Beach Protection Authority Queensland

WAVE DATA RECORDING PROGRAMME

TOWNSVILLE REGION

HARBOURS MARINE

Caring for our coast

WAVE DATA RECORDING PROGRAMME

TOWNSVILLE REGION

REPORT NO. W03.2

Beach Protection Authority

November 1988

This report has been prepared by the Beach Protection Branch of the Harbours and Marine Department on behalf of the Beach Protection Authority.

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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ISSUING ORGANISATION:- Beach Protection Authority
G.P.O. BOX 2595
BRISBANE QLD 4001
AUSTRALIA

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ABSTRACT:-

This is the second report to provide summaries of primary analysis of wave data recorded in 20 metres of water offshore near Townsville in North Queensland. Data was recorded using a Datawell "Waverider" buoy, and covers the period November 19, 1975 to December 29, 1987. The data was divided into seasonal groupings for analysis. Wave data recorded between July 16, 1975 and November 19, 1975 is presented in this report in Figure 7 only since this data was recorded on paper chart and not as magnetic tape.

This report supersedes Wave Data Recording Programme, Townsville Region (Report No. W03.1).

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)
Wave Data Recording Programme, Mackay Region (Report No. W02.2)
Wave Data Recording Programme, Townsville Region (Report No. W03.1)
Wave Data Recording Programme, Sunshine Coast Region (Report No. W04.1)
Wave Data Recording Programme, Burnett Heads Region (Report. No. W05.1)
Wave Data Recording Programme, Abbot Point Region (Report No. W06.1)
Wave Data Recording Programme, Weipa Region (Report No. W07.1)
Wave Data Recording Programme, Gladstone Region (Report No. W08.1)
Wave Data Recording Programme, Brisbane Region (Report No. W09.1)
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WAVE DATA RECORDING PROGRAMME

TOWNSVILLE REGION

REPORT NO. W03.2

1.0 INTRODUCTION

The Beach Protection Authority as part of its long term programme of investigating erosion problems along Queensland's coastline has been recording wave characteristics through a network of wave recording stations since 1968.

This report summarizes the primary analysis of wave data collected in the Townsville 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.

Initially the installation comprised a Waverider 6000 series buoy transmitting to a shore based WAREP Mark II receiver which in turn was coupled to an ANMA analogue recording unit. From January 20, 1986 the ANMA analogue recording unit was replaced with a DIMA digital recording unit while the remainder of the wave recording equipment for this installation was retained.

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 record and relayed the analogue signal to tape on the ANMA recorder or DIMA recorder.

3.0 WAVE RECORDING AND ANALYSIS PROCEDURES

In general between November 9, 1975 and January 22, 1982 two recordings of water levels each of 20 minutes duration were made each day with the timing of the recordings set at 0300 hours and 1500 hours respectively.

During cyclonic events or other periods of severe wave action the recording frequency may have been increased to 4 times daily. Twenty minute records are still maintained at such times.

From January 23, 1982 there have been 4 recordings per day each of 20 minutes duration at 0300 hours, 0900 hours, 1500 hours and 2100 hours.

Digitization of the analogue data tapes was carried out at the Brisbane Office and the digital records held on 9 track digital tapes compatible with the computing facilities available to the Authority. In this process the analogue tapes produced in the field were sampled electronically at half second intervals and this information together with necessary administration information was transferred to the digital tape by a digitizer which was specifically developed for this purpose.

The DIMA recorder provides digital data on cassette sampled at half second intervals with the necessary administration information included at the beginning of each record. Digital wave data can be transferred directly from the cassette to the Authority's computer facilities by a digital cassette reader.

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 height 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 (Tp)	The wave period corresponding to the peak of the energy density spectrum.
6.	Significant Period (Tsig)	The average period of the highest one third of waves in the record.
7.	Zero Crossing Period (Tz)	The average period of all waves in the record based on upward zero crossings.
8.	Crest Period (Tc)	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 Townsville 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. In addition, similar analyses are carried out on the relationships between the various wave parameters and these are presented in Figure 5.

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 6.

5.3 Return Intervals

The percentage of time of exceedance data for various wave heights (Figure 2) are combined with the persistence data (Figure 6) to determine the average wave height recurrence intervals.

The technique used to calculate the return intervals presented in Figure 8 is given below:-

No. of hours per year of exceedance of a given wave height

$$H = \frac{Pe \times 8760 \text{ hrs}}{100}$$
$$= 87.6\ Pe \text{ hrs}$$

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

Average No. of events per year in which H is exceeded

$$= \frac{87.6\ Pe}{P}$$

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.
i.e. No. of events per year in which H is exceeded for at least the specified duration

$$= \frac{87.6\ Pe}{P} \times \frac{Pn}{100}$$

$$= \frac{0.876\ Pe \times Pn}{P}$$

where Pn may be determined from Figure 6.

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 -

$$\text{Return Interval} = \frac{1}{\text{Ave. No. of occurrences per year}}$$

$$= \frac{P}{0.876\ Pe \times Pn}$$

It should be noted that the data presented in Figure 8 are for the average wave height recurrence interval and include all exceedance events of the given wave height without regard for 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 "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/Wave Height Occurrences, All Data, All Directions.

Table 2: Wave Statistics; Wave Period/Wave Height Occurrences, Summer Data, All Directions.

Table 3: Wave Statistics; Wave Period/Wave Height Occurrences, Winter Data, All Directions.

Figure 1: Locality Map.

Figure 2: Percentage (of time) Exceedance of Wave Heights (Hsig) for All Wave Periods (Tp).

Figure 3: Histogram Percentage (of time) Occurrence of Wave Heights (Hsig) for All Wave Periods (Tp).

Figure 4: Histogram Percentage (of time) Occurrence of Wave Periods (Tp) for All Wave Heights (Hsig).

Figure 5: Wave Parameter Relationships.

Figure 6: Average Duration of Exceedance of Wave Heights (Hsig).

Figure 7: Daily Wave Recordings.

Figure 8: Wave Height (Hsig) 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:- Townsville Region

Buoy Location:-

Co-ordinates:- 147°03'54" East 19° 09'36" South

Description:- 6 kms North-East of Cape Cleveland.

Water Depth at Buoy:- 20 metres relative to Australian Height Datum

Location of Recording Station:- Cape Cleveland Lighthouse Reserve
July 16 to July 31, 1985

Harbours and Marine office
(Navigation Aids) Townsville
September 18, 1985 to
December 29, 1987

Period of Data Collection:- July 16, 1975 to
December 29, 1987

Normal Recording Interval:- Two twenty minute records daily at 0300 hours and 1500 hours between May 16, 1975 and January 22, 1981.

Four twenty minute records daily at 0300 hours, 0900 hours, 1500 hours and 2100 hours between January 22, 1982 and December 29, 1987.

Total No. of Records Analysed:- 10,813

Number of Records Lost Due to:-

Losses during Analysis	144
Damaged Accelerometer Cables	182
Losses due to equipment malfunction	1,897

Periods during which three recordings per day were taken:-

February 16, 1977 to February 18, 1977 - Times for the three twenty minute records were varied over this three day period.

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 off NSW Coast and Low Pressure System off Tasmania	1020 + 980	11/12/75		1.80	2.74	6.31
High Pressure System over Tasman Sea	1032	11/4/76		1.74	3.16	5.78
Cyclone Ted	996	20/12/76	500 NW	1.71	3.01	6.26
Cylone Keith	1000	1/2/77	40 E	1.89	3.30	6.15
Cyclone Nancy	998	13/2/77	300 NNW	1.80	2.86	6.30
Cyclone Otto	988	7/3/77	400 NW	1.86	2.98	6.92
High Pressure System over Tasmania	1024	28/11/77		1.73	2.83	6.21
Low Pressure System off NQ Coast	1004	23/12/77		1.73	3.03	6.15
Cyclone Hal	999	9/4/78	200 NE	#	#	#
High Pressure System over NSW & Low Pressure System off Adelaide	1024 + 1012	25/8/78		1.70	2.70	5.95
High Pressure System off Coast of NSW	1028	10/10/78		1.78	2.73	6.42
High Pressure System over NSW Coast	1028	21/10/78		1.72	2.63	6.09
Cyclone Peter	980	5/1/79	300 N	2.36	4.70	6.67

Meteorological Event	*Central Pressure (mb)	Date	*Estimated Position of Cyclone Relative to Buoy (km)	Maximum Hsig Recorded (metres)	Maximum Hmax Recorded (metres)	Tp (secs)
Cyclone Kerry	988	3/3/79	100 N	2.76	4.58	7.69
High Pressure System over NSW Coast and Low Pressure System over Tasman Sea	1028 + 988	17/6/79		1.70	2.77	6.08
Cyclone Paul	995	6/1/80	400 W	1.72	2.95	5.94
Cyclone Simon	965	28/2/80	700 SE	2.65	3.02	6.27
High Pressure System over NSW Coast	1032	6/9/81		1.74	3.15	6.17
Cyclone Dominic	998	10/4/82	400 NNE	1.77	3.45	6.37
High Pressure System over Tasman Sea	1028	17/5/82		1.82	3.73	5.93
High Pressure System over Tasman Sea	1038	18/8/82		1.70	2.58	7.12
Cyclone Elinor	998	19/2/83	400 NW	1.65	2.61	6.04
High Pressure System over Victoria	1036	3/6/83		1.73	3.26	5.54
High Pressure System over NSW & Low Pressure System off South Australia	1024 + 984	19/9/83		1.71	2.89	5.66
High Pressure System over SE Queensland & Low Pressure System over Tasmania	1024 + 992	27/9/83		1.71	3.06	5.64

Meteorological Event	*Central Pressure (mb)	Date	*Estimated Position of Cyclone Relative to Buoy (km)	Maximum Hsig Recorded (metres)	Maximum Hmax Recorded (metres)	Tp (secs)
Cyclone Fritz	999	10/12/83	500 NE	1.84	3.48	6.04
Cyclone Ingrid	1000	20/2/84	200 N	1.65	3.14	6.14
Cyclone Lance	1000	4/4/84	550 NE	1.69	2.54	5.54
High Pressure System over South East Queensland	1024	9/10/84		1.84	2.61	5.75
High Pressure System over Tasman Sea	1028	16/11/84		2.23	3.44	6.72
High Pressure System over North Queensland	1004	15/1/85		2.05	3.56	6.44
Cyclone Pierre	985	21/2/85	150 E	#	#	#
High Pressure System over Tasman Sea	1028	21/4/85		1.76	2.83	5.73
High Pressure System over Tasman Sea	1028	30/9/85		1.76	3.36	6.03
Cyclone Winifred	957	2/2/86	150 N	2.50	4.95	7.36
High Pressure System over Tasman Sea	1032	29/3/86		1.80	3.13	6.28
High Pressure System over NSW Coast	1028	1/6/87		1.70	2.64	6.31
High Pressure System on NSW Coast	1040	8/7/87		1.69	2.89	5.44
High Pressure System over Tasman Sea	1024	1/11/87		1.87	3.87	6.08

Highest Significant Wave Height (Hsig) recorded was 2.76 m on March 3, 1979 due to Cyclone Kerry.

Highest Maximum Wave Height (Hmax) recorded was 4.95 m on February 2, 1986 due to Cyclone Winifred.

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.

Field Equipment not operating.

