



**Beach Protection
Authority
Queensland**

WAVE DATA RECORDING PROGRAMME

MACKAY (BLACKS BEACH) REGION



HARBOURS MARINE

Caring for our coast

ISSN 0158-7757

WAVE DATA RECORDING PROGRAMME

MACKAY (BLACKS BEACH) REGION

REPORT NO. BPA 21.3

Beach Protection Authority

December 1989

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All reasonable care and attention has been exercised in the collection, processing and compilation of the wave data included in this report. However, the accuracy and reliability of this information is not guaranteed in any way by the Beach Protection Authority and the Authority accepts no responsibility for the use of this information in any way whatsoever.

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- Mackay (Blacks Beach) Region

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ABSTRACT:-

This report provides summaries of primary analysis of wave data recorded in 5 metres of water offshore near Blacks Beach in Queensland. Data was recorded using a Datawell "Waverider" buoy, and covers the period ~~May 12, 1987 to May 6, 1988~~. The data was divided into seasonal groupings for analysis and no estimations of wave directional data have been provided.

OTHERS AVAILABLE IN THIS SERIES:-

Wave Data Recording Programme, Cairns Region (Report No. W01.1)
Wave Data Recording Programme, Cairns Region (Report No. W01.2)
Wave Data Recording Programme, Mackay Region (Report No. W02.1) ✓
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WAVE DATA RECORDING PROGRAMME

MACKAY (BLACKS BEACH) REGION

REPORT NO. BPA 21.3

1.0 INTRODUCTION

This report summarizes the primary analysis of wave data collected in the Mackay (Blacks Beach) region. In addition brief details of the recording equipment, the method of handling raw data and the type of analysis employed are provided.

2.0 RECORDING EQUIPMENT

All wave recording installations operated by the Authority employ the "Waverider" system developed by Datawell b.v. of the Netherlands.

The installation comprised a Waverider 6000 series buoy transmitting to a shore based WAREP Mark II receiver which in turn was coupled to an DIMA recording unit.

This system utilised a buoy mounted accelerometer to follow the water surface movements and transmitted a frequency modulated analogue signal of these water level movements to a shore based receiver (WAREP). The WAREP receiver provided a paper chart of the recording and relayed the analogue signal to the DIMA digital recorder.

3.0 WAVE RECORDING AND ANALYSIS PROCEDURES

In general between May 12, 1987 and May 6, 1988 four recordings of water levels each of 20 minutes duration were made each day with the timing of the recordings set at 0300 hours, 0900 hours, 1500 hours and 2100 hours respectively.

Data recorded on the Dima digital recording unit automatically has the Julian day of the year and the time inserted at the start of each record. The data is stored on digital cassettes which are translated via a Memodyne M80 Data Translator and used in computer programs developed by the Beach Protection Authority.

Routine and spectral analysis of digital wave data was performed by a computer program to obtain the following parameters:

- | | | |
|----|-------------------------------------|--|
| 1. | Energy Density Spectrum | A representation of the distribution of wave energy over the component wave frequencies. |
| 2. | Significant Wave Height (Hsig) | The average of the highest one third of waves in the record. |
| 3. | Root Mean Square Wave Height (Hrms) | The root mean square of the wave heights from the record. |
| 4. | Maximum Wave Height (Hmax) | The highest individual wave in the record (zero upward crossing). |

- | | | |
|----|----------------------------------|---|
| 5. | Peak Energy Period (T_p) | The wave period corresponding to the peak of the energy density spectrum. |
| 6. | Significant Period (T_{sig}) | The average period of the highest one third of waves in the record. |
| 7. | Zero Crossing Period (T_z) | The average period of all waves in the record based on upward zero crossings. |
| 8. | Crest Period (T_c) | The average period of all the waves in the record based on successive crests. |

These parameters are the basis for the summary plots and tables attached to this report.

4.0 DATA LOSSES

Data losses can be divided into three categories - losses due to recording equipment failure, losses during routine processing and losses as a result of spurious data produced by twisted accelerometer cables within the Waverider buoy.

Losses in the first two categories are usually non-recoverable. Data produced when accelerometer cables are twisted, however, are generally recoverable. The twisting of the cables causes a low frequency component to be added to the analogue wave data at the recording stage. When analysis is carried out, the component is easily detected and may be eliminated during data editing following the completion of routine processing and spectral analysis of data.

Details of data losses in the Mackay (Blacks Beach) Region are included in Summary Sheet 1, "Details of Wave Recorder Installation".

5.0 WAVE CLIMATE

5.1 General

The wave climate presented in this report is based on statistical analyses of the parameters obtained from the recorded wave data.

Computer programs developed by the Authority provide statistical information on percentage of time occurrence and exceedance for wave heights and periods. The results of these analyses are presented in Tables 1, 2 and 3 and Figures 2, 3 and 4.

5.2 Wave Persistence

Wave height persistence is the duration for which any given wave height is exceeded in any single event. Persistence information has been calculated from the recorded data by linearly interpolating the times of exceedance of various wave heights. Wave height persistence data is presented in Figure 5.

5.3 Return Intervals

The percentage of time of exceedance data for various wave heights (Figure 2) is combined with the persistence data (Figure 5) to determine the average wave height recurrence intervals.

The technique used to calculate the return intervals presented in Figure 7 is given below:-

$$\begin{aligned} \text{No. of hours per year of exceedance} & & H &= \frac{Pe \times 8760 \text{ hrs}}{100} \\ \text{of a given wave height} & & &= 87.6 Pe \text{ hrs} \end{aligned}$$

where Pe is the percentage of time of exceedance from Figure 2.

$$\begin{aligned} \text{Average No. of events per year in} & & &= \frac{87.6 Pe}{P} \\ \text{which H is exceeded} & & & \end{aligned}$$

where P is the average persistence (hours) of events of exceedance of the given wave height (H).

However, of this number of events, a certain percentage Pn will persist for at least the specified duration.

$$\begin{aligned} \text{i.e. No. of events per year in which H is exceeded} & & & \\ \text{for at least the specified duration} & & = & \frac{87.6 Pe}{P} \times \frac{Pn}{100} \\ & & & = \frac{0.876 Pe \times Pn}{P} \end{aligned}$$

where Pn may be determined from Figure 5.

By inverting this, the average return interval of the occurrence of an event in which H is exceeded for the given duration is given by -

$$\begin{aligned} \text{Return Interval} & & = & \frac{1}{\text{Ave. No. of occurrences}} \\ & & & \text{per year} \\ & & = & \frac{P}{0.876 Pe \times Pn} \end{aligned}$$

It should be noted that the data presented in Figure 7 are for the average wave height recurrence interval and include all exceedance events of the given wave height without regard to duration of the event. In these calculations Pn was taken as 100 percent.

6.0 DATA PRESENTATION

No attempt has been made to interpret the recorded data for design purposes or to apply corrections for refraction, diffraction and shoaling to obtain equivalent deep water waves. Before any use is made of this data it is therefore necessary to note the exact location of the buoy and the water depth in which the buoy was moored. This data is shown on Summary Sheet 1, "Details of the Wave Recorder Installation". The data herein presented does not include any information on wave directions. The "Waverider" recording system which is utilised by the Authority is designed to record vertical movements of the water surface only and any wave directions must be assigned to the individual wave records by other means.

Wherever major meteorological events such as cyclones have occurred during the recording period, these were noted and are summarized together with the maximum wave height recorded and any other relevant comments in Summary Sheet 2, "Major Meteorological Events".

In addition to the above Summary Sheets the following tables and figures are presented to complete this report.

Table 1: Wave Statistics; Wave Period (T_p)/Wave Height (H_{sig}) Occurrences, All Data, All Directions.

Table 2: Wave Statistics; Wave Period (T_p)/Wave Height (H_{sig}) Occurrences, Summer Data, All Directions.

