	6109	61091612	241	927	17	55.8	4	ESTHER
12	6110	61100400	133	948	11	36.1	3	FRANCES
13	6208	62082700	85	986	6	19.7	1	ALMA
14	6210	62100312	109	965	14	45.9	2	DAISY
15	6220	62101512	157	960	13	42.6	3	ELLA
16	6308	63080712	73	969	8	26.2	2	ARLENE
17	6310	63101906	253	948	10	32.8	3	GINNY
18	6408	64082600	217	967	6	19.7	2	CLEO
19	6409	64090500	145	942	15	49.2	4	DORA
20	6429	64090712	157	970	9	29.5	2	ETHEL
21	6439	64091612	187	951	11	36.1	3	GLADYS
22	6410	64101412	61	980	7	23.0	1	ISBELL
23	6509	65090206	157	946	15	49.2	3	BETSY
24	6606	66061000	109	993	8	26.2	1	ALMA
25	6607	66071918	49	997	5	16.4	1	CELIA
26	6608	66082712	157	954	15	49.2	3	FAITH
27	6610	66100212	61	985	5	16.4	1	INEZ
28	6709	67090912	181	975	10	32.8	2	DORIA
29	6710	67102100	73	994	6	19.7	1	HEIDI
30	6806	68062012	97	990	7	23.0	1	BRENDA
31	6810	68101812	73	965	10	32.8	2	GLADYS
32	6908	69081100	43	992	7	23.0	1	BLANCHE
33	6909	69090800	55	977	7	23.0	2	GERDA
34	6929	69092400	49	985	7	23.0	1	T.S. #10
35	6910	69101112	151	978	8	26.2	2	KARA
36	7108	71081400	73	977	11	36.1	2	BETH
37	7109	71092212	217	969	13	42.6	2	GINGER
38	7209	72090612	133	997	5	16.4	1	DAWN
39	7307	73070212	85	986	10	32.8	1	ALICE
40	7408	74082712	61	979	9	29.5	2	BECKY
41	7507	75072606	55	980	10	32.8	1	BLANCHE
42	7509	75092600	61	979	11	36.1	2	FAYE
43	7529	75092900	103	939	12	39.4	4	GLADYS

Damage category figures refer to the Saffir/Simpson scale where 1 = minimal damage, 2 = moderate damage, 3 = extensive damage, 4 = extreme damage, and 5 = catastrophic damage.

Table A-4. Atlantic Hurricanes (1956-1975).

Figures A-6 and A-7 give examples of information available for individual hurricanes and 1988 WIS Atlantic hindcast stations.

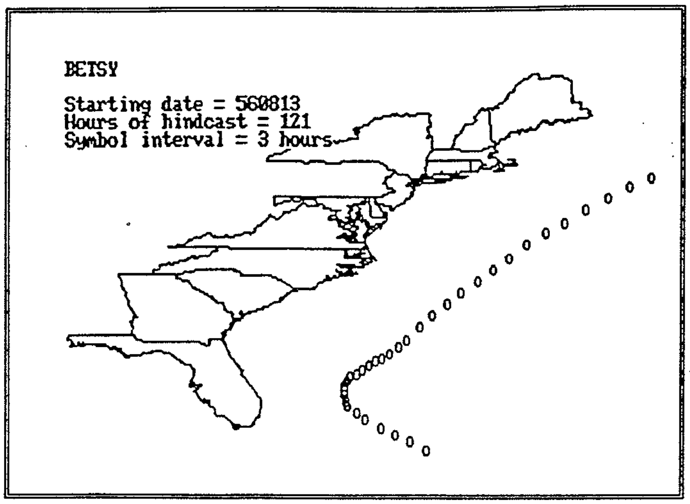

Figure A-6. Hurricane Track Map
1988 WIS Atlantic Hindcast

STORM: 5808

STATION A2061 LATITUDE: 29.9 LONGITUDE: 80.3

STATION	MAX WAVE HT (METERS)	PERIOD OF MAX WAVE (SECONDS)
61	3.6	11.1

Figure A-7. Hurricane Maximum Wave Height.
1988 WIS Atlantic Hindcast

National Oceanographic and Atmospheric Administration (NOAA)

NOAA data are available for nine (9) Atlantic coast stations (see Table A-5 and Regional Map for station locations). Data are available as shown in tables below for months indicated with 'X'. Sea stations are indicated by numeric names such as 41003. Land stations are indicated by alphanumeric names such as FBIS1.

Example A-2 - NOAA Extract File (Stations that contain wind and wave data)

Output files for NOAA data are named using 8 characters as follows:

```
      character  1     N
      characters 2-6   station name
      character  7     - (dash)
      character  8     file number 0-9 (user selected)
      extension        .DAT
```

Example for station 42001 as output file 3 to drive B:

```
      B:N42001-3.DAT
```

The user may select (1) every measurement (2) measurements every 3 hours, or (3) measurements every 6 hours during extraction of NOAA data.