Note: The mean Hsig value for the total twelve year period was 0.55m. A value of 3 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

WAVE PERIOD/WAVE HEIGHT OCCURRENCES

ALL DATA, ALL DIRECTIONS

Significant Wave Height (metres)	Peak Energy Wave Periods (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 - .20	40.87	35.50	39.00	19.37	6.25	3.25	*	*	144.24
.21 - .40	275.95	370.57	242.43	119.80	6.49	2.75	0.75	*	1018.74
.41 - .60	61.70	643.74	128.16	46.41	4.01	1.25	0.50	*	885.77
.61 - .80	1.00	423.09	184.27	11.50	1.00	*	*	*	620.86
.81 - 1.00	*	189.19	283.10	4.75	*	1.00	*	*	478.04
1.01 - 1.20	*	73.20	262.49	0.49	0.50	0.50	*	*	337.18
1.21 - 1.40	*	11.51	146.83	0.50	*	*	*	*	158.84
1.41 - 1.60	*	2.50	66.95	0.75	*	*	*	*	70.20
1.61 - 1.80	*	0.50	29.47	0.50	*	*	*	*	30.47
1.81 - 2.00	*	*	6.75	*	*	*	*	*	6.75
2.01 - 2.20	*	*	2.25	*	*	*	*	*	2.25
2.21 - 2.40	*	*	1.50	0.50	*	*	*	*	2.00
2.41 - 2.60	*	*	*	0.25	*	*	*	*	0.25
2.61 - 2.80	*	0.50	*	0.50	*	*	*	*	1.00
TOTALS	379.52	1750.30	1393.20	205.32	18.25	8.75	1.25	0.0	3756.59

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

TABLE 2

WAVE STATISTICS

WAVE PERIOD/WAVE HEIGHT 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 - .20	15.25	18.75	12.50	4.25	3.25	*	*	*	54.00
.21 - .40	158.15	216.40	112.04	50.65	5.00	2.00	0.25	*	544.49
.41 - .60	42.54	329.76	58.83	22.26	3.26	1.00	0.50	*	458.15
.61 - .80	0.50	201.17	67.04	5.75	1.00	*	*	*	275.46
.81 - 1.00	*	99.38	105.12	3.75	*	1.00	*	*	209.24
1.01 - 1.20	*	43.84	113.61	0.25	0.50	0.50	*	*	158.70
1.21 - 1.40	*	7.26	64.71	0.50	*	*	*	*	72.47
1.41 - 1.60	*	1.25	39.11	0.50	*	*	*	*	40.86
1.61 - 1.80	*	0.50	18.24	0.25	*	*	*	*	18.99
1.81 - 2.00	*	*	5.25	*	*	*	*	*	5.25
2.01 - 2.20	*	*	2.00	*	*	*	*	*	2.00
2.21 - 2.40	*	*	1.50	0.50	*	*	*	*	2.00
2.41 - 2.60	*	*	*	0.25	*	*	*	*	0.25
2.61 - 2.80	*	0.50	*	0.50	*	*	*	*	1.00
TOTALS	216.44	918.81	599.95	89.40	13.01	4.50	0.75	0.0	1842.86

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

TABLE 3

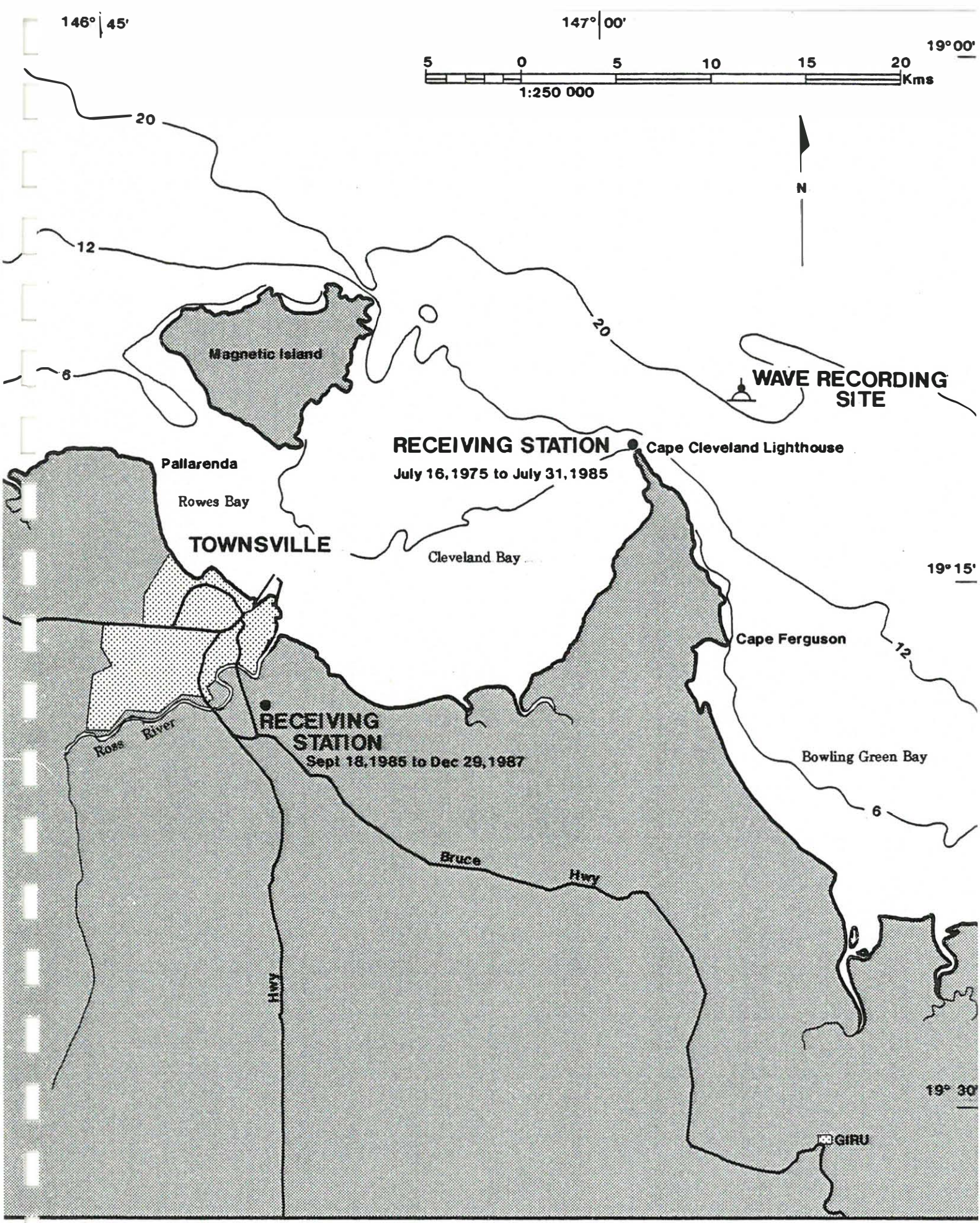
WAVE STATISTICS

WAVE PERIOD/WAVE HEIGHT 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 - .20	25.62	16.75	26.50	15.13	2.99	3.25	*	*	90.24
.21 - .40	117.79	154.16	130.39	69.15	1.50	0.75	0.50	*	474.24
.41 - .60	19.17	313.98	69.33	24.14	0.75	0.25	*	*	427.62
.61 - .80	0.50	221.92	117.23	5.75	*	*	*	*	345.40
.81 - 1.00	*	89.82	177.98	1.00	*	*	*	*	268.80
1.01 - 1.20	*	29.36	148.88	0.25	*	*	*	*	178.49
1.21 - 1.40	*	4.25	82.12	*	*	*	*	*	86.37
1.41 - 1.60	*	1.25	27.84	0.25	*	*	*	*	29.34
1.61 - 1.80	*	*	11.23	0.25	*	*	*	*	11.48
1.81 - 2.00	*	*	1.50	*	*	*	*	*	1.50
2.01 - 2.20	*	*	0.25	*	*	*	*	*	0.25
TOTALS	163.08	831.49	793.27	115.92	5.24	4.25	0.50	0.00	1913.73

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

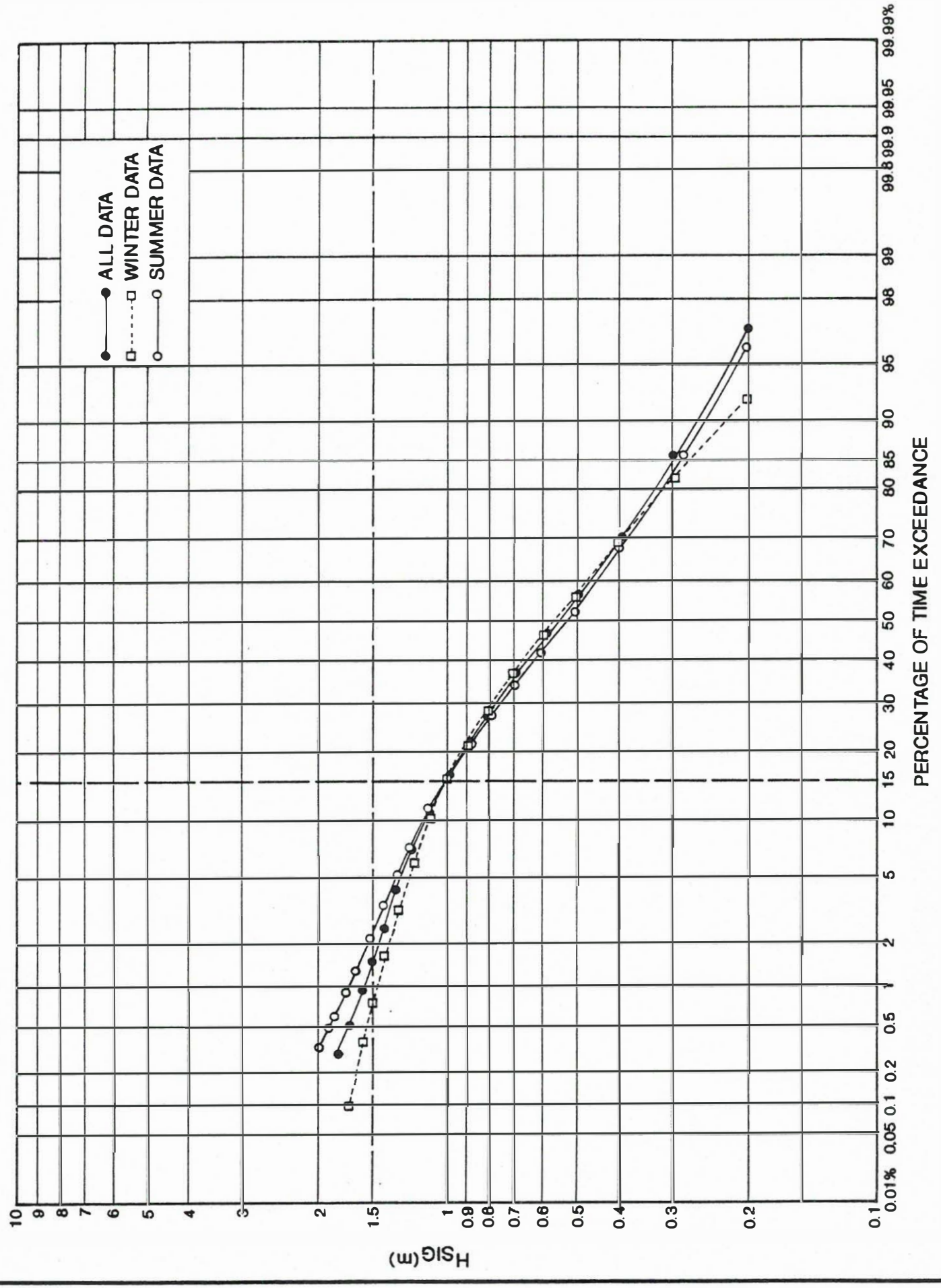


Beach Protection Authority

LOCALITY MAP

Wave Data Recording Programme
Townsville Region

Figure 1
W03.2



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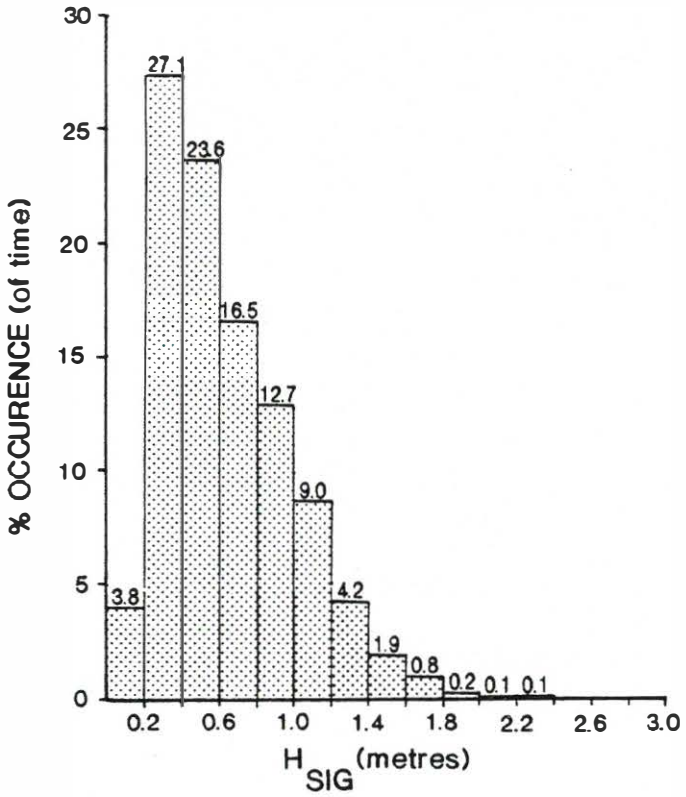
PERCENTAGE (OF TIME) EXCEEDANCE OF WAVE HEIGHTS (H_{sig}) FOR ALL WAVE PERIODS