Table 3: Wave Statistics; Wave Period (T_p)/Wave Height (H_{sig}) Occurrences, Winter Data, All Directions.

Figure 1: Locality Map.

Figure 2: Percentage (of time) Exceedance of Wave Heights (H_{sig}) for All Wave Periods. (T_p)

Figure 3: Histogram Percentage (of time) Occurrences of Wave Heights (H_{sig}) for All Wave Periods. (T_p)

Figure 4: Histogram Percentage (of time) Occurrences of Wave Periods (T_p) for All Wave Heights. (H_{sig})

Figure 5: Average Duration of Exceedance of Wave Heights (H_{sig}).

Figure 6: Daily Wave Recordings.

Figure 7: Wave Height (H_{sig}) Recurrence Intervals.

The above tables refer to data recorded in Summer and Winter. For the purposes of analysis, Summer has been taken as the period from November 1 to April 30 in the following year. Winter covers the period May 1 to October 31 in any one year.

SUMMARY SHEET 1

DETAILS OF WAVE RECORDER INSTALLATION

Region:- Mackay (Blacks Beach) Region

Buoy Location:-

Co-ordinates:- 149° 11'36" East 21° 02'36" South.

Description:- 2.0km East of Blacks Beach (See Figure 1).

Water Depth at Buoy:- 5 metres relative to Australian Height Datum

Location of Recording Station:- Mackay Harbour Masters Office

Period of Data Collection:- May 12, 1987 to May 6, 1988

Normal Recording Interval:-

Two twenty minute records daily at 0300 hours, 0900 hours, 1500 hours and 2100 hours.

Total No. of Records Analysed:- 1,076

Number of Records Lost Due to:-

Rejected Records during Analysis	20
Field Equipment Failure	278
Damaged Accelerometer	8

SUMMARY SHEET 2

MAJOR METEOROLOGICAL EVENTS

Meteorological Event	*Central Pressure (mb)	Date	*Estimated Position of Cyclone Relative to Buoy (km)	Maximum Hsig Recorded (metres)	Maximum Hmax Recorded (metres)	Tp (secs)
High Pressure System over Tasman Sea	1040	8/7/87		1.36	2.39	7.02
Cyclone Agi	1000	21/1/88	800 NE	1.10	1.76	6.32
Low Pressure System off North Queensland	1004	17/2/88		1.27	2.02	6.51
Cyclone Charlie	990	28/2/88	250 N	1.62	2.52	7.10
Low Pressure System over Mackay	1004	2/3/88		1.38	2.41	6.16
High Pressure System over Tasmania	1028	18/3/88		1.33	2.56	5.90
High Pressure System over Tasman Sea	1024	27/3/88		1.43	2.90	6.11
High Pressure System over New South Wales	1020	14/4/88		1.24	2.17	6.13

Highest Significant Wave Height (Hsig) recorded was 1.62 m on February 28, 1988 due to Cyclone Charlie.

Highest Maximum Wave Height (Hmax) recorded was 2.90 m on March 27, 1988 due to High Pressure System over Tasman Sea.

Meteorological information obtained from the "Monthly Weather Review" published by the Bureau of Meteorology.

* Central pressure and position of cyclone at time of maximum wave conditions.

Note: The mean Hsig value for the total twelve year period was 0.49m. A value of 2.25 times the mean Hsig has been adopted for this station to determine a Major Meteorological Event based on significant wave height.

TABLE 1
WAVE STATISTICS
OCCURRENCES
ALL DATA, ALL DIRECTIONS

Significant Wave Height (metres)	Peak Energy Wave Period (Seconds)								Totals
	0 - 2.99	3 - 4.99	5 - 6.99	7 - 8.99	9 - 10.99	11 - 12.99	13 - 14.99	> 14.99	
.00 - .10	*	0.25	*	*	0.25	0.25	*	*	0.75
.10 - .20	1.25	3.76	0.50	2.88	5.36	3.99	0.25	*	17.99
.20 - .30	3.84	14.26	2.76	6.42	11.39	4.50	0.25	*	43.41
.30 - .40	6.49	22.76	3.00	2.66	10.73	3.87	1.00	*	50.51
.40 - .50	1.49	29.87	7.48	2.75	4.50	1.00	0.50	*	47.58
.50 - .60	*	20.10	11.48	1.49	0.75	0.50	*	*	34.33
.60 - .70	*	11.23	13.97	2.01	0.25	0.25	*	*	27.71
.70 - .80	*	5.61	15.90	1.25	0.50	*	*	*	23.26
.80 - .90	*	1.26	16.98	*	*	*	*	*	18.24
.90 - 1.00	*	0.75	7.89	0.25	*	*	*	*	8.89
1.00 - 1.10	*	*	5.01	1.51	*	*	*	*	6.51
1.10 - 1.20	*	*	1.52	*	*	*	*	*	1.52
1.20 - 1.30	*	*	2.74	0.50	*	*	*	*	3.24
1.30 - 1.40	*	*	1.50	0.48	*	*	*	*	1.98
1.40 - 1.50	*	*	0.75	*	*	*	*	*	0.75
1.50 - 1.60	*	*	0.25	*	*	*	*	*	0.25
1.60 - 1.70	*	*	*	0.25	*	*	*	*	0.25
1.70 - 1.80	*	*	*	*	*	*	*	*	0.00
1.80 - 1.90	*	*	*	*	*	*	*	*	0.00
1.90 - 2.00	*	*	*	*	*	*	*	*	0.00
2.00 - 2.10	*	*	*	*	*	*	*	*	0.00
2.10 - 2.20	*	*	*	*	*	*	*	*	0.00
2.20 - 2.30	*	*	*	*	*	*	*	*	0.00
2.30 - 2.40	*	*	*	*	*	*	*	*	0.00
2.40 - 2.50	*	*	*	*	*	*	*	*	0.00
TOTALS	13.07	109.86	91.73	22.45	33.73	14.36	2.00	0.00	287.19

Values in the above table are durations in days and have been rounded to the second decimal place.

