Public Works
Manly Hydraulics Laboratory

NSW WAVE CLIMATE AND COASTAL AIR PRESSURE ANNUAL SUMMARY 2012-2013

Report MHL2221
November 2013

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Office of Environment and Heritage

Office of Environment & Heritage

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NSW Wave Climate and Coastal Air Pressure Annual Summary 2012-2013

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Cover photograph: Sydney Waverider Buoy, 21 August 2012

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Foreword

This annual summary presents the ocean wave climate and air pressure information collected along the New South Wales coast from 1 July 2012 to 30 June 2013. Wave and air pressure data are collected for the NSW Office of Environment and Heritage by NSW Public Works' Manly Hydraulics Laboratory. Previous annual summaries have documented the available wave data for each offshore wave data station and air pressure data from the digital barometer network from the start of records.

Wave and air pressure data are being collected to provide essential input into design, construction and performance monitoring of projects undertaken as part of the NSW Government programs in the areas of coastal management, beach improvement, estuary management, ports and marine facilities, waterways and fishing, and wastewater engineering.

The summary has been prepared to catalogue available wave and air pressure data and provide information on the analysis/presentation software resident at Manly Hydraulics Laboratory.

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WWW : www.mhl.nsw.gov.au

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Contents

FIGURES

1. Wave Climate Program

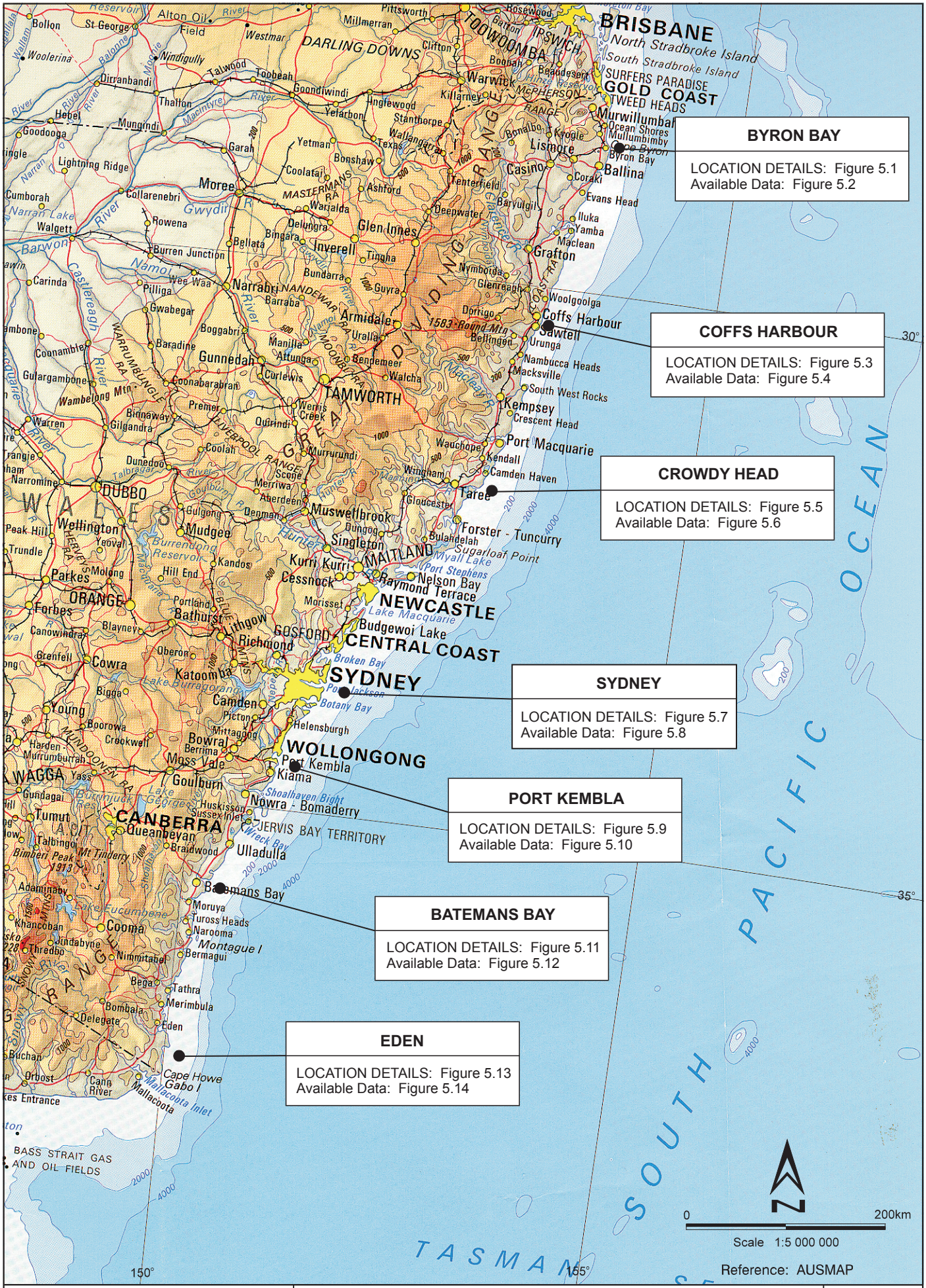
The NSW Wave Climate Program is centred around a network of offshore wave sensing buoys (Figure 1.1) which telemeter information to onshore recording stations. All stations are based on the Datawell Waverider system which uses an accelerometer mounted in a loose-tethered buoy to measure the vertical accelerations of the buoy as it moves with the water surface. The accelerations are integrated twice within the buoy and the displacement signal so obtained is then transmitted to the shore station. In recent years, buoys that also measure wave direction have replaced the original non-directional buoys at three wave recording stations. The Directional Waverider buoy was also developed by Datawell and utilises three accelerometers and a compass to provide wave direction information. At the receiving station the Waverider data signal is processed and stored by a personal computer (PC) and telemetered every hour via the internet to Manly Hydraulics Laboratory's central computer.