19th November 1975 to 29th December 1987

Wave Data Recording Programme
Townsville Region

Figure 2
W03.2



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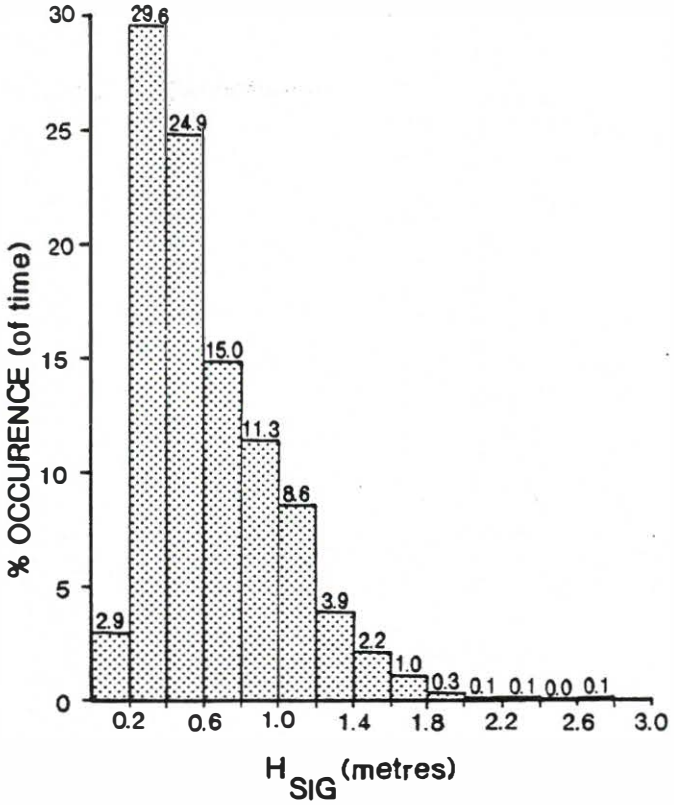
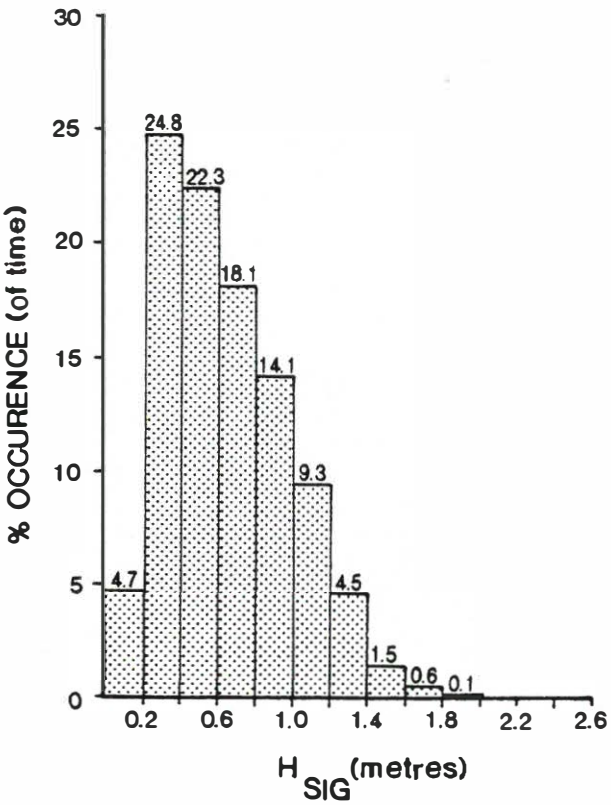


SUMMER DATA



WINTER DATA

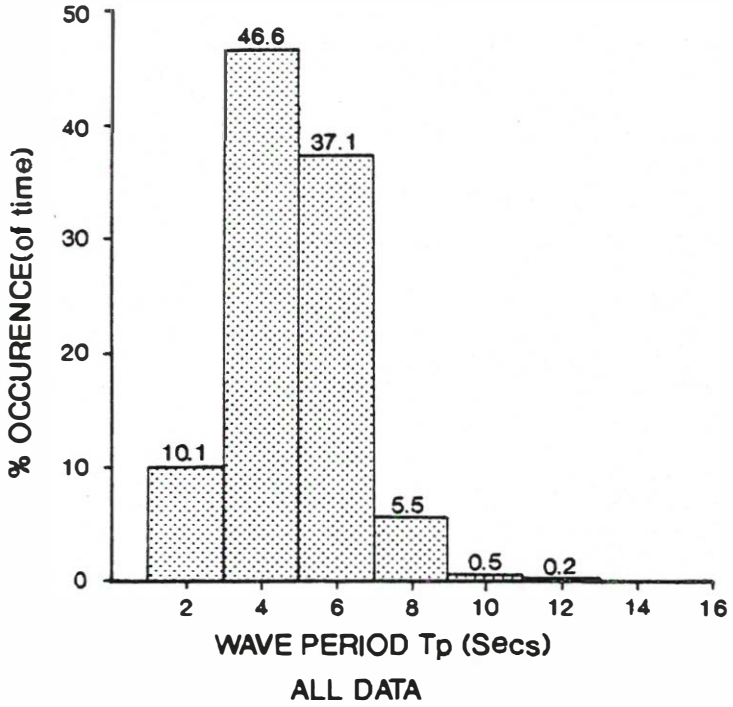
Beach Protection Authority

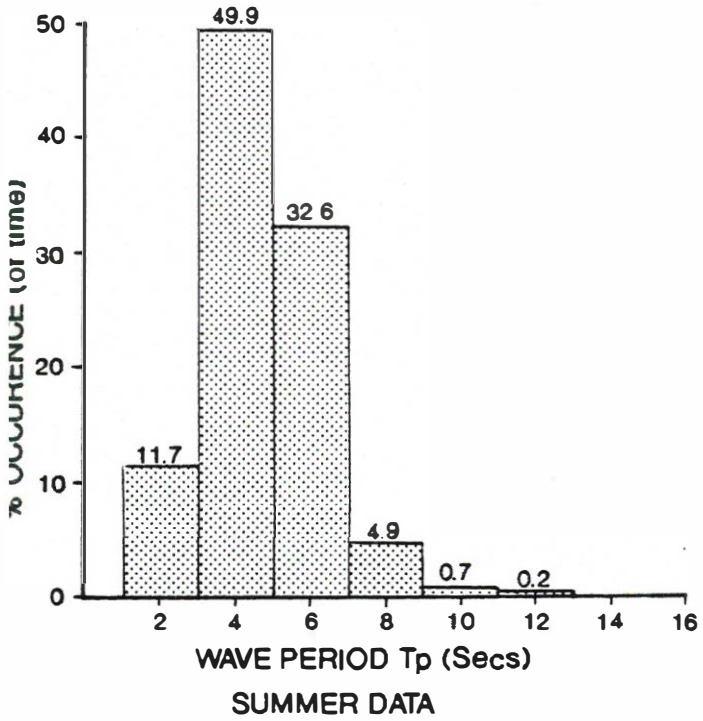
HISTOGRAM PERCENTAGE (OF TIME) OCCURENCE OF WAVE HEIGHTS (H_{sig}) FOR ALL WAVE PERIODS (T_p)

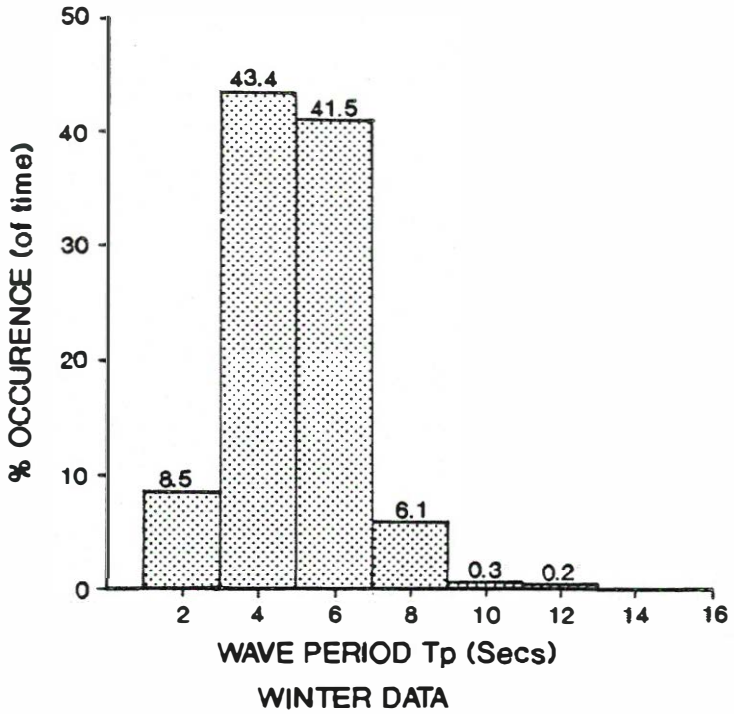
19th November 1975 to 29th December 1987

Wave Data Recording Programme
Townsville Region

Figure 3
W03.2







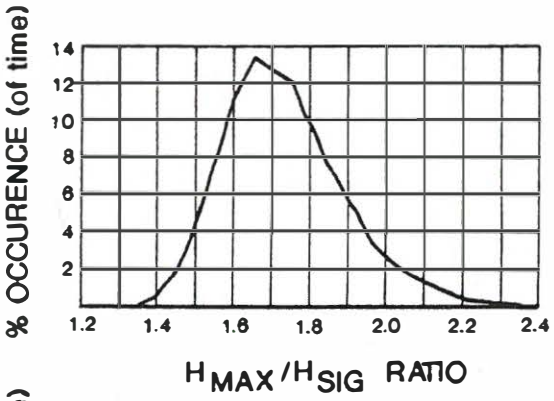
Beach Protection Authority

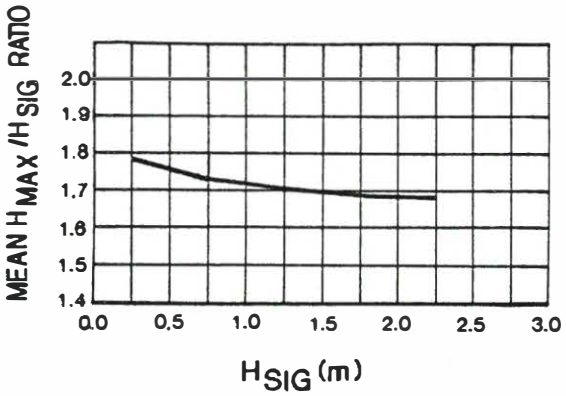
HISTOGRAM PERCENTAGE (OF TIME) OCCURENCE OF WAVE PERIODS (T_p) FOR ALL WAVE HEIGHTS (H_{sig})

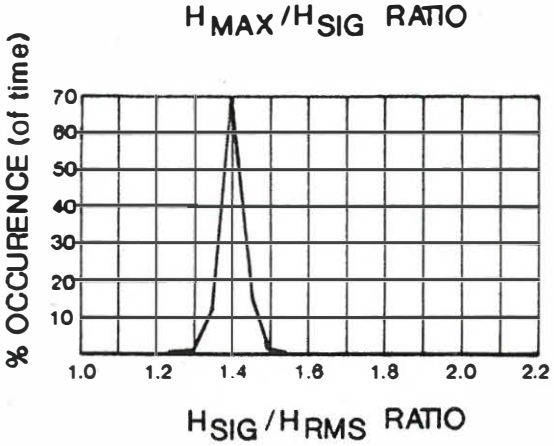
19th November 1975 to 29th December 1987

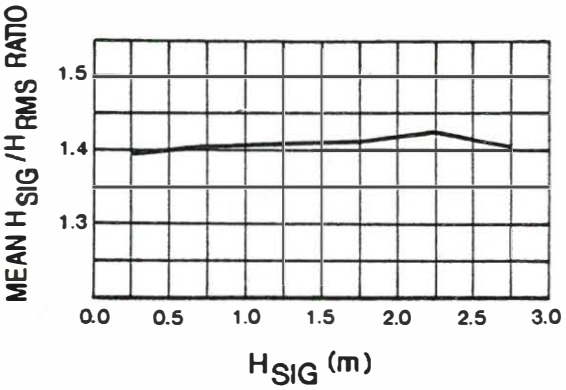
Wave Data Recording Programme
Townsville Region