TABLE 2
WAVE STATISTICS
OCCURRENCES
SUMMER DATA, ALL DIRECTIONS

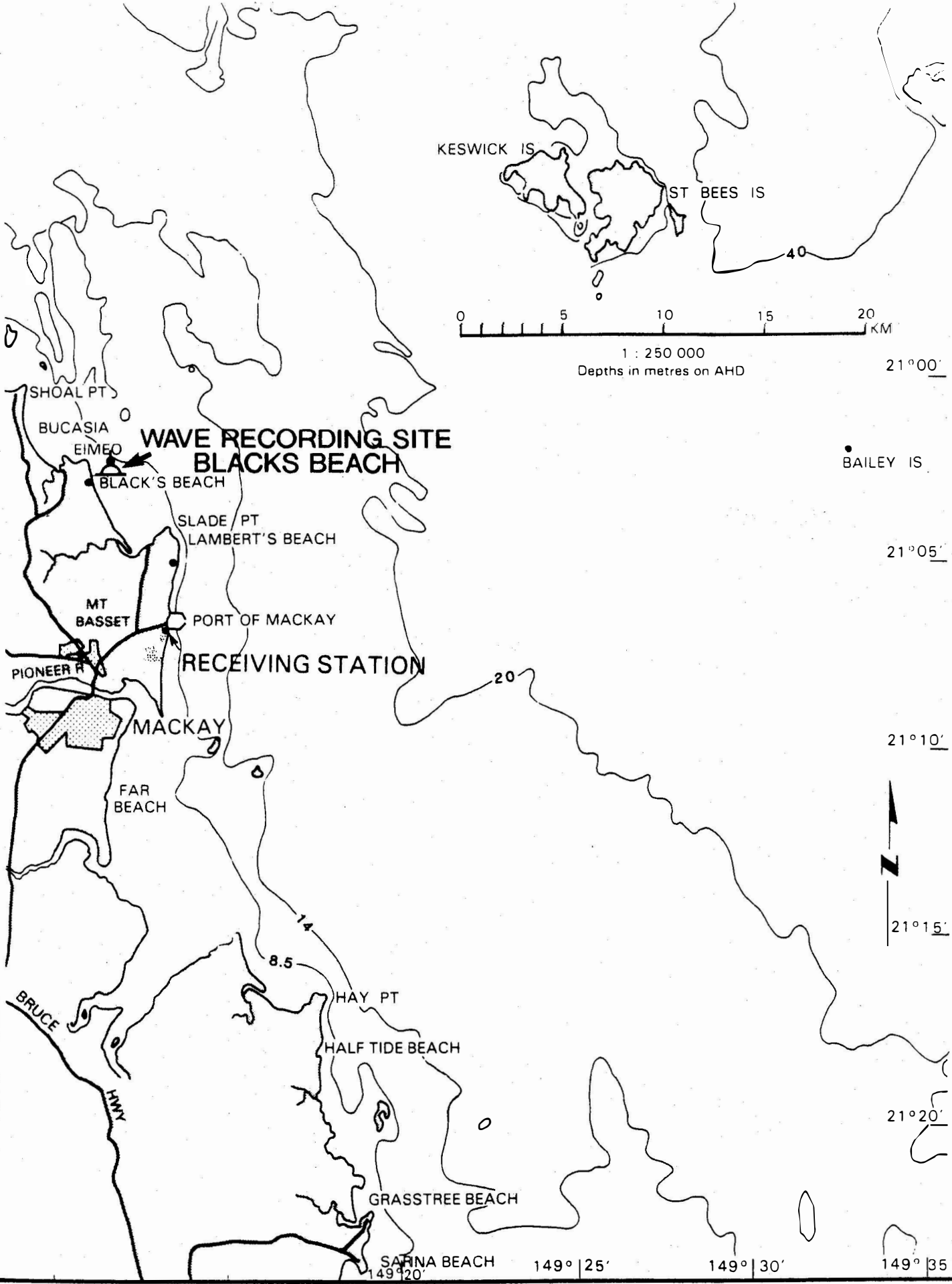
Significant Wave Height (metres)	Peak Energy Wave Period (Seconds)								Totals
	0 - 2.99	3 - 4.99	5 - 6.99	7 - 8.99	9 - 10.99	11 - 12.99	13 - 14.99	> 14.99	
.00 - .10	*	0.25	*	*	*	*	*	*	0.25
.10 - .20	0.50	1.01	0.25	0.51	1.98	0.74	*	*	4.99
.20 - .30	2.72	8.01	0.75	2.92	4.27	2.25	*	*	20.91
.30 - .40	2.50	11.77	1.25	0.67	5.73	3.62	0.75	*	26.30
.40 - .50	0.50	17.48	2.24	1.50	3.25	1.00	0.50	*	26.46
.50 - .60	*	13.36	5.49	0.75	0.50	0.50	*	*	20.60
.60 - .70	*	8.25	8.74	0.76	*	0.25	*	*	17.99
.70 - .80	*	3.87	12.38	0.75	*	*	*	*	17.00
.80 - .90	*	0.75	13.36	*	*	*	*	*	14.11
.90 - 1.00	*	0.75	6.51	0.25	*	*	*	*	7.51
1.00 - 1.10	*	*	4.26	1.25	*	*	*	*	5.51
1.10 - 1.20	*	*	1.00	*	*	*	*	*	1.00
1.20 - 1.30	*	*	2.50	0.50	*	*	*	*	3.00
1.30 - 1.40	*	*	1.50	*	*	*	*	*	1.50
1.40 - 1.50	*	*	0.75	*	*	*	*	*	0.75
1.50 - 1.60	*	*	0.25	*	*	*	*	*	0.25
1.60 - 1.70	*	*	*	0.25	*	*	*	*	0.25
1.70 - 1.80	*	*	*	*	*	*	*	*	0.00
1.80 - 1.90	*	*	*	*	*	*	*	*	0.00
1.90 - 2.00	*	*	*	*	*	*	*	*	0.00
2.00 - 2.10	*	*	*	*	*	*	*	*	0.00
2.10 - 2.20	*	*	*	*	*	*	*	*	0.00
2.20 - 2.30	*	*	*	*	*	*	*	*	0.00
2.30 - 2.40	*	*	*	*	*	*	*	*	0.00
2.40 - 2.50	*	*	*	*	*	*	*	*	0.00
TOTALS	6.22	65.49	61.22	10.11	15.73	8.36	1.25	0.00	168.38

Values in the above table are durations in days and have been rounded to the second decimal place.

TABLE 3
WAVE STATISTICS
OCCURRENCES
WINTER DATA, ALL DIRECTIONS

Significant Wave Height (metres)	Peak Energy Wave Period (Seconds)								Totals
	0 - 2.99	3 - 4.99	5 - 6.99	7 - 8.99	9 - 10.99	11 - 12.99	13 - 14.99	> 14.99	
.00 - .10	*	*	*	*	0.25	0.25	*	*	0.50
.10 - .20	0.75	2.75	0.25	2.37	3.38	3.25	0.25		13.00
.20 - .30	1.12	6.25	2.01	3.50	7.13	2.25	0.25	*	22.50
.30 - .40	3.98	10.99	1.75	1.99	5.00	0.25	0.25	*	24.21
.40 - .50	1.00	12.39	5.24	1.25	1.25	*	*	*	21.12
.50 - .60	*	6.74	5.99	0.74	0.25	*	*	*	13.73
.60 - .70	*	2.99	5.23	1.25	0.25	*	*	*	9.72
.70 - .80	*	1.74	3.52	0.50	0.50	*	*	*	6.26
.80 - .90	*	0.51	3.62	*	*	*	*	*	4.13
.90 - 1.00	*	*	1.38	*	*	*	*	*	1.38
1.00 - 1.10	*	*	0.75	0.26	*	*	*	*	1.01
1.10 - 1.20	*	*	0.52	*	*	*	*	*	0.52
1.20 - 1.30	*	*	0.24	*	*	*	*	*	0.24
1.30 - 1.40	*	*	*	0.48	*	*	*	*	0.48
1.40 - 1.50	*	*	*	*	*	*	*	*	0.00
1.50 - 1.60	*	*	*	*	*	*	*	*	0.00
1.60 - 1.70	*	*	*	*	*	*	*	*	0.00
1.70 - 1.80	*	*	*	*	*	*	*	*	0.00
1.80 - 1.90	*	*	*	*	*	*	*	*	0.00
1.90 - 2.00	*	*	*	*	*	*	*	*	0.00
2.00 - 2.10	*	*	*	*	*	*	*	*	0.00
2.10 - 2.20	*	*	*	*	*	*	*	*	0.00
2.20 - 2.30	*	*	*	*	*	*	*	*	0.00
2.30 - 2.40	*	*	*	*	*	*	*	*	0.00
2.40 - 2.50	*	*	*	*	*	*	*	*	0.00
TOTALS	6.85	44.36	30.51	12.34	18.00	6.00	0.75	0.00	118.81

Values in the above table are durations in days and have been rounded to the second decimal place.