Header line 1 contains the following identification information: data type, station name, start date, end date, number of records, latitude, longitude, water depth.

```
       DTYPE = 'NOAA'
       WRITE(*,3106) DTYPE,STATION,ISTART,IEND,NREC,RLAT,RLON,IDEP
  3106 FORMAT(1X,A4,1X,A5,2I10,I7,F7.2,F8.2,I8)
```

Lines 2 thru n contain date, time, wind speed, wind direction, significant wave height, average wave period, and dominant wave period.

```
       WRITE(*,3490)NID,NDATE,NTIME,NUSP,NUDIR,NHS,NT,ETP
  3490 FORMAT(1X,I6,I5,F6.2,F6.1,3F5.1)
```

```
 NOAA  42001     880101    880103      6  26.00  90.00  3139.0
 880101    0  6.48 190.4   .0   .0   .0
 880101  300  4.33 183.8  1.8  6.7  9.1
 880101  600  3.02 184.5  1.8  6.7  9.1
 880101  900  3.28 144.3  2.1  6.9  8.3
 880101 1200  3.80 122.0  2.1  7.1  9.1
 880101 1500  2.59 101.0  2.0  7.2 10.0
```

Recorded units:

time	GMT
wind speed	meters per second (8.5 minute average)
wind direction	degrees from true north
significant wave height	meters
average wave period	seconds
dominant wave period	seconds

Example A-3 - NOAA Extract File (Stations that contain only wind data)

Output files for NOAA data are named using 8 characters as follows:

character 1	N
characters 2-6	station name
character 7	- (dash)
character 8	file number 0-9 (user selected)
extension	.DAT

Example for station VENF1 as output file 3 to drive B:

B:NVENF1-3.DAT

The user may select (1) every measurement (2) measurements every 3 hours, or (3) measurements every 6 hours during extraction of NOAA data.

Header line 1 contains the following identification information: data type, station name, start date, end date, number of records, latitude, longitude, water depth.

```
      DTYPE = 'NOAA'
      WRITE(*,3106) DTYPE,STATION,ISTART,IEND,NREC,RLAT,RLON,IDEP
 3106 FORMAT(1X,A4,1X,A5,2I10,I7,F7.2,F8.2,I8)
```

Lines 2 thru n contain date, time, wind speed, and wind direction.

```
      WRITE(*,3491)NDATE,NTIME,USP,UDIR
 3491 FORMAT(1X,I6,I5,F6.2,F6.1)
```

```
NOAA  VENF1      880101    880103     6  27.10  82.50     0.0
880101    0  3.61  80.0
880101  100  3.09  70.0
880101  200  4.12  80.0
880101  300  3.09  90.0
880101  400  3.09  80.0
880101  500  4.12  90.0
```

Recorded units:

time	GMT
wind speed	meters per second (8.5 minute average)
wind direction	degrees from true north

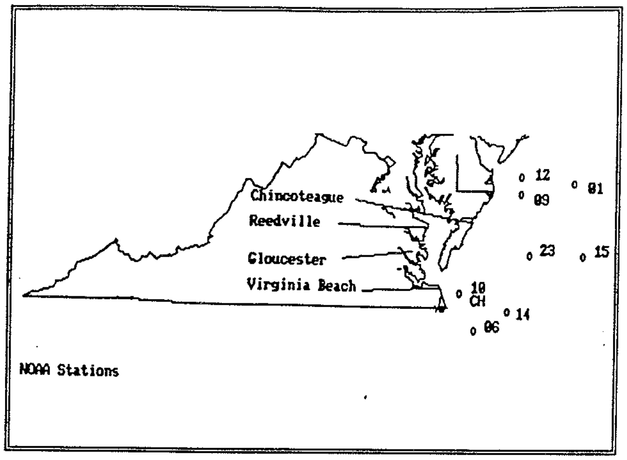

Figure A-8. CEDRS Region 11
NOAA Stations

SOURCE	STATION	LATITUDE/LONGITUDE		WATER DEPTH (m)	WATER DEPTH (ft)	INCLUSIVE DATES	DESCRIPTION
N	44001	38.7	73.6	60	197	Oct 78-Oct 79	
N	44001*	38.4	73.6	115	377	Sep 90-Apr 91	
N	44006	36.3	75.4	35	115	Oct 80-May 82	
N	44006*	36.2	75.5	26	85	Sep 87-Mar 88	
N	44009	38.5	74.6	277	909	Jan 84-Dec 92	
N	44010	36.9	75.7	20	66	Feb 84-Nov 84	
N	44012	38.8	74.6	24	79	Jun 84-Dec 92	
N	44014	36.6	74.8	48	157	Oct 90-Dec 92	
N	44015	37.5	73.4	2469	8098	Sep 90-Apr 91	
N	44023	37.5	74.4	102	335	Jan 91-Apr 91	
N	CHLV2#	36.9	75.7	12	39	Jan 85-Dec 92	Chesapeake Light,VA