Routine offshore wave measurement commenced in 1971 with the establishment of a Sydney station by the Maritime Services Board off Botany Bay. This was followed in 1974 by the then Public Works Department's first station at Port Kembla. Following the establishment of the Port Kembla station, coastal studies by the Public Works Department required further Waverider buoys to be deployed to monitor site specific wave conditions. During these early deployments the importance of reliable long-term wave statistics for coastal management and design purposes was emphasised by several destructive storms that caused severe beach erosion and considerable damage to coastal structures. Therefore, during the 1980s the operation of the Waverider buoys was continued to establish a database of offshore wave statistics for the NSW coast.

In March 1992 the Waverider buoy network was enhanced through the deployment of a Directional Waverider buoy off Sydney. As the name suggests, the Directional Waverider buoy measures wave direction in addition to wave height and period. Following the success of the Sydney Directional Waverider buoy deployment, a second Directional Waverider buoy was added to the network in October 1999 when the Byron Bay station was upgraded to a directional site. To provide directional data for the NSW south coast region, the Batemans Bay Waverider station was also upgraded with a Directional Waverider buoy in February 2001. During 2011 and 2012 the buoys at Coffs Harbour, Crowdy Head, Port Kembla and Eden were all upgraded with Directional Waverider buoys, thus enabling the measurement of wave direction at all NSW offshore wave monitoring stations. The Directional Waverider buoys also measure sea surface temperature that is telemetered to the receiving station along with the wave data.

Figure 1.2 presents a flowchart of the wave data collection, distribution and presentation system operated by Manly Hydraulics Laboratory.

Detailed station location information and data plots for 2012–2013 for all offshore sites are presented in Figures 5.1 to 5.14.