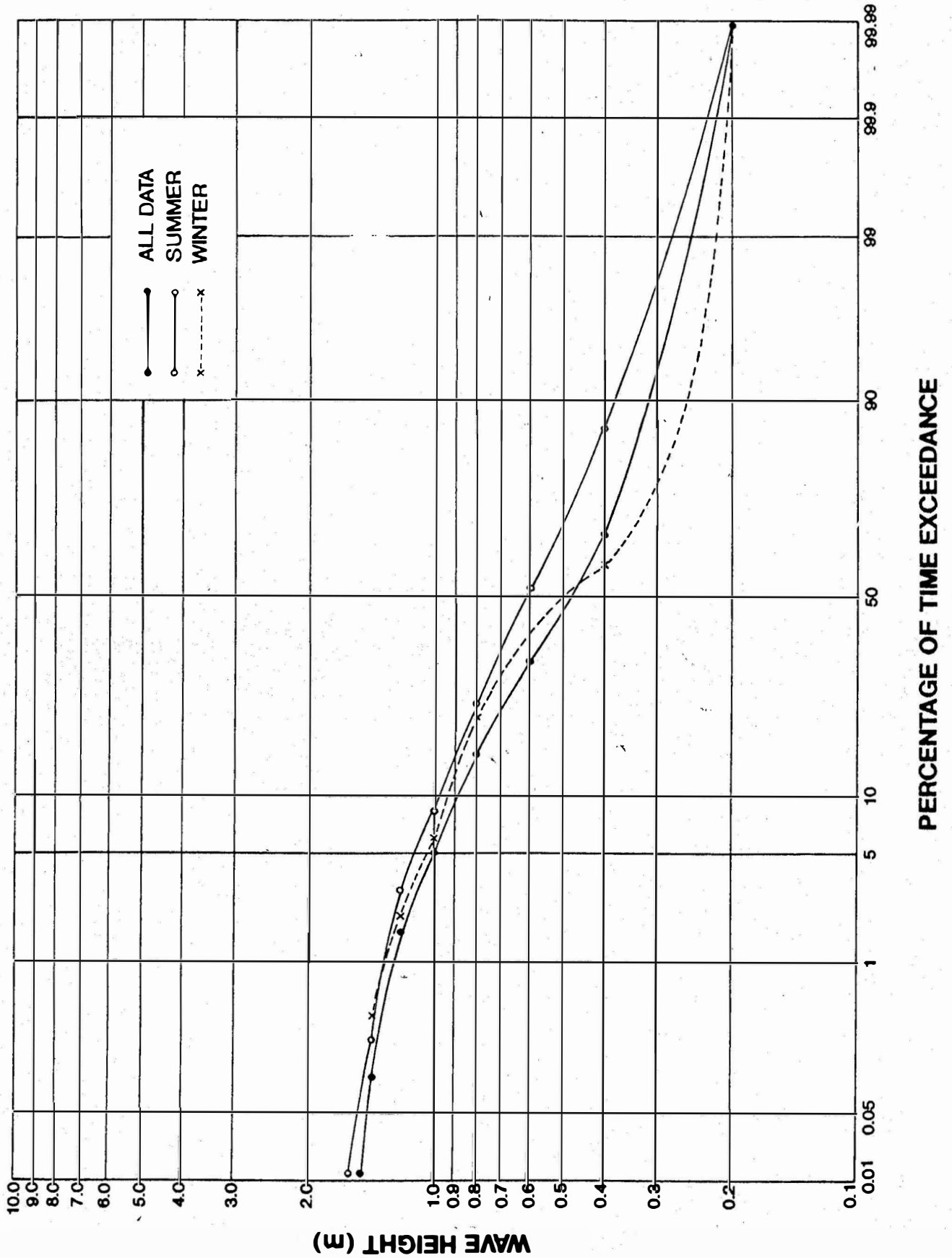
**LOCALITY MAP
BLACKS BEACH**

Figure
1



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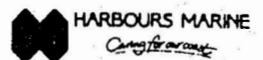
**PERCENTAGE (OF TIME) EXCEEDANCE
 OF WAVE HEIGHTS (H_{sig}) FOR ALL
 WAVE PERIODS**

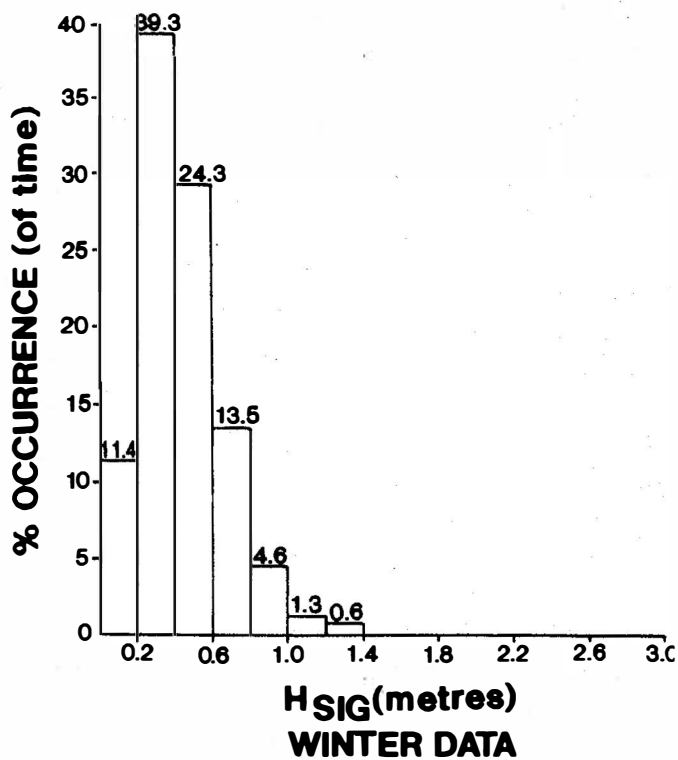
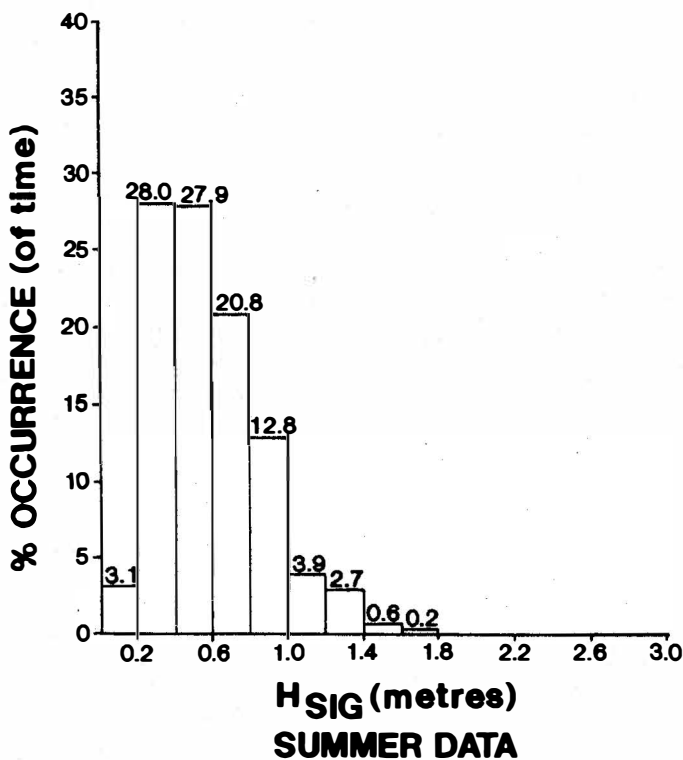
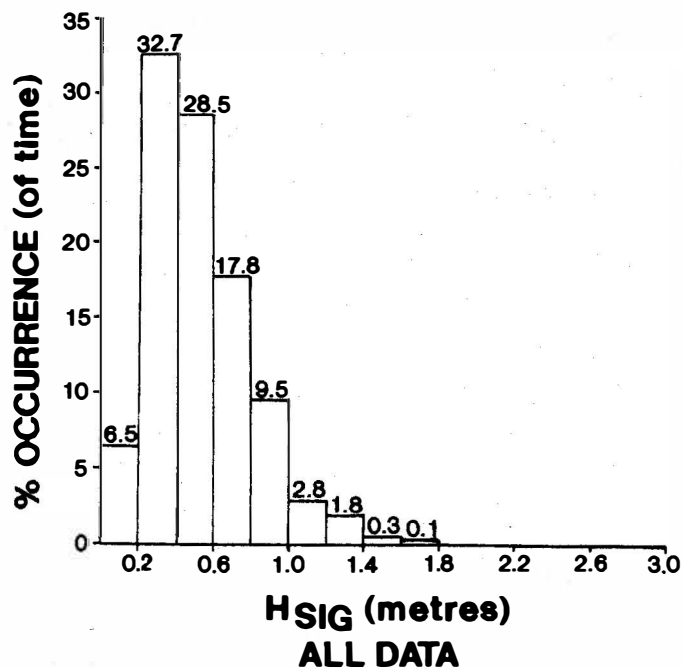
12th May 1987 to 6th May 1988