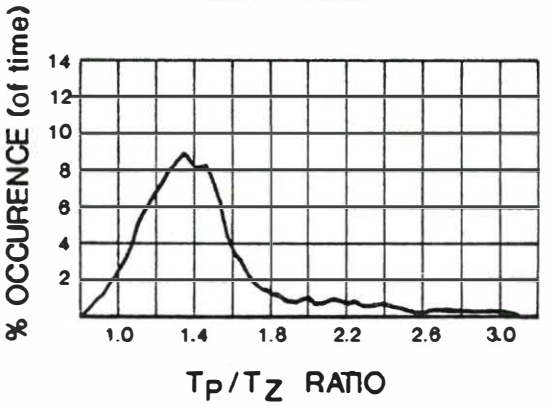
Figure 4
W03.2

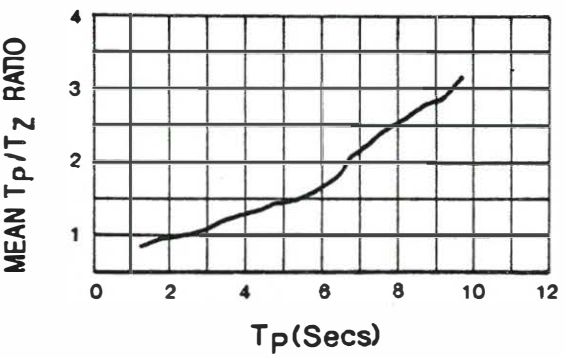


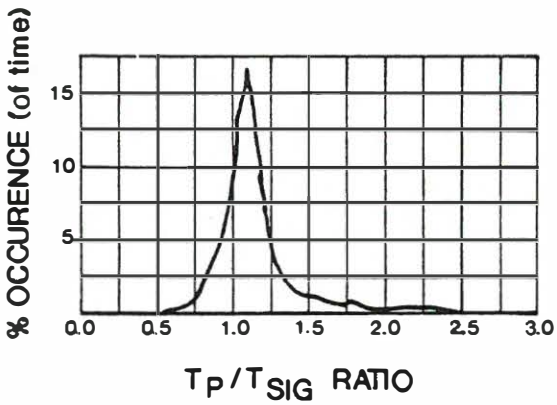


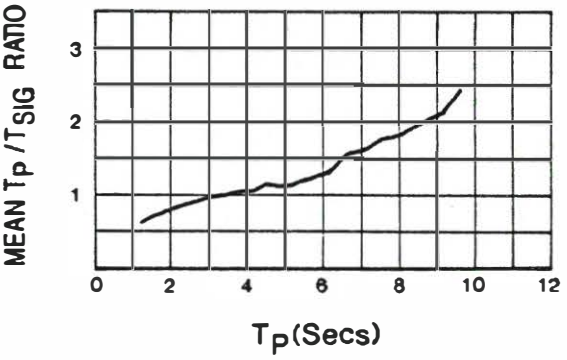












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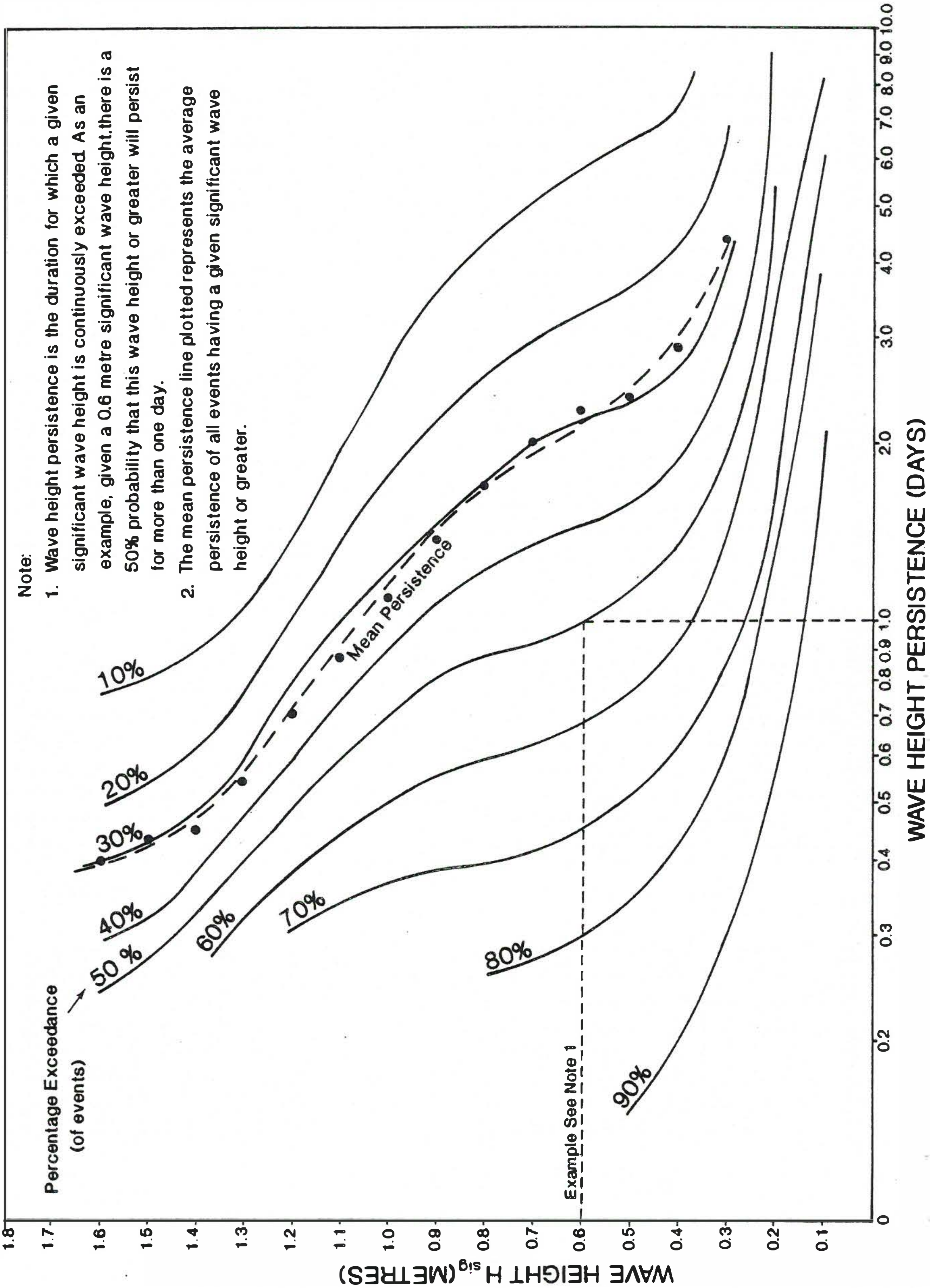
WAVE PARAMETER RELATIONSHIPS

19th November 1975 to 29th December 1987

Wave Data Recording Programme
Townsville Region

Figure 5
W03.2



Wave Data Recording Programme

Townsville Region

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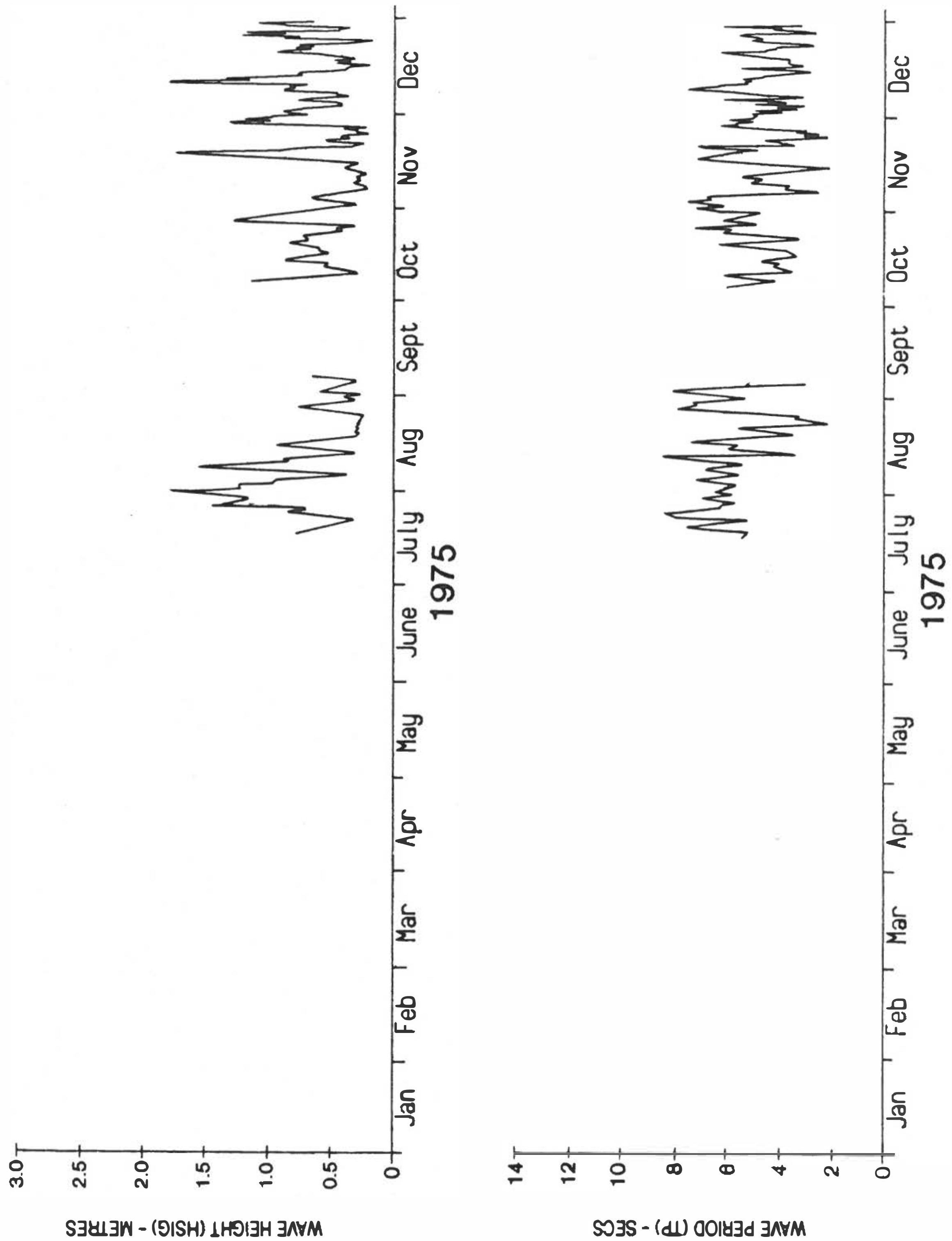
AVERAGE DURATION OF EXCEEDANCE OF WAVE HEIGHTS (H_{sig})

19th November 1975 to 29th December 1987

Figure 6

W03.2



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DAILY WAVE RECORDINGS

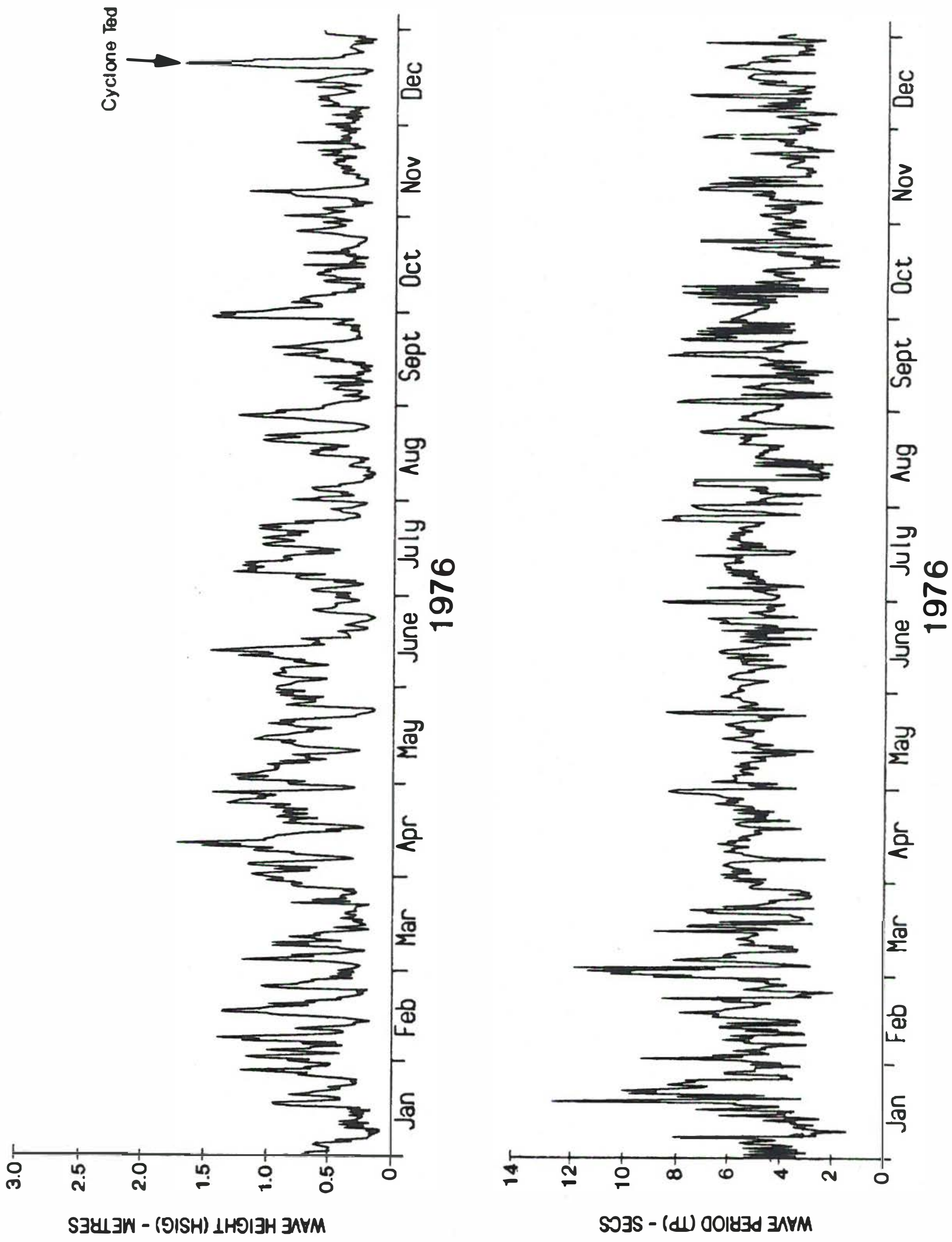
19th November 1975 to 29th December 1987