BYRON BAY

LOCATION DETAILS: Figure 5.1
Available Data: Figure 5.2

COFFS HARBOUR

LOCATION DETAILS: Figure 5.3
Available Data: Figure 5.4

CROWDY HEAD

LOCATION DETAILS: Figure 5.5
Available Data: Figure 5.6

SYDNEY

LOCATION DETAILS: Figure 5.7
Available Data: Figure 5.8

PORT KEMBLA

LOCATION DETAILS: Figure 5.9
Available Data: Figure 5.10

BATEMANS BAY

LOCATION DETAILS: Figure 5.11
Available Data: Figure 5.12

EDEN

LOCATION DETAILS: Figure 5.13
Available Data: Figure 5.14

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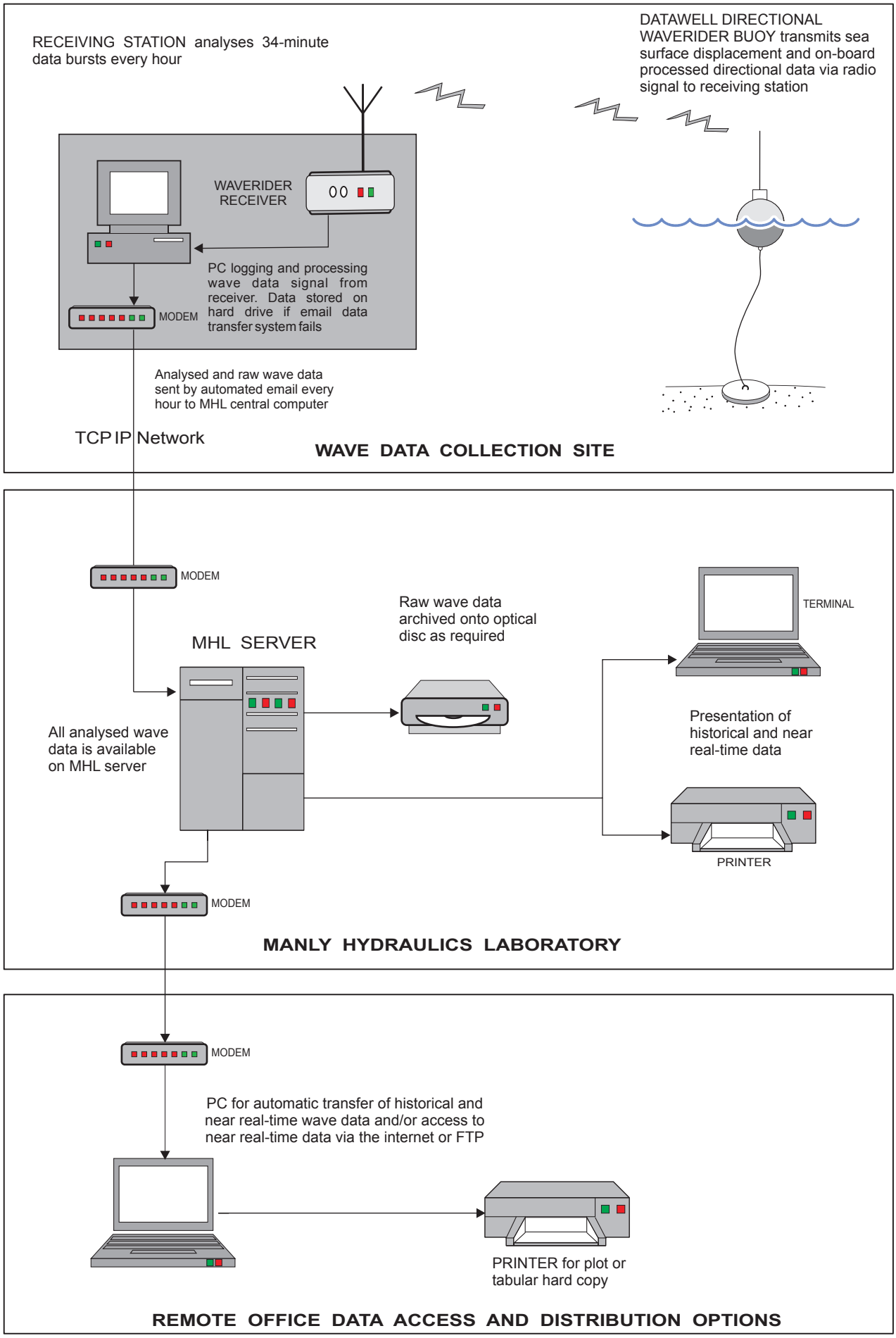
NEW SOUTH WALES OFFSHORE DIRECTIONAL WAVERIDER BUOY LOCATIONS

MHL Report 2221

Figure 1.1

DRAWING 2221-01-01.cdr



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WAVE DATA COLLECTION, DISTRIBUTION AND PRESENTATION SYSTEM

MHL Report 2221
Figure 1.2
DRAWING 2221-01-02.cdr

2. Air Pressure Program

Manly Hydraulics Laboratory has measured air pressure along the NSW coast since 1987. Barometers developed by Manly Hydraulics Laboratory, utilising a SPX100 pressure transducer, were installed at six Waverider buoy receiving stations until the network was decommissioned during late 1999. The original SPX100 barometer network was superseded by a more comprehensive coastal air pressure monitoring system between August 1999 and February 2000 (Figure 2.1). This data is recorded to allow the correction of water level data recorded by total pressure transducers and to provide barometric information to assist understanding of water levels associated with ocean storms.

The barometer network utilises Vaisala PTB200 digital barometers that sample air pressure every 15 minutes to an accuracy of ± 0.2 hPa. At the barometer station air pressure data is corrected to mean sea level and stored by a Campbell CR800 data logger before it is downloaded twice per day to Manly Hydraulics Laboratory's central computer by telephone link.

Figure 2.2 presents a flowchart of the air pressure data collection, distribution and presentation system operated by Manly Hydraulics Laboratory.