Beach Protection Authority
 Queensland

Figure
2





**HISTOGRAM PERCENTAGE (OF TIME)
OCCURRENCE OF WAVE HEIGHTS (H_{sig})
FOR ALL WAVE PERIODS (T_p)**

12th May 1987 to 6th May 1988

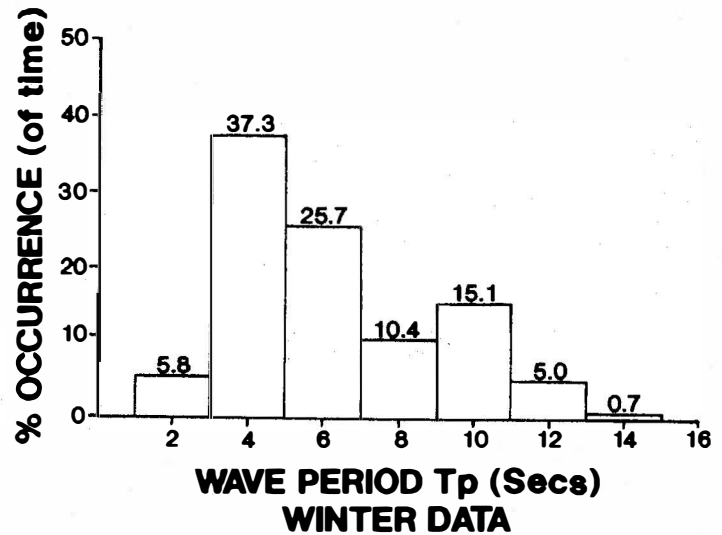
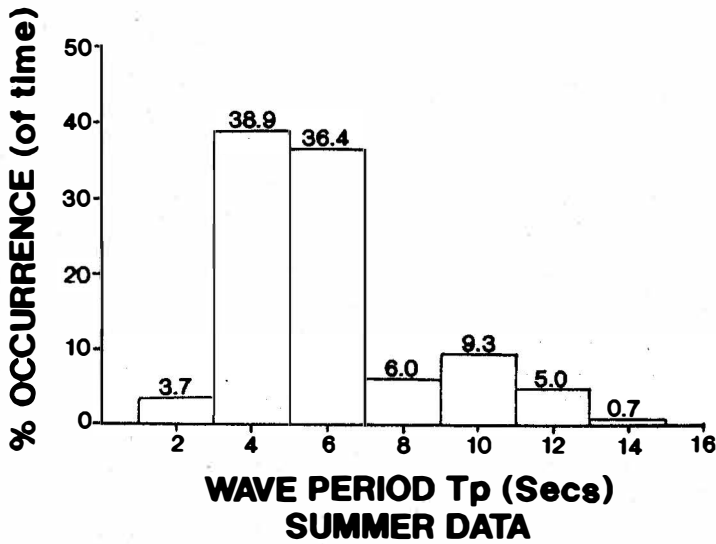
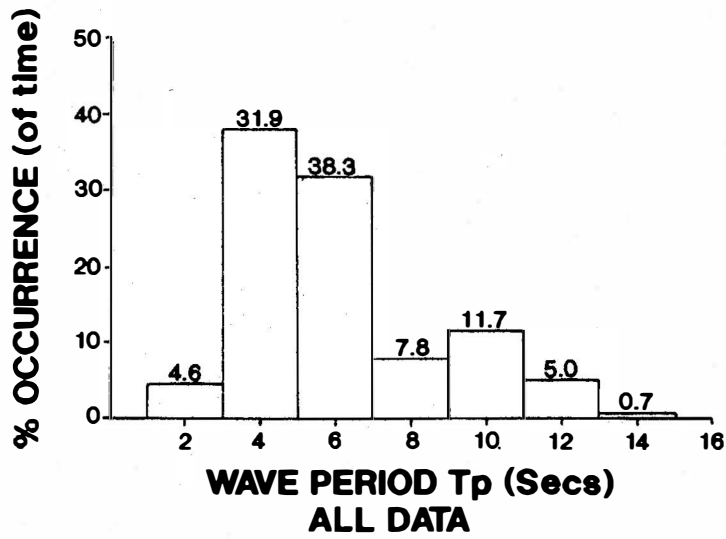