Wave Data Recording Programme

Townsville Region

Figure 7

W03.2



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DAILY WAVE RECORDINGS

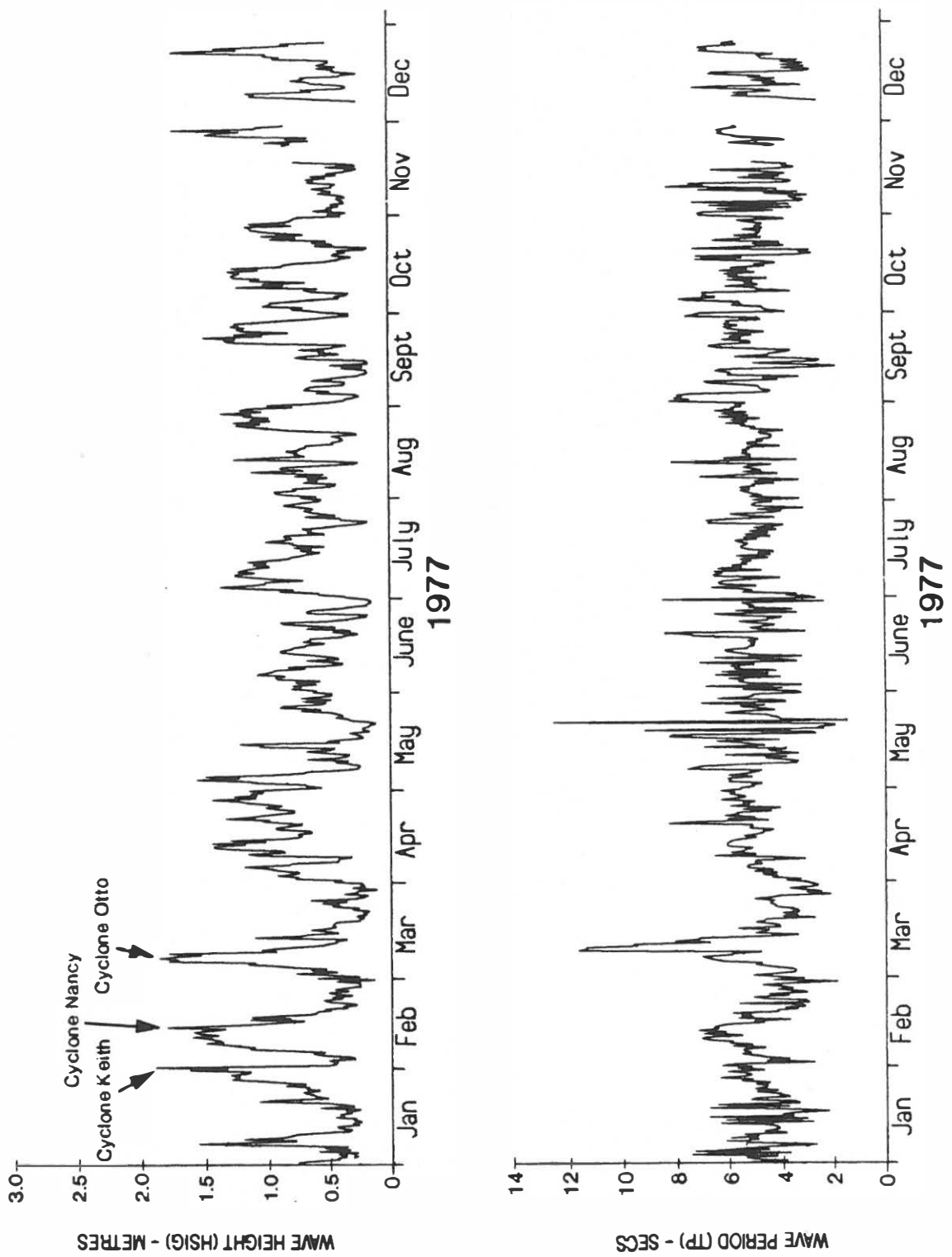
19th November 1975 to 29th December 1987

Wave Data Recording Programm

Townsville Region

Figure 7

W03.2



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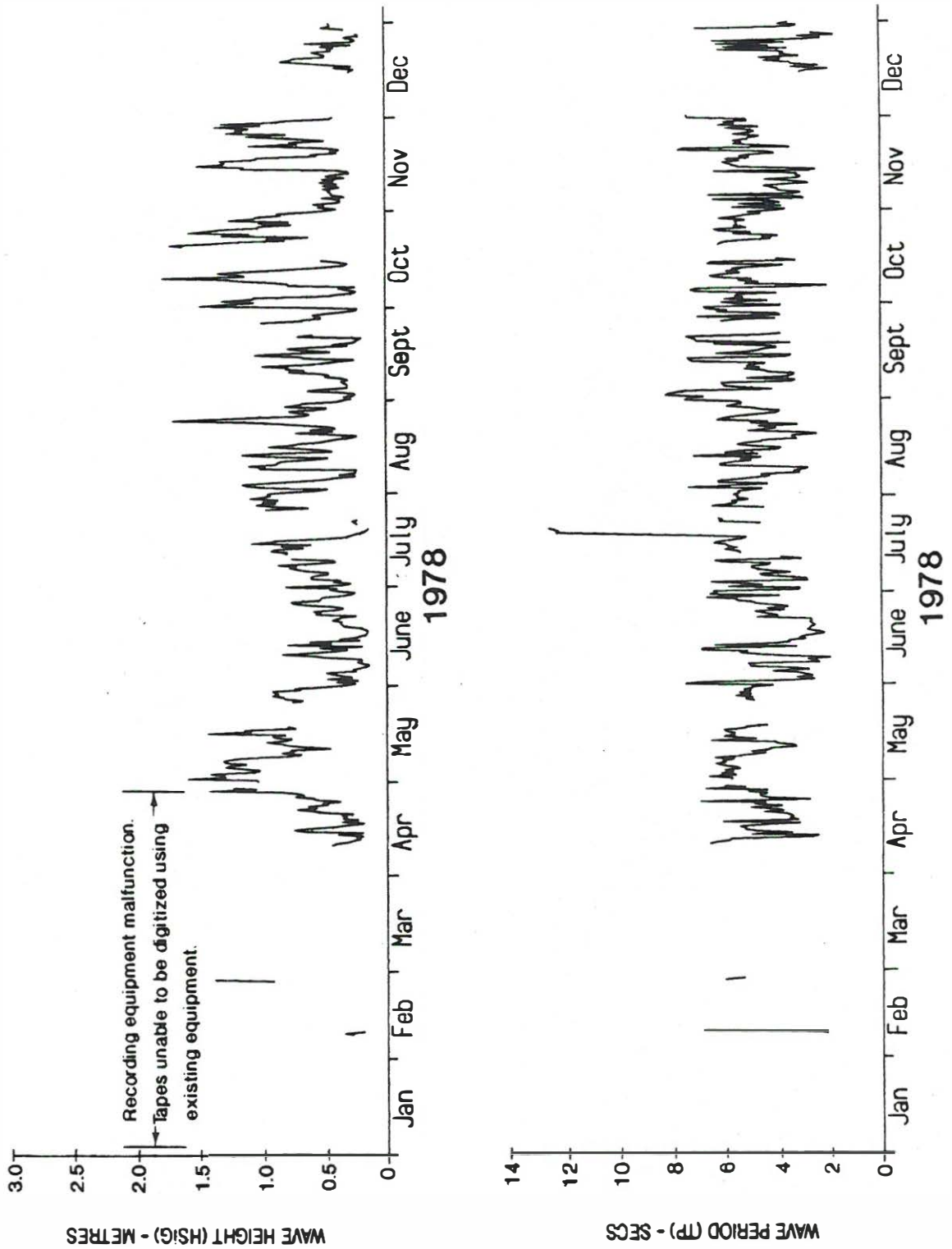
DAILY WAVE RECORDINGS

19th November 1975 to 29th December 1987

Wave Data Recording Programme
Townsville Region

Figure 7
W03.2

Sheet 3 of 13



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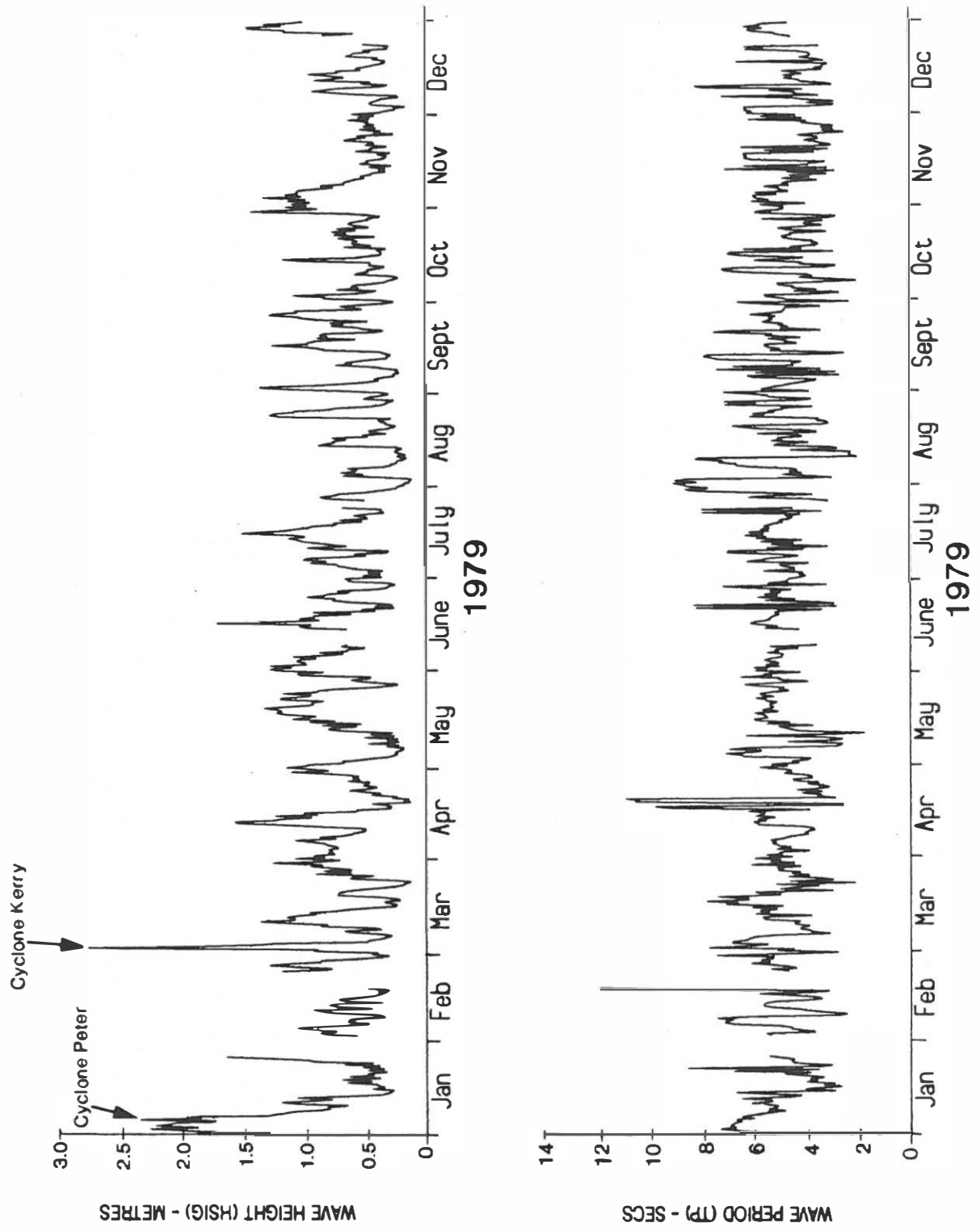
DAILY WAVE RECORDINGS