N = NOAA, * = Location change, # Includes wave data

Table A-5. NOAA Station Descriptions

STATION 44001

	1978	1979	1990	1991
Jan	-	X	-	X
Feb	-	X	-	X
Mar	-	X	-	X
Apr	-	X	-	X
May	-	X	-	-
Jun	-	X	-	-
Jul	X	X	-	-
Aug	X	X	-	-
Sep	X	X	X	-
Oct	X	X	X	-
Nov	X	-	X	-
Dec	X	-	X	-

STATION 44006

	1980	1981	1982	1987	1988
Jan	-	X	X	-	X
Feb	-	X	X	-	X
Mar	-	X	X	-	X
Apr	-	X	X	-	-
May	-	X	X	-	-
Jun	-	X	-	-	-
Jul	-	X	-	-	-
Aug	-	X	-	-	-
Sep	-	X	-	X	-
Oct	X	X	-	X	-
Nov	X	X	-	X	-
Dec	X	X	-	X	-

STATION 44009

	1984	1985	1986	1987	1988	1989	1990	1991	1992
Jan	X	-	-	X	X	X	X	X	X
Feb	X	X	-	X	X	X	X	X	X
Mar	X	X	X	X	X	X	X	X	X
Apr	X	X	X	X	X	X	X	X	X
May	X	X	X	X	X	X	X	X	X
Jun	X	X	X	X	X	X	X	X	X
Jul	X	X	X	X	X	X	X	X	X
Aug	X	X	X	X	X	X	X	X	X
Sep	X	X	X	X	X	X	X	X	X
Oct	X	X	X	X	X	X	X	X	X
Nov	X	X	X	X	X	X	X	X	-
Dec	X	X	X	X	X	X	X	X	-

STATION 44010

	1984
Jan	-
Feb	X
Mar	X
Apr	X
May	X
Jun	X
Jul	X
Aug	X
Sep	X
Oct	X
Nov	X
Dec	-

STATION 44014

	1990	1991	1992
Jan	-	X	X
Feb	-	X	X
Mar	-	X	X
Apr	-	X	X
May	-	X	X
Jun	-	X	X
Jul	-	X	X
Aug	-	X	X
Sep	-	X	X
Oct	X	X	X
Nov	X	X	X
Dec	X	X	X

STATION 44012

	1984	1985	1986	1987	1988	1989	1990	1991	1992
Jan	-	X	X	X	X	X	-	X	X
Feb	-	X	X	X	X	X	-	X	X
Mar	-	X	X	X	X	X	-	X	X
Apr	-	X	X	X	X	-	-	X	X
May	-	X	X	X	X	-	-	X	X
Jun	X	X	X	X	X	-	-	X	X
Jul	X	X	X	X	-	-	-	X	X
Aug	X	X	X	X	-	-	-	X	X
Sep	X	X	-	X	X	-	X	X	X
Oct	X	X	X	X	X	-	X	X	X
Nov	X	X	X	X	X	-	X	X	X
Dec	X	X	X	X	X	-	X	X	-

STATION 44015

	1990	1991
Jan	-	X
Feb	-	X
Mar	-	X
Apr	-	X
May	-	-
Jun	-	-
Jul	-	-
Aug	-	-
Sep	X	-
Oct	X	-
Nov	X	-
Dec	X	-

STATION 44023

	1991
Jan	X
Feb	X
Mar	X
Apr	X
May	-
Jun	-
Jul	-
Aug	-
Sep	-
Oct	-
Nov	-
Dec	-

STATION CHLV2

	1985	1986	1987	1988	1989	1990	1991	1992
Jan	X	X	X	X	X	X	X	X
Feb	X	X	X	X	X	X	X	X
Mar	X	X	X	X	X	X	X	X
Apr	X	X	X	X	X	X	X	X
May	X	X	X	X	X	X	X	X
Jun	X	X	X	X	X	X	X	X
Jul	X	X	X	X	X	X	X	X
Aug	X	X	X	X	X	X	X	X
Sep	X	X	X	X	X	X	X	X
Oct	X	X	X	X	X	X	X	X
Nov	X	X	X	X	X	X	X	X
Dec	X	X	X	X	X	X	X	X

LEO (Littoral Environment Observation)

LEO data are available for one (1) Atlantic coast station (see Table A-8 and Regional Map for station location). Data are available as indicated in table below for months indicated with "X".