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Figure

3

HARBOURS MARINE
Consultants

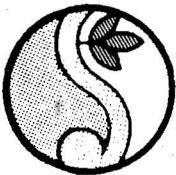


**HISTOGRAM PERCENTAGE (OF TIME)
OCCURRENCE OF WAVE PERIODS (T_p)
FOR ALL WAVE HEIGHTS (H_{sig})**

12th May 1987 to 6th May 1988

Figure

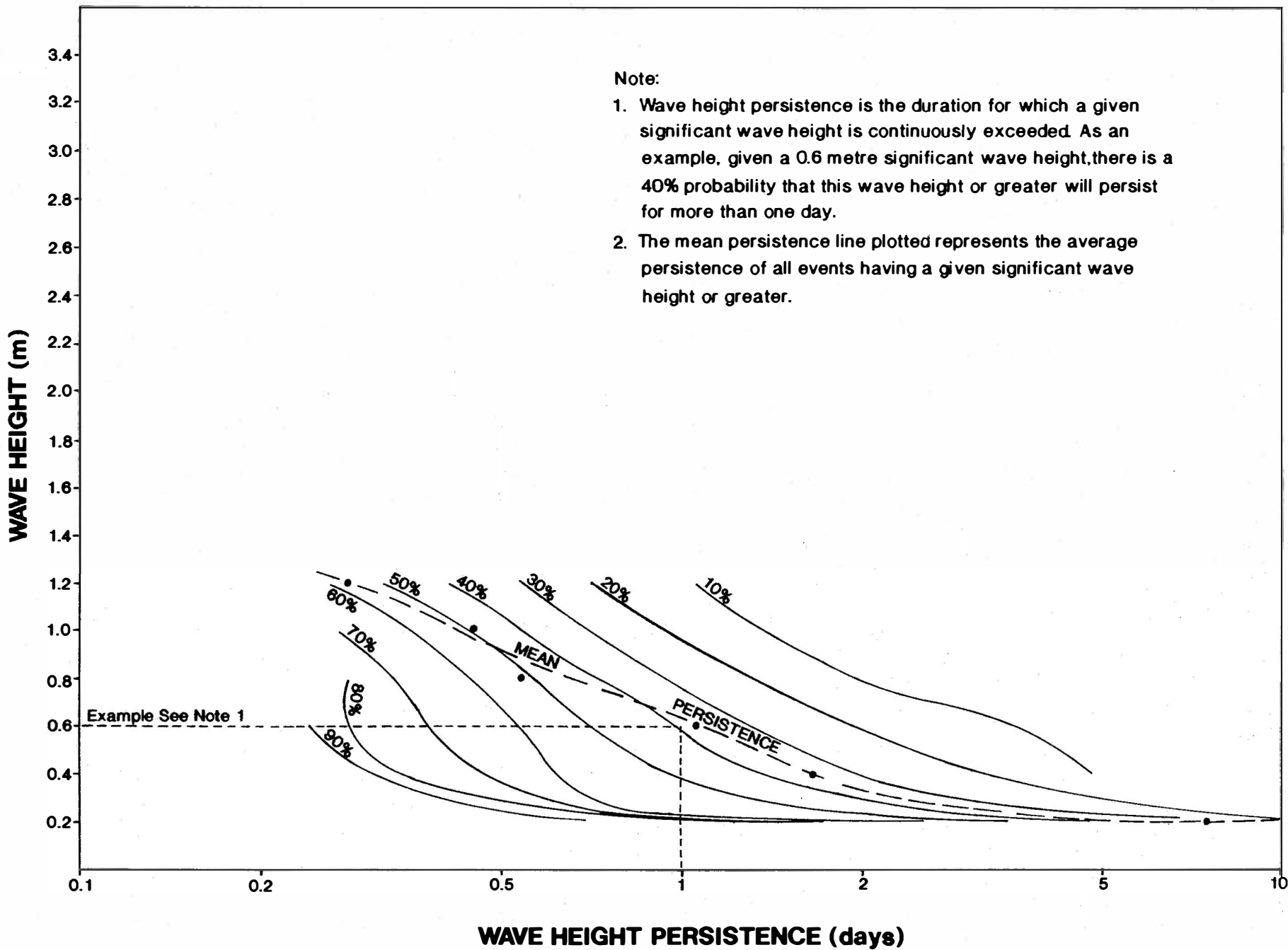
4

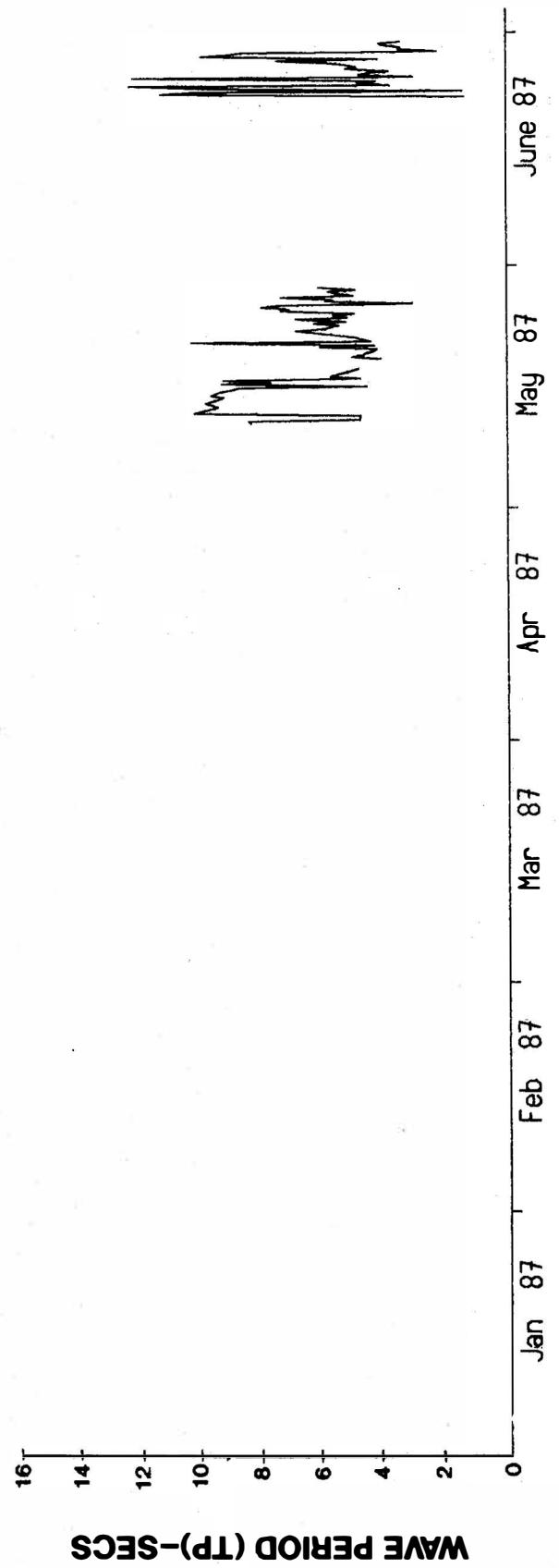
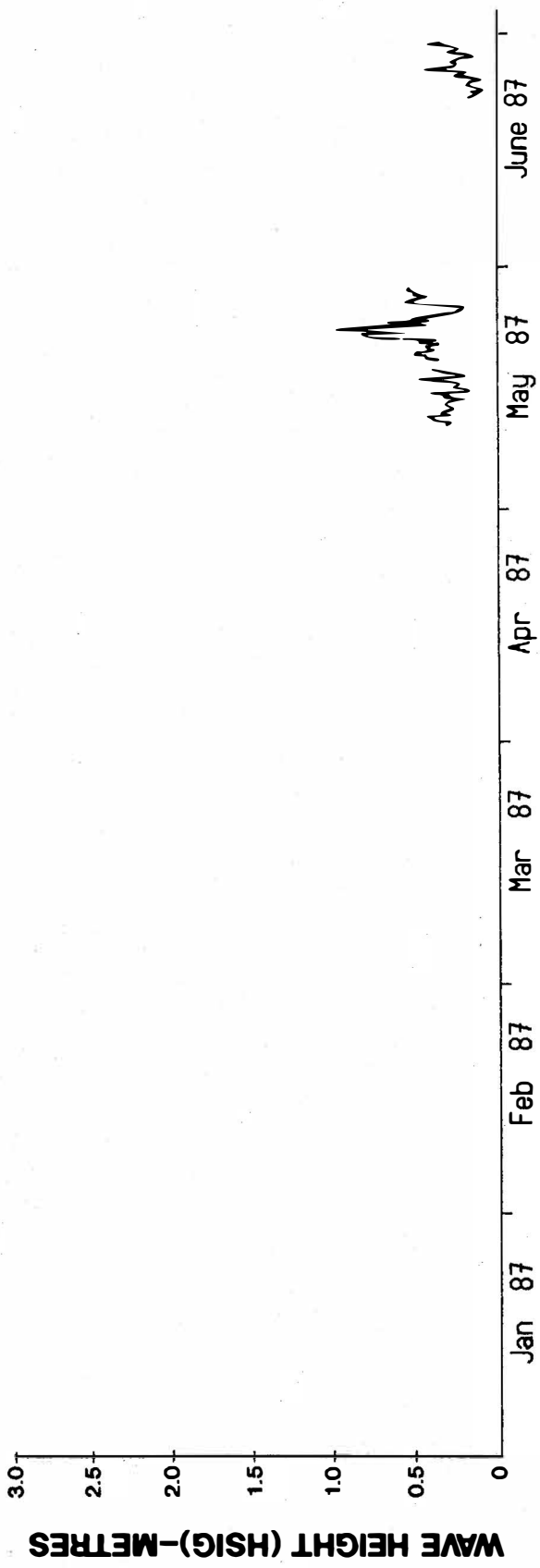


AVERAGE DURATION OF EXCEEDANCE OF WAVE HEIGHTS (H_{sig})