19th November 1975 to 29th December 1987

Wave Data Recording Programme
Townsville Region

Figure 7
W03.2

Sheet 4 of 13



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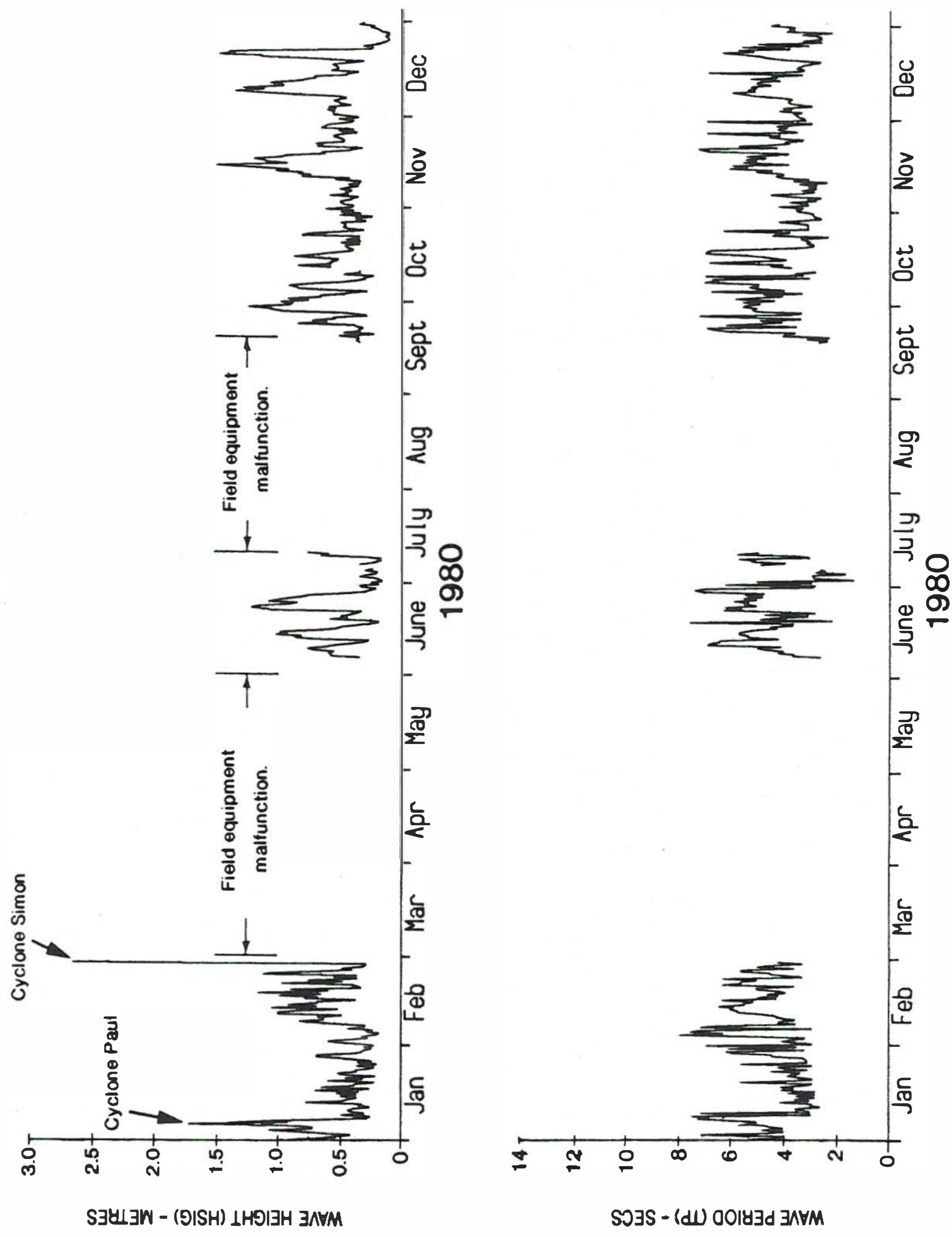
DAILY WAVE RECORDINGS

19th November 1975 to 29th December 1987

Wave Data Recording Programme
Townsville Region

Figure 7
WO3.2



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Wave Data Recording Programme

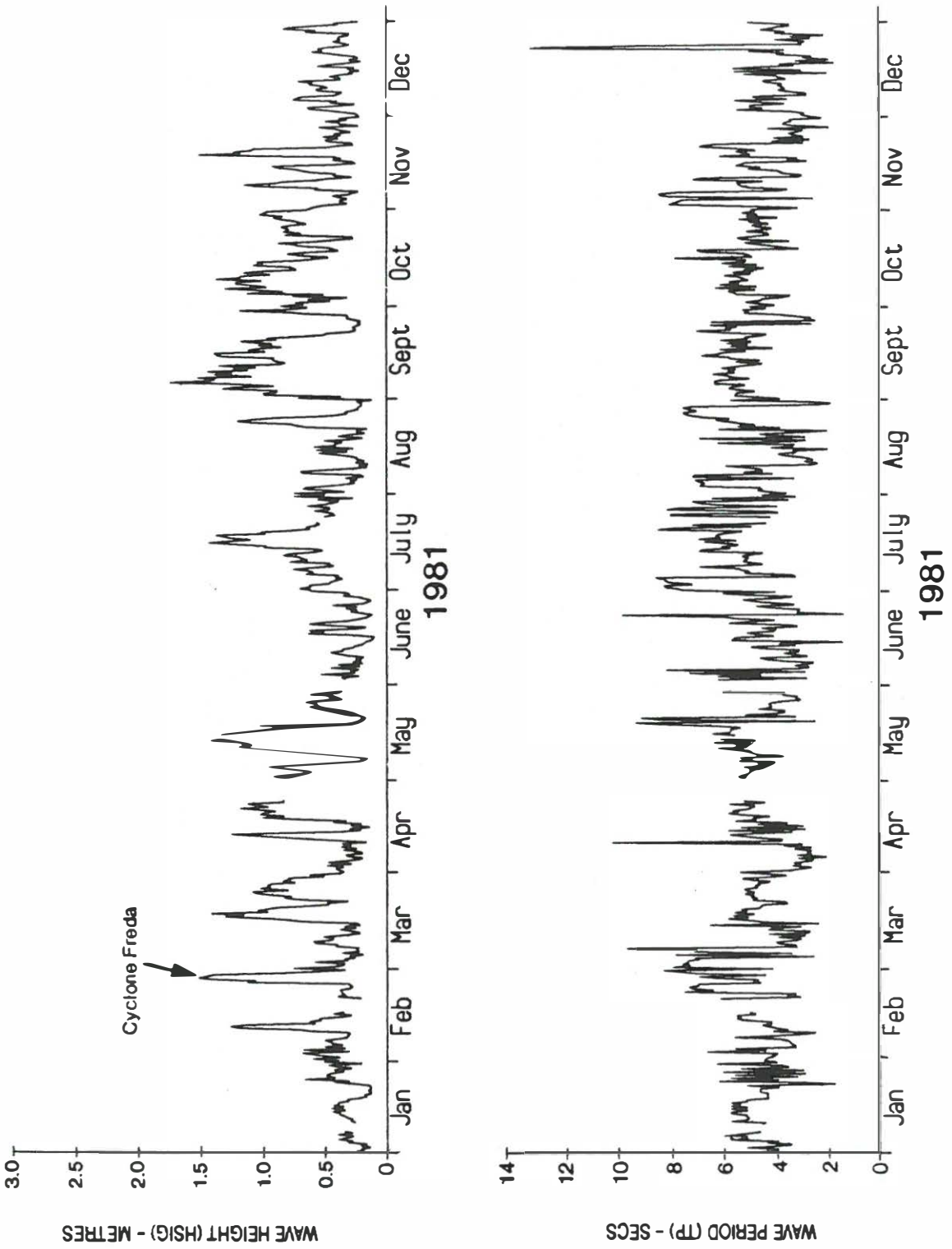
Townsville Region

DAILY WAVE RECORDINGS

19th November 1975 to 29th December 1987

Figure 7

WO3.2



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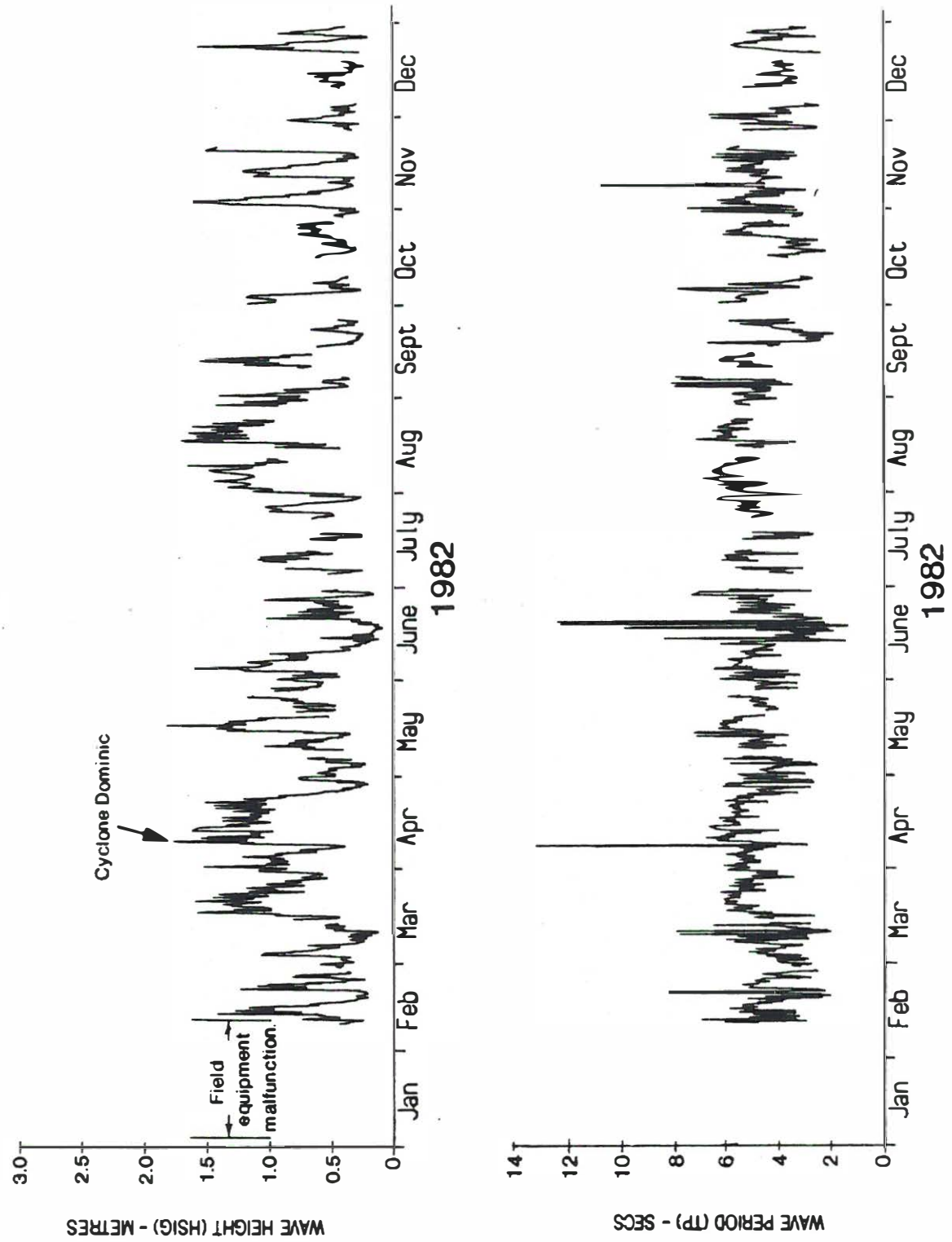
DAILY WAVE RECORDINGS