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NEW SOUTH WALES COASTAL BAROMETER LOCATIONS

MHL Report 2221

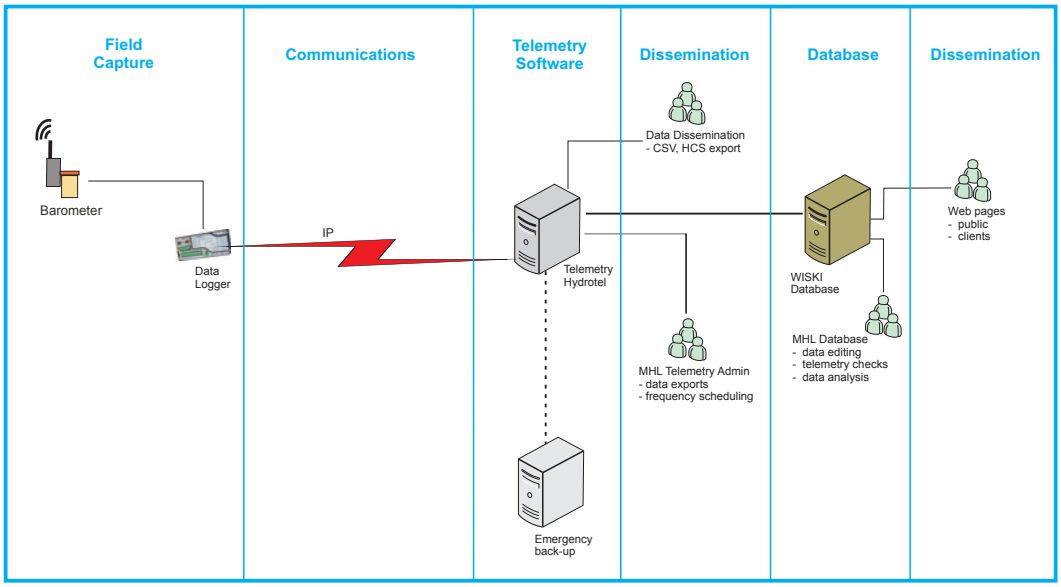
Figure 2.1

DRAWING 2221-02-01.cdr

Eden barometer station

Vaisala digital barometer

DATA TRANSFER
via telephone modem
(landline or cellular)



3. How to Use the Report

The wave and air pressure information is organised in a menu style.

From the NSW offshore Waverider buoy location map (Figure 1.1), a reference is given to a detailed station location map for each Waverider site and to the annual time history plots of wave height from which the user can readily check for data availability, storm events, etc.

Annual time history plots of air pressure are referenced from the NSW barometer location map (Figure 2.1).

Once a choice has been made of the duration for which wave or air pressure information is required, a variety of ways exist in which a detailed examination of the data can be made. Samples of the selected data presentation formats are provided in Appendix A.

In addition to the offshore Waverider buoy and air pressure data presented in this summary, details of project-specific sites for which data is available in the same formats are catalogued in Sections 7 and 9.

The appropriate information can then be ordered from the Laboratory.

> THE SITE INFORMATION IN THIS REPORT HAS BEEN PRESENTED AS A CATALOGUE OF DATA FOR EACH SITE. THE GRAPHICAL SCALES HAVE BEEN SELECTED FOR THIS PURPOSE. AT THESE SCALES THE INFORMATION IS NOT NECESSARILY DIRECTLY SUITABLE FOR ANALYSIS PURPOSES. IT IS THEREFORE RECOMMENDED THAT THIS REPORT ONLY BE UTILISED TO SELECT THE DATA SET REQUIRED. THE FORMAT APPROPRIATE TO THE INTENDED USE CAN THEN BE DETERMINED AND THE DATA PRESENTED ACCORDINGLY.

4. How to Access the Data

Four modes of database access/distribution are available:

- direct access at Manly Hydraulics Laboratory using a screen terminal for data review in plot or table form
- hard copy tables and plots at Manly Hydraulics Laboratory
- data can be provided in digital form by Manly Hydraulics Laboratory by email or on CD / DVD suitable for transfer to a personal computer
- automated ftp or email distribution from Manly Hydraulics Laboratory to any remote computer.

Quality controlled data can be requested by contacting MHL by email via data-request@mhl.nsw.gov.au

Plots of near-real time wave data and air pressure data for the previous four days can also be accessed by the internet through Manly Hydraulics Laboratory's home page at:

www.mhl.nsw.gov.au

ANY FEES CHARGED BY MANLY HYDRAULICS LABORATORY FOR THE PROVISION OF DATA ONLY INCLUDE QUALITY CONTROL, COMPUTING, SOFTWARE MAINTENANCE AND DISSEMINATION COSTS.

5. Wave Climate Program Summary 2012-2013

5.1 Data Capture

Based on offshore wave data recovery achieved by Manly Hydraulics Laboratory over the past twenty years, the target average annual data recovery for all offshore Waverider buoy stations is 85 percent. During normal operations this target is readily achieved by the Waverider buoy network. Any data loss longer than one week is usually due to loss or damage to Waverider buoys by ship collisions. The monthly percentage data capture during 2012-2013 for each Waverider buoy station is provided in Table 5.1.