Example A-4 - LEO Extract File

Output files for LEO data are named using 8 characters as follows:

character 1	L
characters 2-6	station number
character 7	- (dash)
character 8	file number 0-9 (user selected)
extension	.DAT

Example for station 12895 as output file 2 to drive D:

D:L12895-2.DAT

Header line 1 contains the following identification information: data type, station name, start date, end date, number of records, latitude, longitude, water depth.

```
      DTYPE = 'LEO '
      WRITE(*,3105) DTYPE,STATION,ISTART,IEND,NREC,RLAT,RLON,IDEP
 3105 FORMAT(1X,A4,1X,A5,2I10,I7,F7.2,F8.2,I8)
```

Lines 2 thru n contain date, time, period, wave height, wave angle, wind speed, wind direction, current speed, and current direction.

```
      WRITE(*,861) NDATE,NTIME,WPER,WHT,IWANG,WSP,IWD,ICSP,ICDIR
  861 FORMAT(1X,I6,I5,2F5.1,I4,F5.1,2I4,I3)
```

```
 LEO  12895    860801    860831     37  27.80   82.80       0
 860804 1105  2.7  2.5 100 30.0 315  20 -1
 860804 1704  2.6  3.0 100 14.0 315  20 -1
 860805 1005  2.7  2.0 100 13.0 315  25 -1
 860805 1705  2.6  2.0 100  7.0 315  15 -1
 860806 1010  5.5  1.5  90  3.0  45  15 -1
 860806 9999  7.3  1.5  90   .0   0  10 -1
```

Recorded units:

time	local
wave period	seconds
wave height	feet
wave angle	degrees from normal to observer
wind speed	miles per hour
wind direction	degrees from true north
current speed	feet per minute
current direction	+1 to right and -1 to left

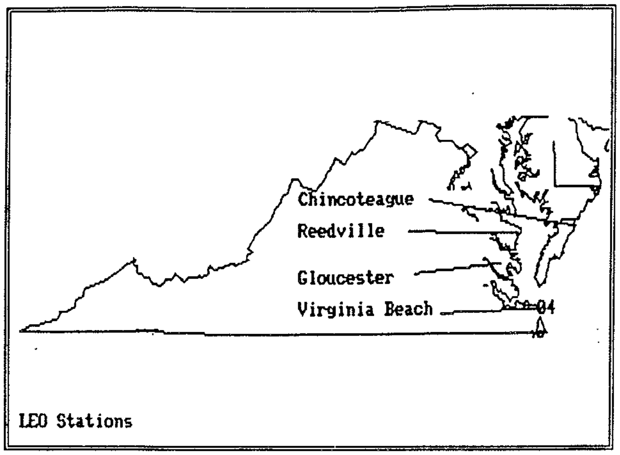

Figure A-9. CEDRS Region 11
LEO Stations

SOURCE	STATION	LATITUDE/LONGITUDE		INCLUSIVE DATES	DESCRIPTION
L	54004	37.03	76.23	1979-1980	Buckroe Beach,VA

L = LEO

Table A-6. LEO Station Descriptions

LEO - 54004 - Buckroe Beach, VA

	1979	1980
Jan	X	X
Feb	X	X
Mar	X	X
Apr	X	X
May	X	X
Jun	X	X
Jul	X	X
Aug	X	X
Sep	X	X
Oct	X	X
Nov	X	X
Dec	X	X

Appendix B
User Comments/Suggestions

USER COMMENTS/SUGGESTIONS

User's Name________________________________ Office Symbol_______________

Office_______________________________________

Address______________________________________

____

Phone _________________

We would appreciate your comments and suggestions for improvements to the CEDRS System and this user's guide. Please use this form to record your remarks; send completed form to:

Doyle L. Jones
Phone (601)634-2069
Coastal Engineering Research Center
US Army Engineer Waterways Experiment Station
3909 Halls Ferry Road
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From a mainframe computer version in the early 1980's to today's microcomputer format, coastal databases have been recognized as important tools for support of Corps of Engineers coastal projects. The Coastal Engineering Data Retrieval System (CEDRS) takes advantage of the microcomputer environment to provide convenient access to voluminous oceanographic data sets. CEDRS uses a regional approach, generally following Corps of Engineers District boundaries, to allow its systems to operate in the microcomputer environment using relational database techniques, and to contain a comprehensive long-term set of both hindcast and measured wind and wave data for the use of Corps coastal engineers and scientists. This presentation of the pitfalls and problems encountered in design and development of the CEDRS databases may be of benefit to other developers of this type of system.

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