19th November 1975 to 29th December 1987

Wave Data Recording Programme
Townsville Region

Figure 7
W03.2

Sheet 7 of 13



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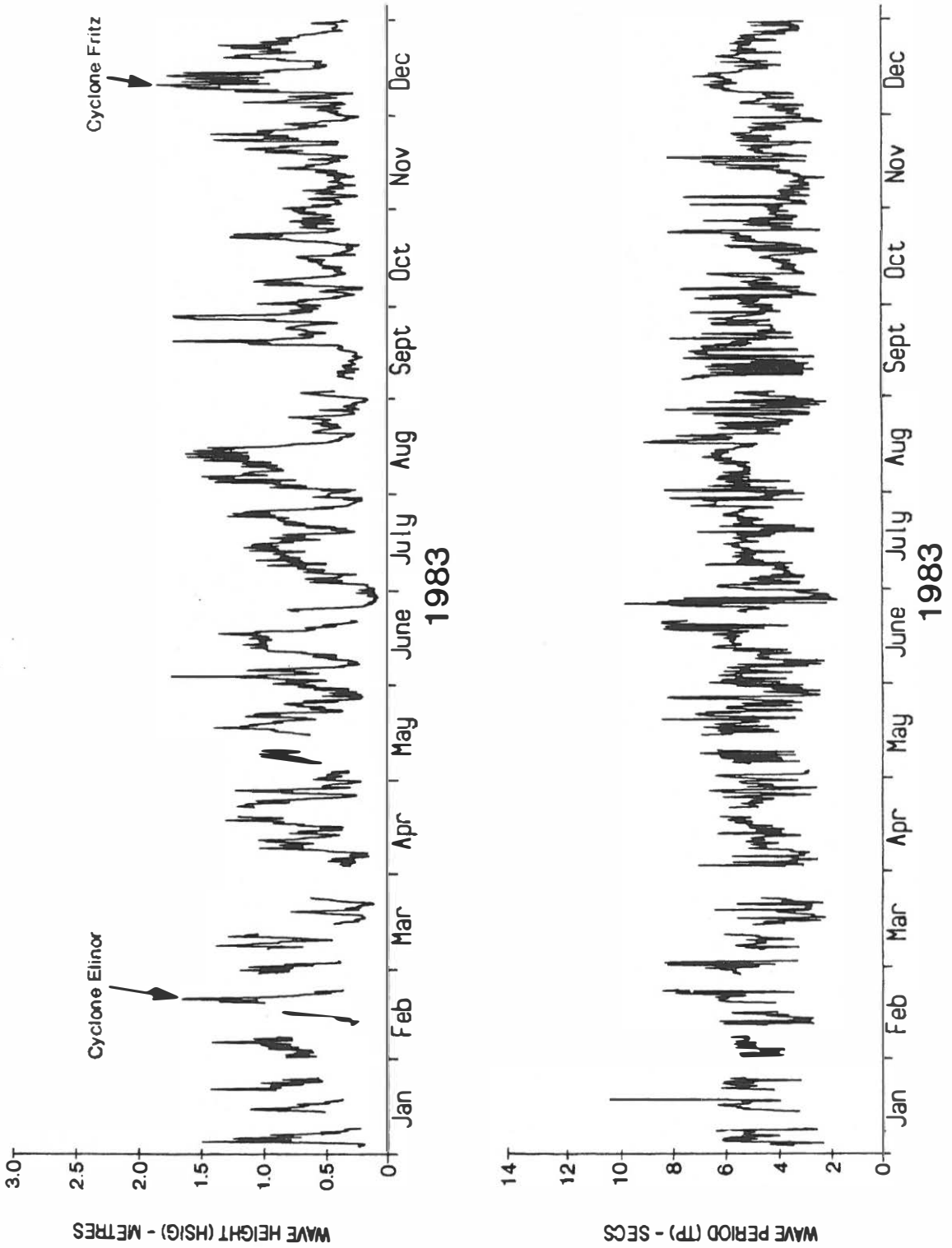
DAILY WAVE RECORDINGS

19th November 1975 to 29th December 1987

Wave Data Recording Programme
Townsville Region

Figure 7
W03.2



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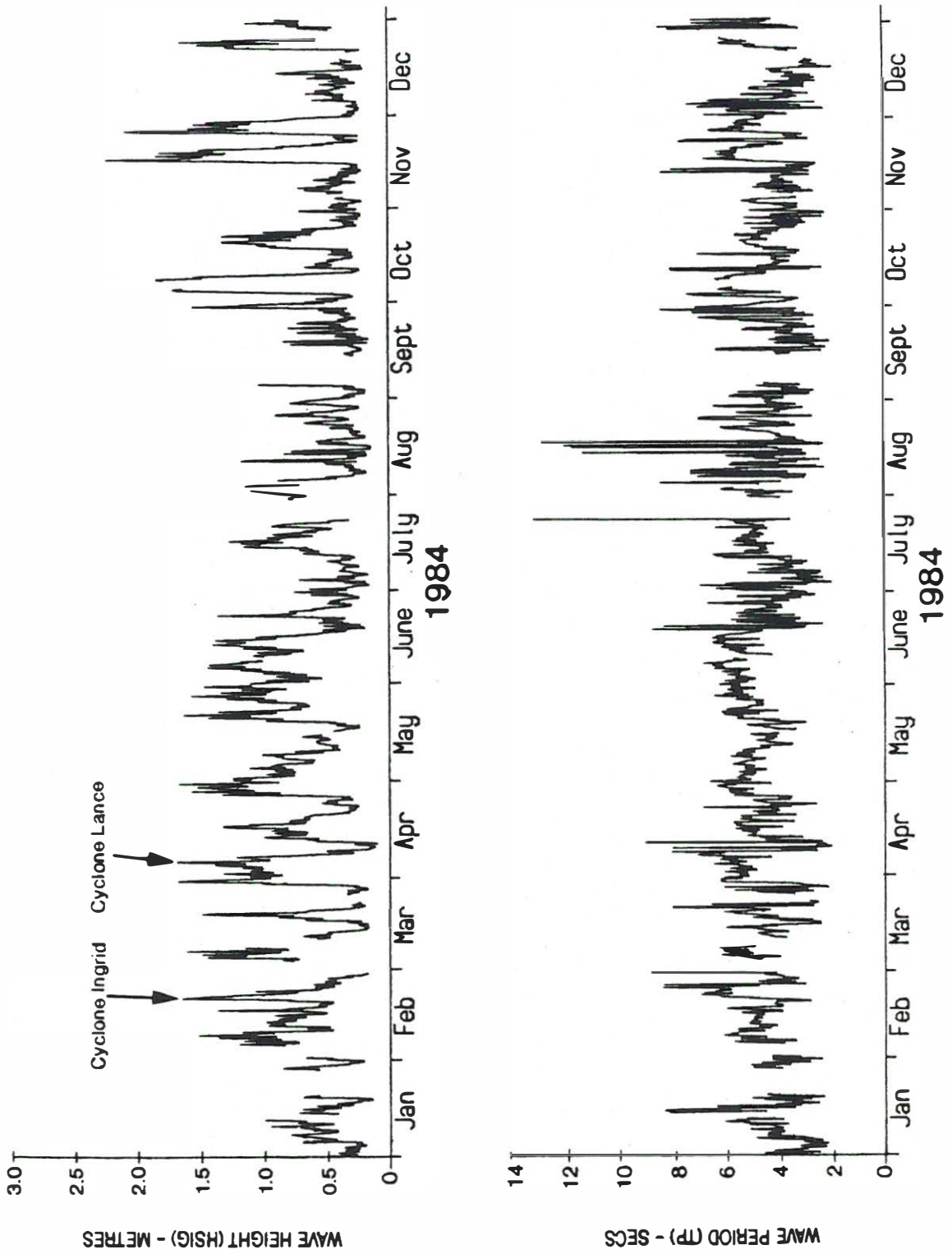
DAILY WAVE RECORDINGS

19th November 1975 to 29th December 1987

Wave Data Recording Programme
Townsville Region

Figure 7
W03.2



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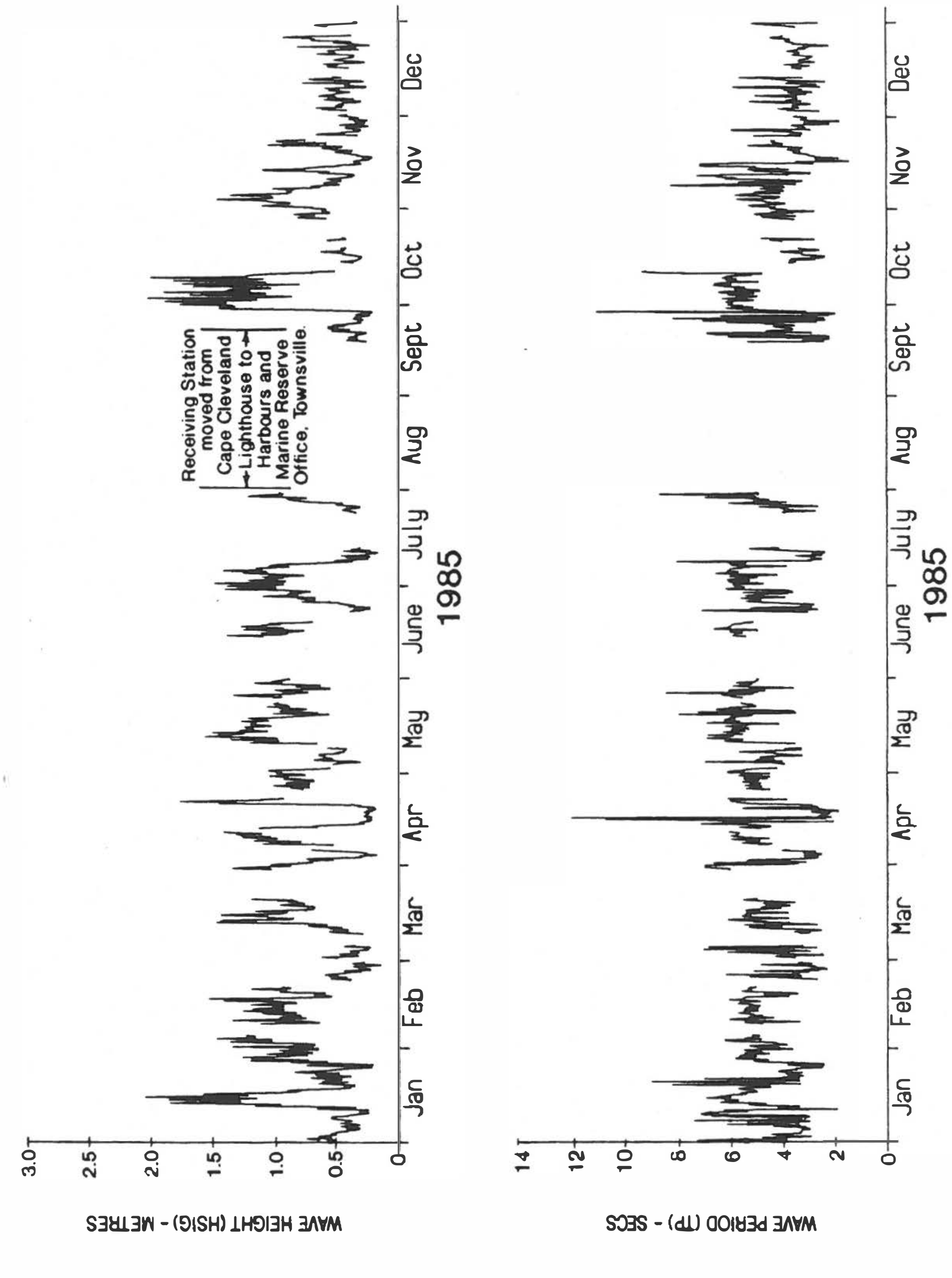
DAILY WAVE RECORDINGS