Table 5.1 New South Wales Wave Climate: 2012-2013 Data Capture

Waverider Site	Data Capture (%)												Total Year
	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	
Byron Bay	95	85	87	59	92	93	71	67	85	86	93	91	**84**
Coffs Harbour	99	97	99	99	100	100	100	98	91	99	92	100	**98**
Crowdy Head	97	100	95	99	1	88	100	100	100	99	96	95	**89**
Sydney	69	68	99	100	98	99	100	95	100	98	99	99	**94**
Port Kembla	96	90	87	81	83	81	81	49	51	70	77	84	**78**
Batemans Bay	98	98	100	99	100	99	98	99	94	15	100	99	**92**
Eden	48	94	96	91	92	84	90	56	79	98	98	98	**85**
Total Months	**86**	**90**	**95**	**90**	**81**	**93**	**91**	**81**	**86**	**81**	**94**	**95**	**89**

Data recovery at four Waverider stations during 2012–2013 was below 90 percent. The higher than average data loss at these stations was due to:

- *Byron Bay* – as the result of a vessel collision the Waverider buoy went adrift on 5 October 2012. A replacement buoy was deployed on 16 October 2012. The buoy went adrift again on 28 January 2013 and was replaced on 8 February 2013.
- *Crowdy Head* – an extended period of data loss during November 2012 was the result of failure of the receiving station data logging and processing PC. Difficulties correctly configuring a replacement PC resulted in data loss from 1 November to 4 December 2012.
- *Port Kembla* – the Port Kembla Waverider buoy station experienced intermittent radio interference and occasional submergence of the buoy due to strong currents during 2012-2013. A fault with the Waverider buoy compass from 2 March to 30 June 2013 resulted in the return of erroneous wave direction data during this period, although the wave height and period data were not affected.

- *Eden* – during July 2012 poor radio reception resulted in intermittent data loss. The poor data reception was rectified when the buoy was moved to a new location on 17 July 2012. The Waverider buoy went adrift on 22 February 2013 resulting in data loss until 7 March 2013 when a replacement buoy was deployed.

Detailed station location information and data plots for 2012–2013 for all offshore sites are presented in Figures 5.1 to 5.14.

5.2 Storm Events

Days on which the significant wave height exceeded 3 metres at each offshore Waverider buoy site are summarised on Figure 5.15.

5.3 System Down Time

A summary of system down time for periods longer than one day for each offshore site is presented on Figure 5.15.

5.4 Bureau of Meteorology Wave Data Access

Since July 1992 wave data has been supplied to the Bureau of Meteorology in various formats using several data delivery systems. At present, the Bureau uses public and password-protected internet pages to access near-real time wave data to assist in the preparation of the NSW Coastal Waters Forecast. The Bureau issues this forecast two times each day at approximately 0400 and 1600 hours.

In addition, the Bureau utilises the internet near-real time service to assist in the preparation of the New South Wales Large Wave and Storm Surge Warning Advice. The advice is confidentially issued by the State Emergency Service when coastal storms are predicted to generate extreme waves and elevated water levels which may result in significant beach erosion, coastal inundation and/or property damage.

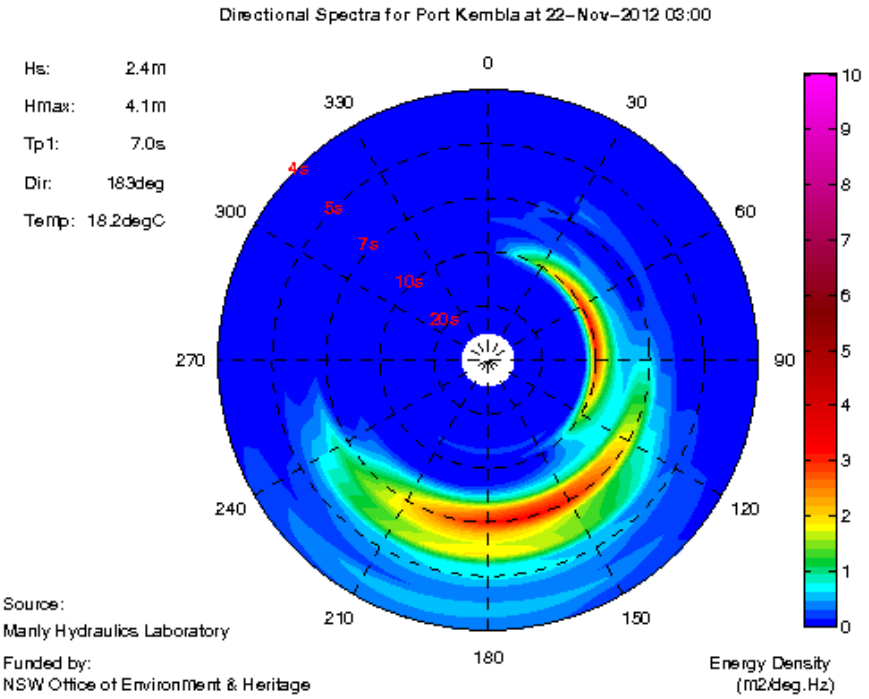
In May 1999 wave data access between the Bureau and Manly Hydraulics Laboratory was further enhanced with the introduction of an automatic data transfer system. Data is now downloaded hourly in a format suitable for input to and verification of the Bureau's wave forecasting models.