12th May 1987 to 6th May 1988

Figure
5



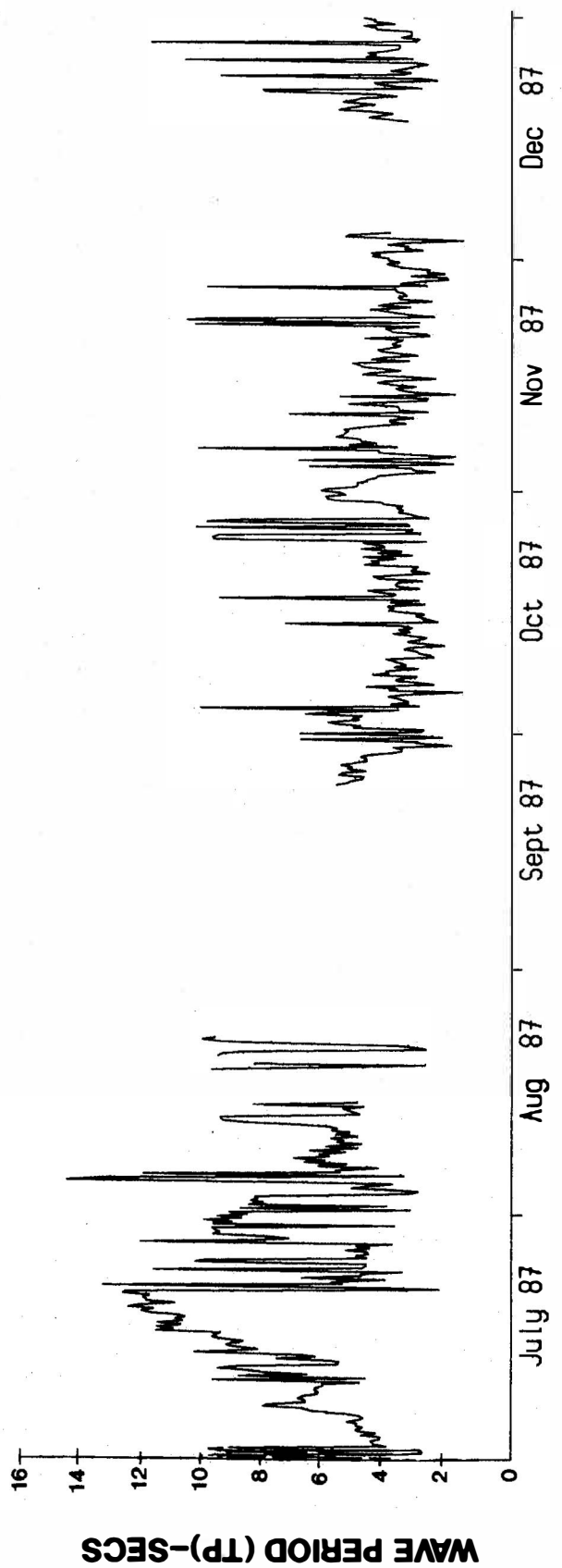
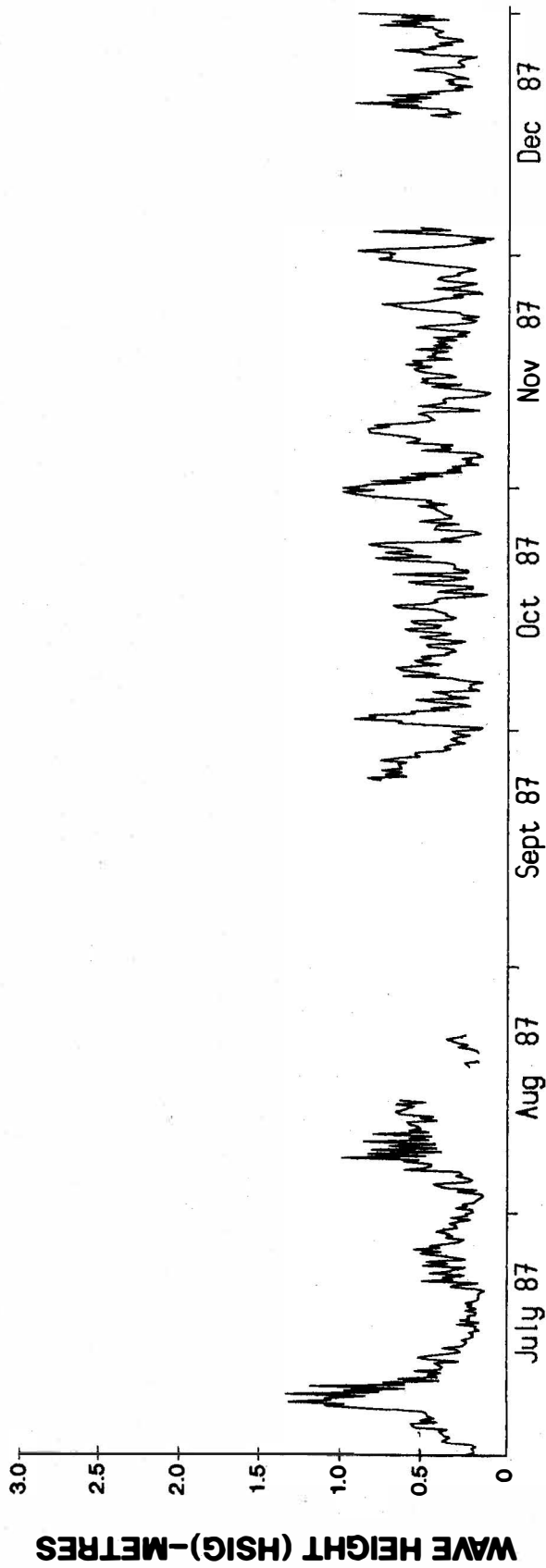