19th November 1975 to 29th December 1987

Wave Data Recording Programm
Townsville Region

Figure 7
W03.2



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DAILY WAVE RECORDINGS

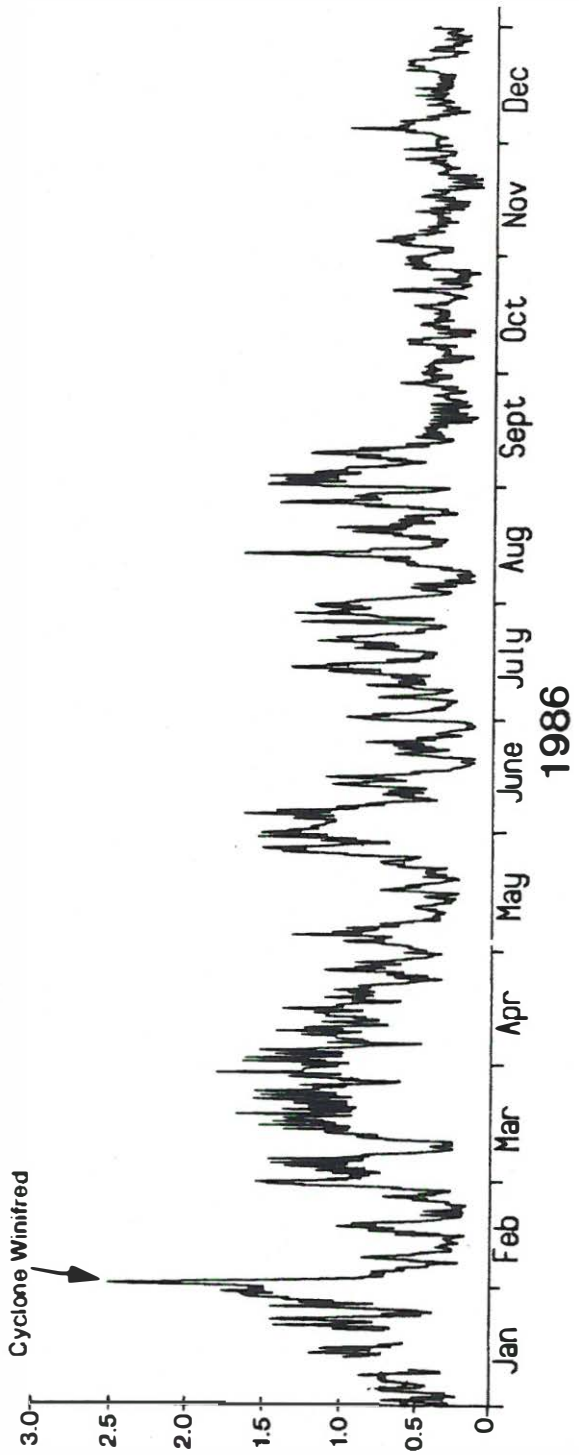
19th November 1975 to 29th December 1987

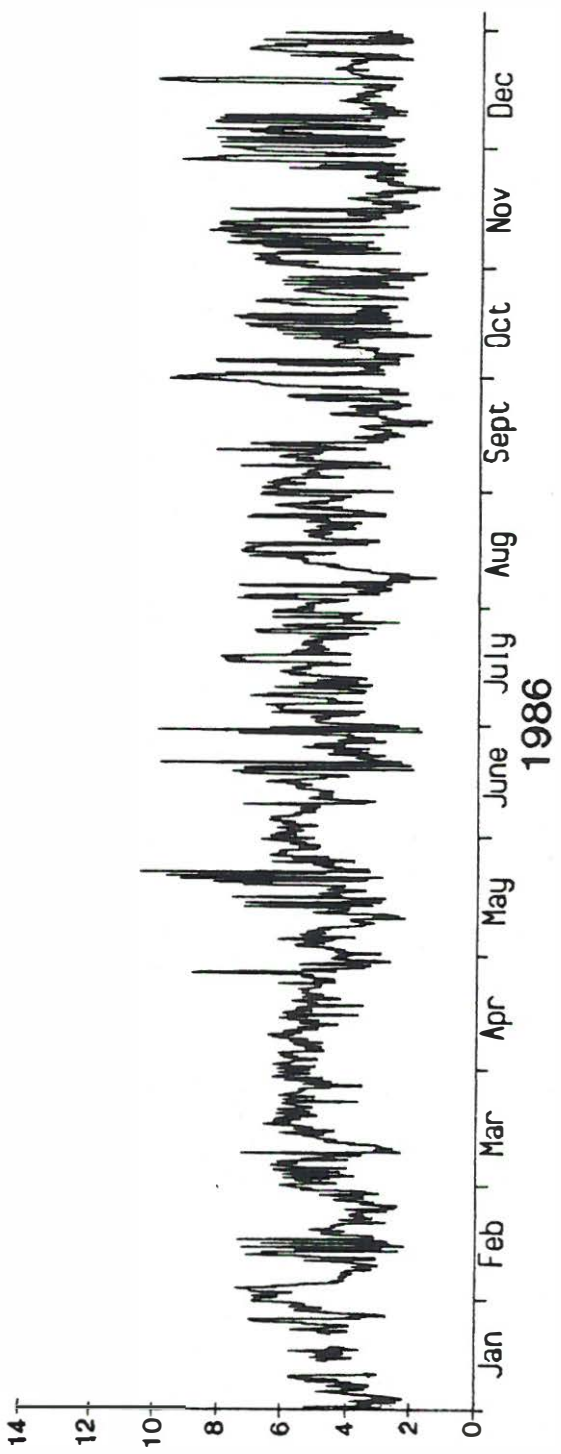
Wave Data Recording Programme

Townsville Region

Figure 7

W03.2





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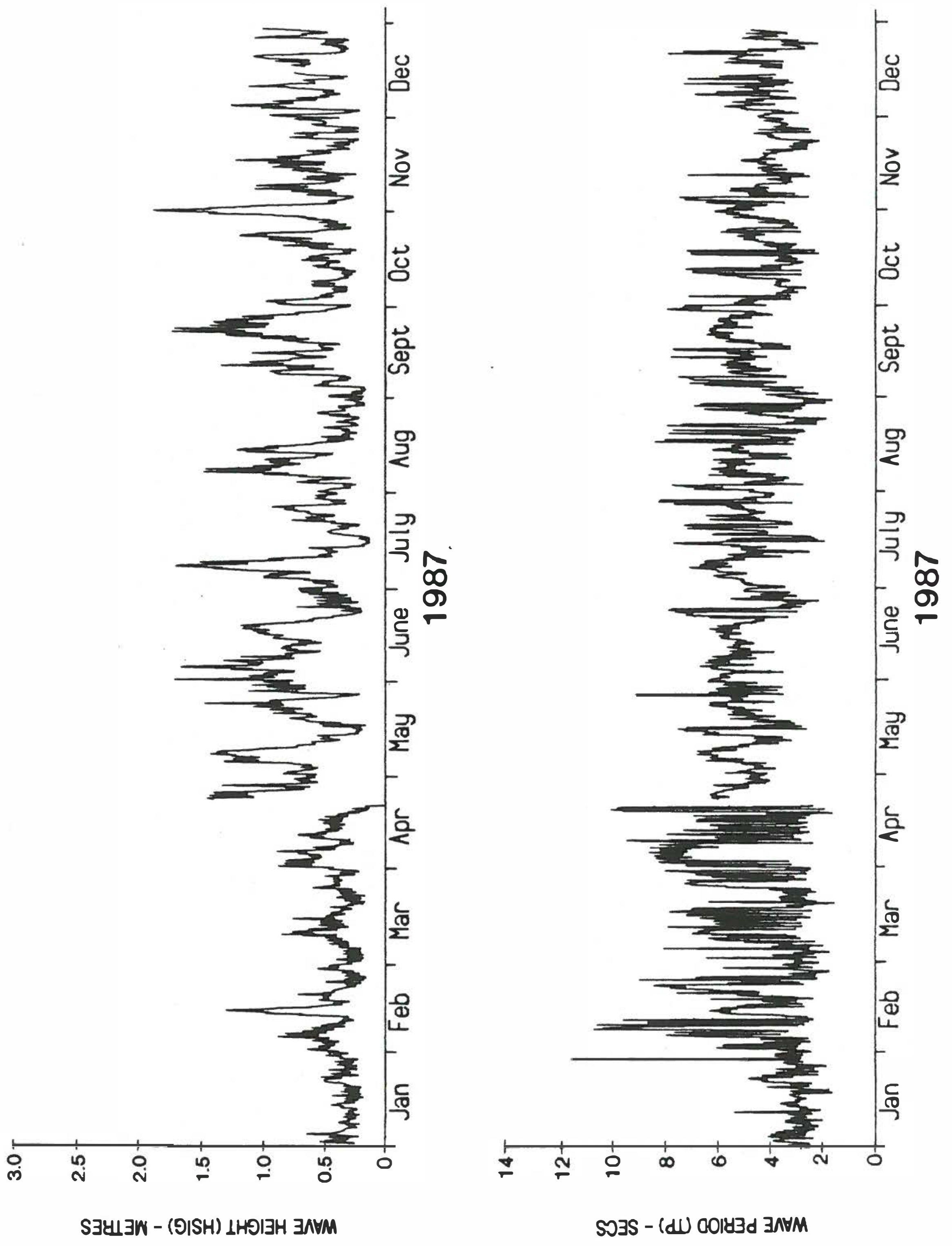
DAILY WAVE RECORDINGS

19th November 1975 to 29th December 1987

Wave Data Recording Programme
Townsville Region

Figure 7
W03.2



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DAILY WAVE RECORDINGS

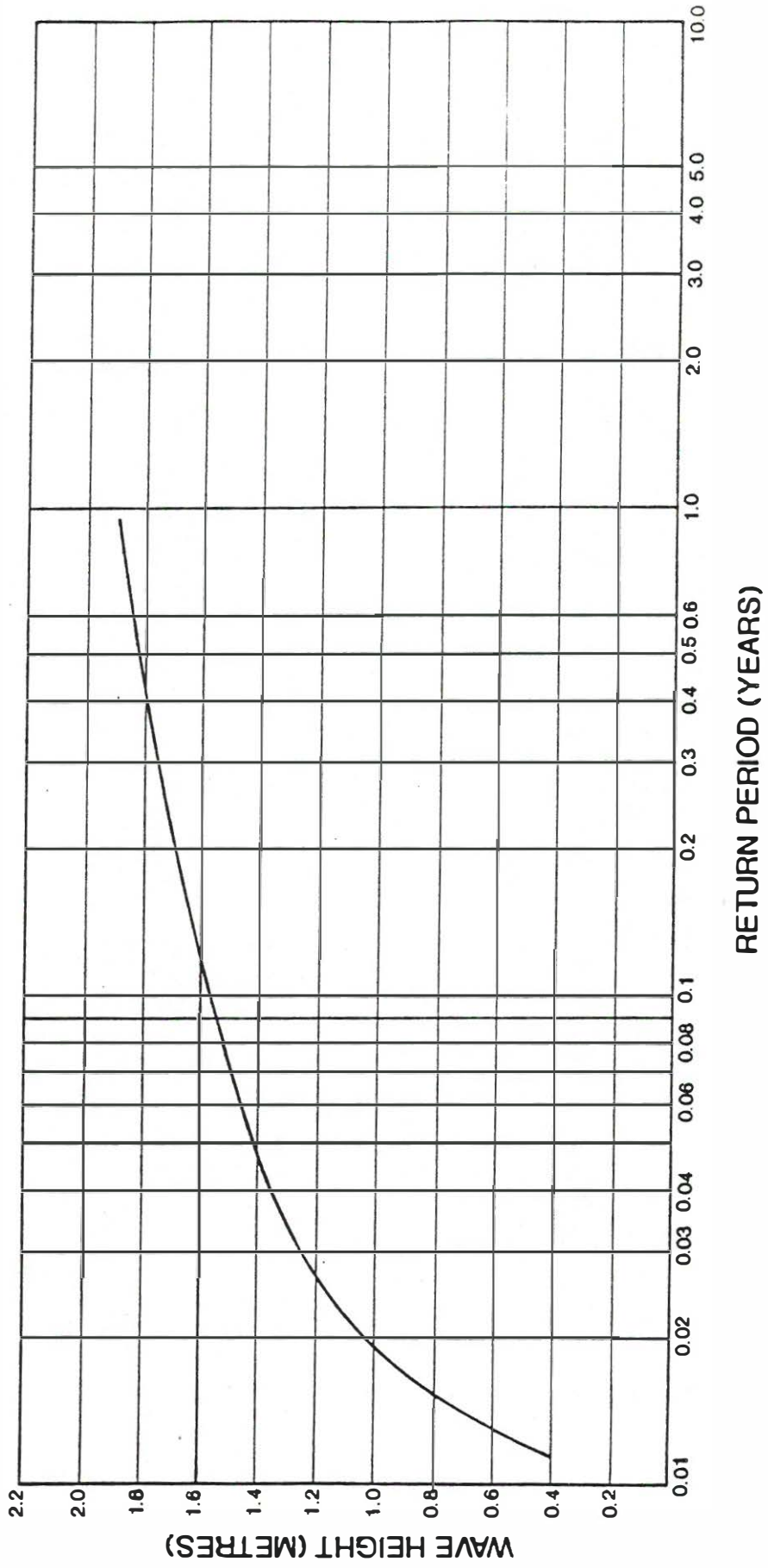
19th November 1975 to 29th December 1987

Wave Data Recording Programme

Townsville Region

Figure 7

W03.2



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WAVE HEIGHT (H_{sig}) RECURRENCE INTERVALS

19th November 1975 to 29th December 1987

Wave Data Recording Programme
Townsville Region

Figure 8
W03.2


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