5.5 Significant Developments 2012-2013

Ongoing development of the wave database system and telemetry system enabled the addition of Directional Waverider buoy directional spectra plots for the Byron Bay, Coffs Harbour, Crowdy Head and Eden stations to the MHL webpages. This development provides graphical output of wave data, clearly illustrating the breakdown of wave energy propagation from different directions. The directional spectra plots provide a comprehensive

overview of wave conditions at a Waverider buoy station, resulting in a better understanding of wave processes, particularly during storm events.

The following plot is an example of a Directional Spectral plot for the Port Kembla Waverider buoy on 22 November 2012 at 0300 hours. The plot shows a decaying long period swell with a period of approximately 10 seconds and a developing southerly swell with a shorter period of 7.1 seconds.



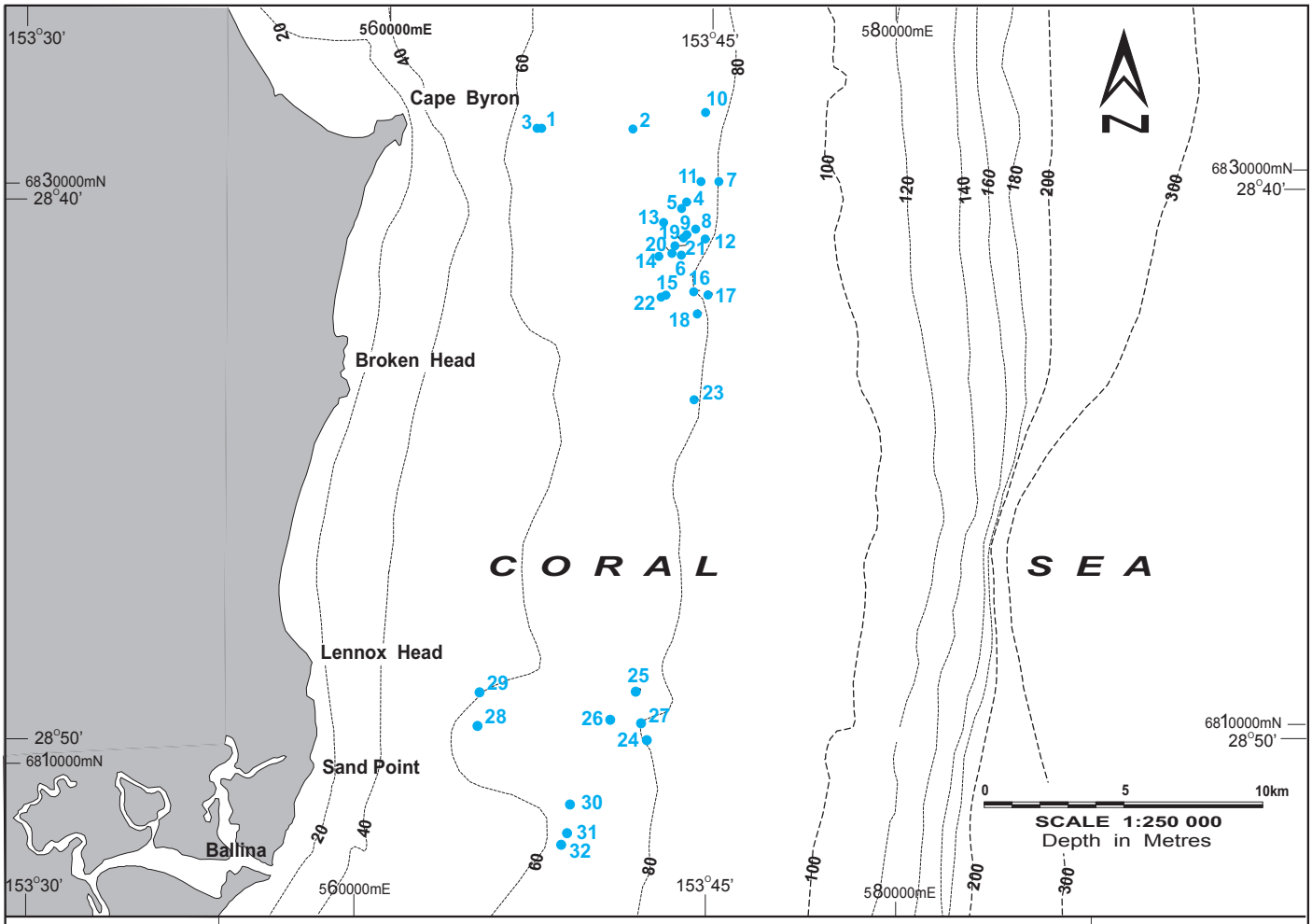
The latest available directional spectra plots for all Waverider buoy stations can be accessed at http://mhl.nsw.gov.au/data/realtime/wave thus providing comprehensive information on wave direction along the NSW coast in near real-time. Animations of the plots are also available to view the history of the development and decay of the sea state over the previous 48 hours.