Beach Protection Authority
Queensland

DAILY WAVE RECORDINGS
12th May 1987 to 6th May 1988

Figure
6
Sheet 1 of 3





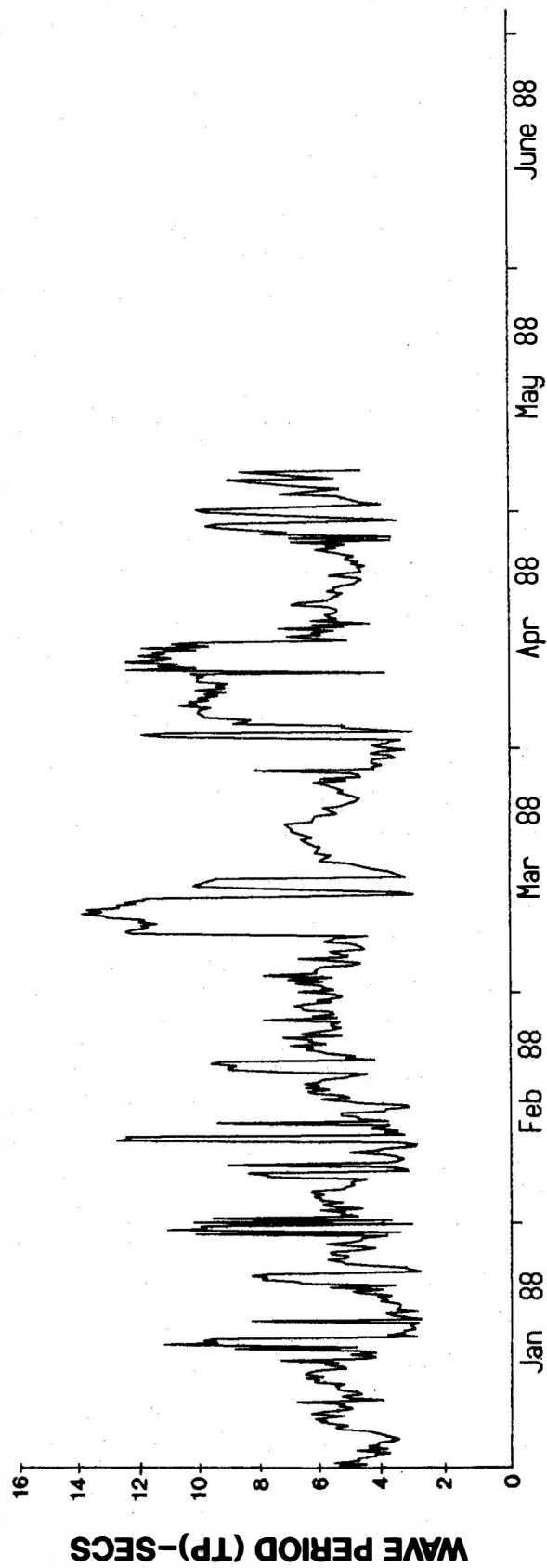
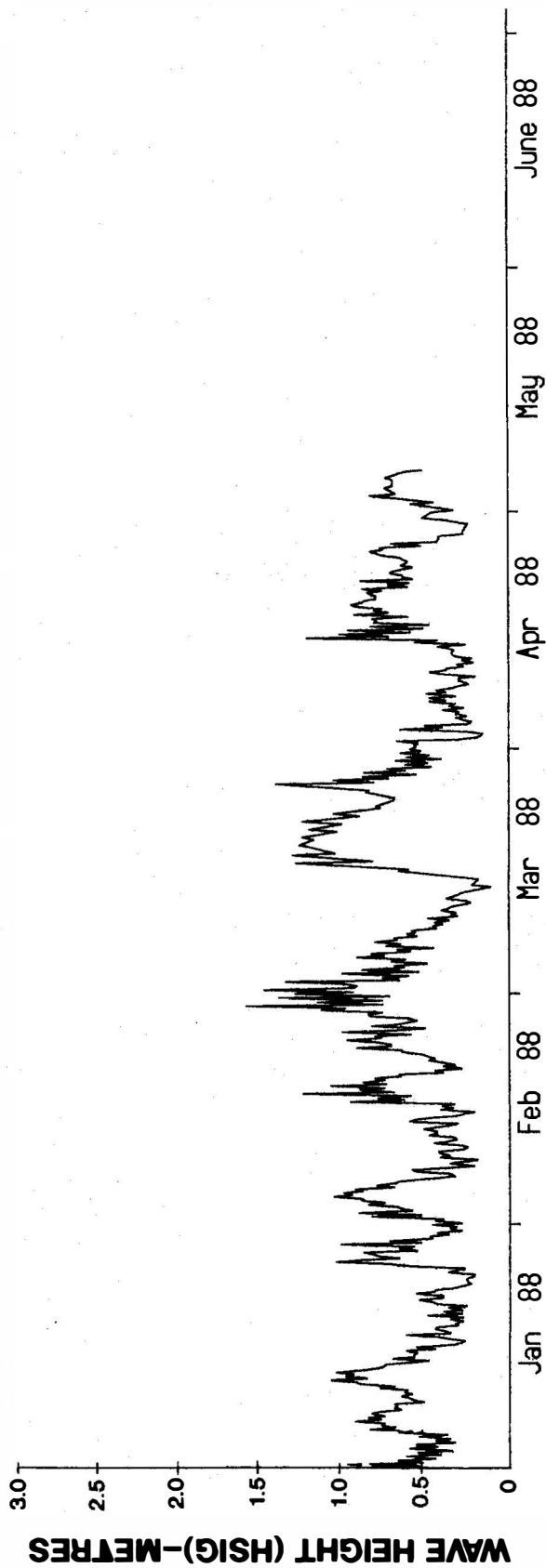
Beach Protection Authority
Queensland

DAILY WAVE RECORDINGS

12th May 1987 to 6th May 1988

Figure
6
Sheet 2 of 3

HARBOURS MARINE
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Beach Protection Authority
Queensland

DAILY WAVE RECORDINGS

12th May 1987 to 6th May 1988

Figure

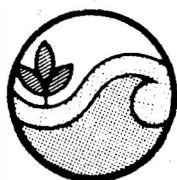
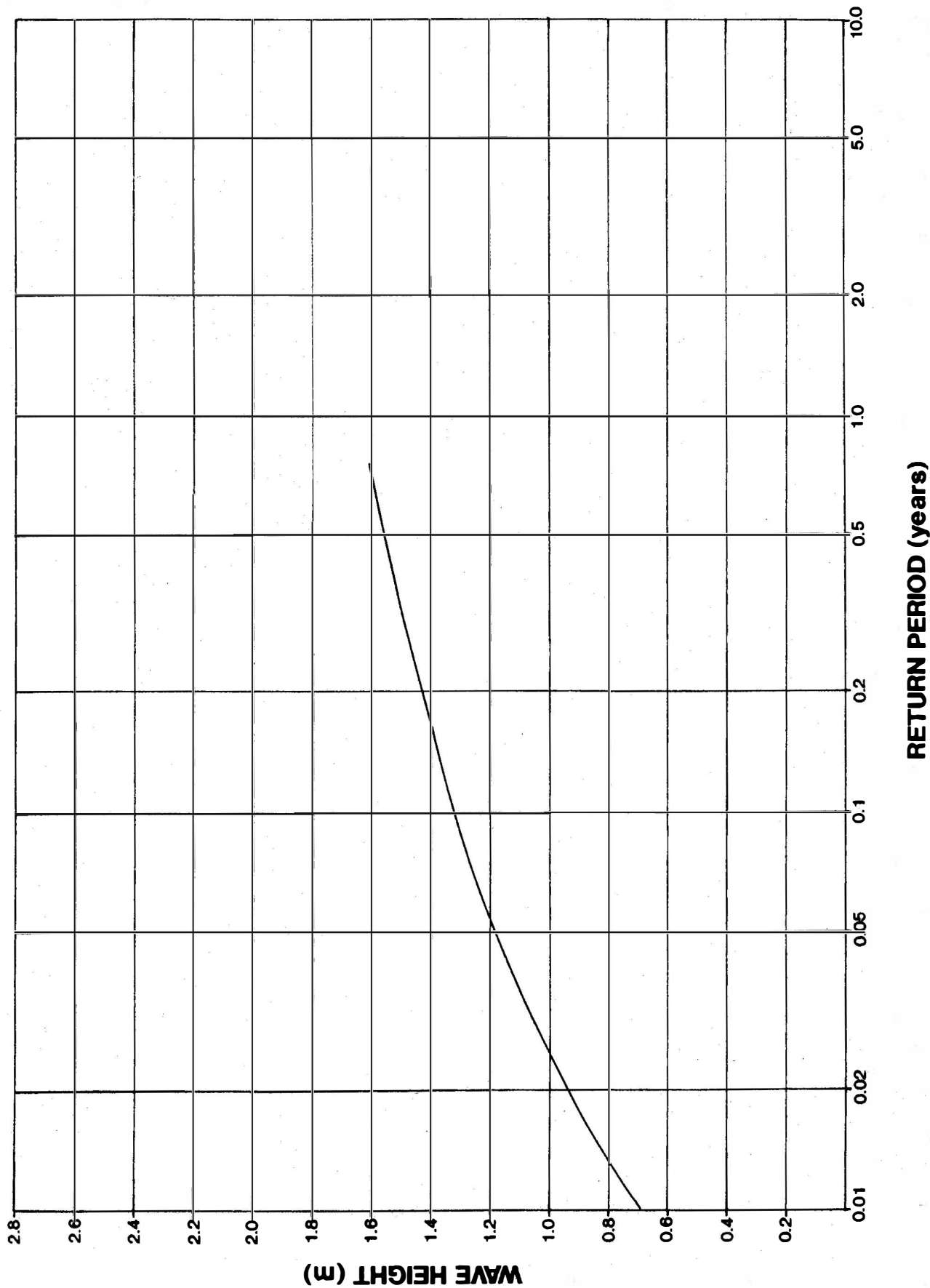
6

Sheet 3 of 3



HARBOURS MARINE

Crang & Co.



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WAVE HEIGHT (H_{sig})
RECURRENCE INTERVALS
 12th May 1987 to 6th May 1988

Figure
7