5.6 Future Developments 2013-2014

The transfer of all historical wave data to the new WISKI database will commence during 2013-2014. The initial plan was to load all wave data directly into the WISKI database. However, this had to be modified due to data loading and management issues associated with the large volume of wave energy and directional spectra data. MHL is continuing with the original Oracle DWAVE database model, however, MHL is migrating from legacy hardware and application platforms to virtual hardware and modern application architecture. MHL is migrating from legacy DEC ALPHA VMS hardware and operating system running Oracle 9 to Department of Finance and Services Data Centre Hosted Virtual Server hardware hosting an Oracle 11 system. The complete set of wave data parameters is maintained in an Oracle Relational Data Base Management System (RDBMS) for all wave

stations (both historical and operational as listed in Tables 7.1, 7.2 and 7.3). A new suite of web-based data editing systems will be introduced to manage data quality control requirements. An ensemble of primary time series wave height, period and direction parameters will ingest data from the Oracle DWAVE system into the WISKI content management system. Presentation systems based on WISKI will be used for the majority of wave data analysis and presentation requirements. Functionality and reporting in the WISKI system will be developed to produce similar analysis and presentation options as those presently available and shown in Appendix A.

Further data extraction functionality will be built into the MHL Data Processing Environment. This will be configured to run custom reports from the WISKI content management or entire analysis and extraction from the full wave suite repository from the Oracle RDBMS.



DEPLOYMENT LOCATION	LOCATION DETAILS				WATER DEPTH (m)	DEPLOYMENT PERIOD	
	Latitude (S)	Longitude (E)	GDA (Zone 56) Easting	GDA (Zone 56) Northing		First Date	Last Date
1	28°38'24"	153°41'18"	567280	6831690	64	14-Oct-1976	07-Jun-1978
2	28°38'24"	153°43'18"	570530	6831670	70	03-Aug-1978	13-Jun-1979
3	28°38'24"	153°41'12"	567110	6831690	62	08-Aug-1979	09-Aug-1983
4	28°39'48"	153°44'30"	572470	6829080	77	09-Aug-1983	13-Dec-1983
5	28°39'54"	153°44'24"	572310	6828890	77	07-Feb-1984	25-Sep-1984
6	28°40'48"	153°44'24"	572300	6827230	73	25-Sep-1984	30-Jun-1985
7	28°39'24"	153°45'12"	573620	6829810	80	27-Aug-1985	22-Nov-1985
8	28°40'18"	153°44'42"	572790	6828140	78	12-Dec-1985	24-Mar-1987
9	28°40'25"	153°44'31"	572480	6827950	78	24-Mar-1987	19-Nov-1987
10	28°38'05"	153°44'54"	573150	6832250	77	03-Dec-1987	07-Apr-1988
11	28°39'24"	153°44'49"	572980	6829800	77	18-May-1988	07-Nov-1988
12	28°40'30"	153°44'55"	573130	6827780	82	06-Dec-1988	08-Dec-1988
13	28°40'12"	153°44'00"	571650	6828350	72	10-Jan-1989	05-Aug-1989
14	28°40'49"	153°43'55"	571500	6827200	71	29-Aug-1989	14-Dec-1989
15	28°41'35"	153°44'03"	571730	6825790	74	07-Feb-1990	06-Dec-1990
16	28°41'30"	153°44'40"	572730	6825950	73	06-Dec-1990	08-May-1991
17	28°41'33"	153°44'59"	573240	6825840	78	29-May-1991	14-May-1992
18	28°41'55"	153°44'46"	572880	6825170	73	14-May-1992	18-Jun-1993
19	28°40'28"	153°44'26"	572360	6827850	73	23-Jun-1993	21-Jul-1993
20	28°40'46"	153°44'12"	571970	6827300	72	21-Jul-1993	11-Nov-1993
21	28°40'37"	153°44'15"	572060	6827570	72	01-Dec-1993	20-Jul-1994
22	28°41'36"	153°43'57"	571560	6825760	72	20-Jul-1994	05-Feb-1996
23	28°43'32"	153°44'40"	572700	6822180	72	05-Feb-1996	28-Nov-2001
24	28°50'09"	153°43'43"	571080	6809970	71	29-Nov-2000	23-Jan-2001
25	28°49'14"	153°43'38"	570950	6811670	71	10-Feb-2001	29-Aug-2003
26	28°49'44"	153°43'08"	570030	6810570	71	29-Aug-2003	12-Aug-2004
27	28°50'02"	153°43'24"	570570	6810200	71	12-Aug-2004	01-Jan-2005
28	28°49'36"	153°39'48"	564720	6811040	62	04-Feb-2005	11-Dec-2007
29	28°49'21"	153°39'56"	564940	6811500	62	11-Dec-2007	20-Aug-2009
30	28°51'14"	153°42'07"	568470	6808000	62	20-Aug-2009	11-Feb-2012
31	28°51'58"	153°42'00"	568270	6806650	62	11-Feb-2012	05-Oct-2012
32	28°52'04"	153°41'39"	567600	6806540	62	16-Oct-2012	Present

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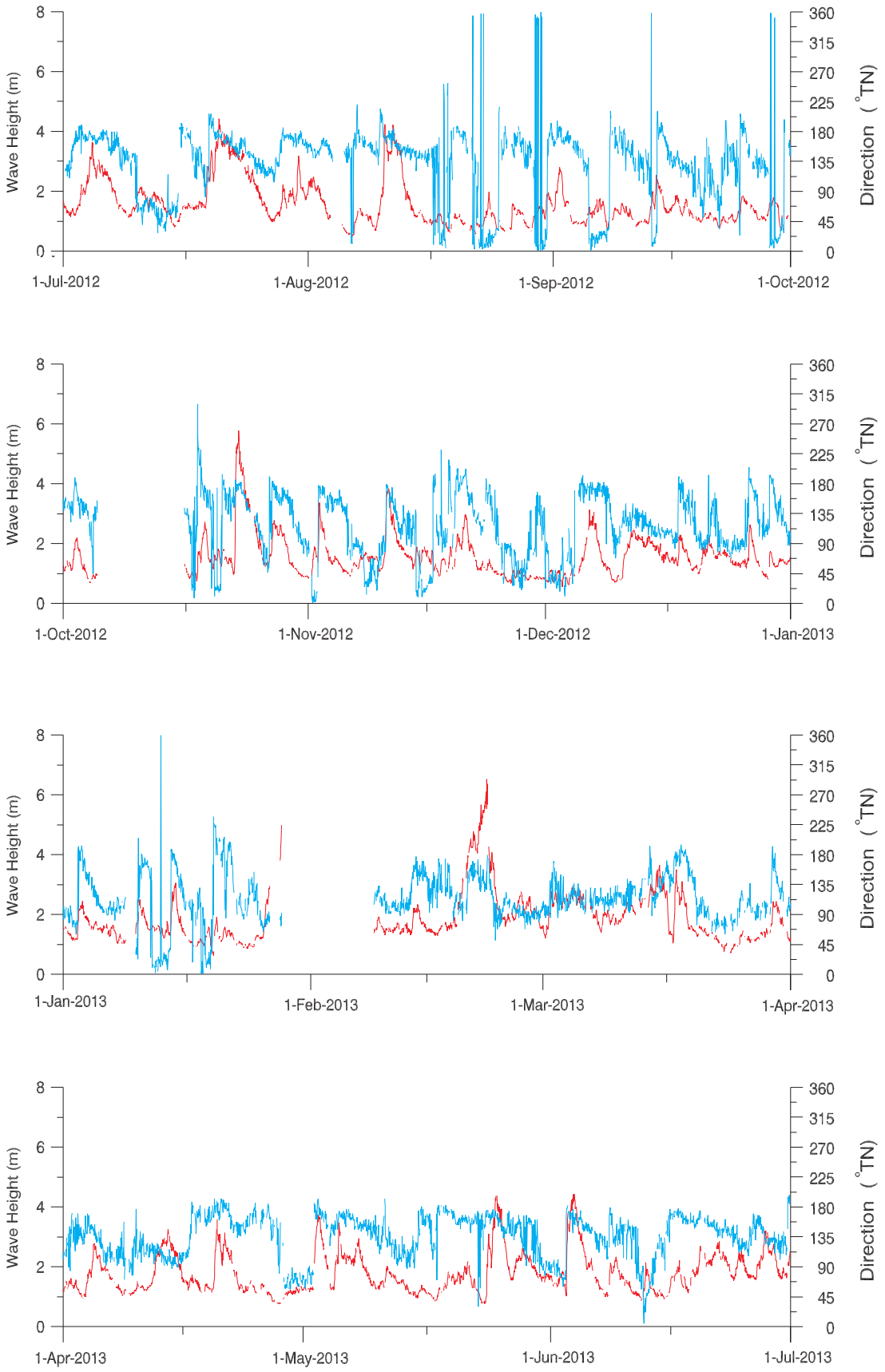
BYRON BAY WAVERIDER BUOY LOCATION HISTORY

MHL Report 2221

Figure 5.1

DRAWING 2221-05-01.cdr



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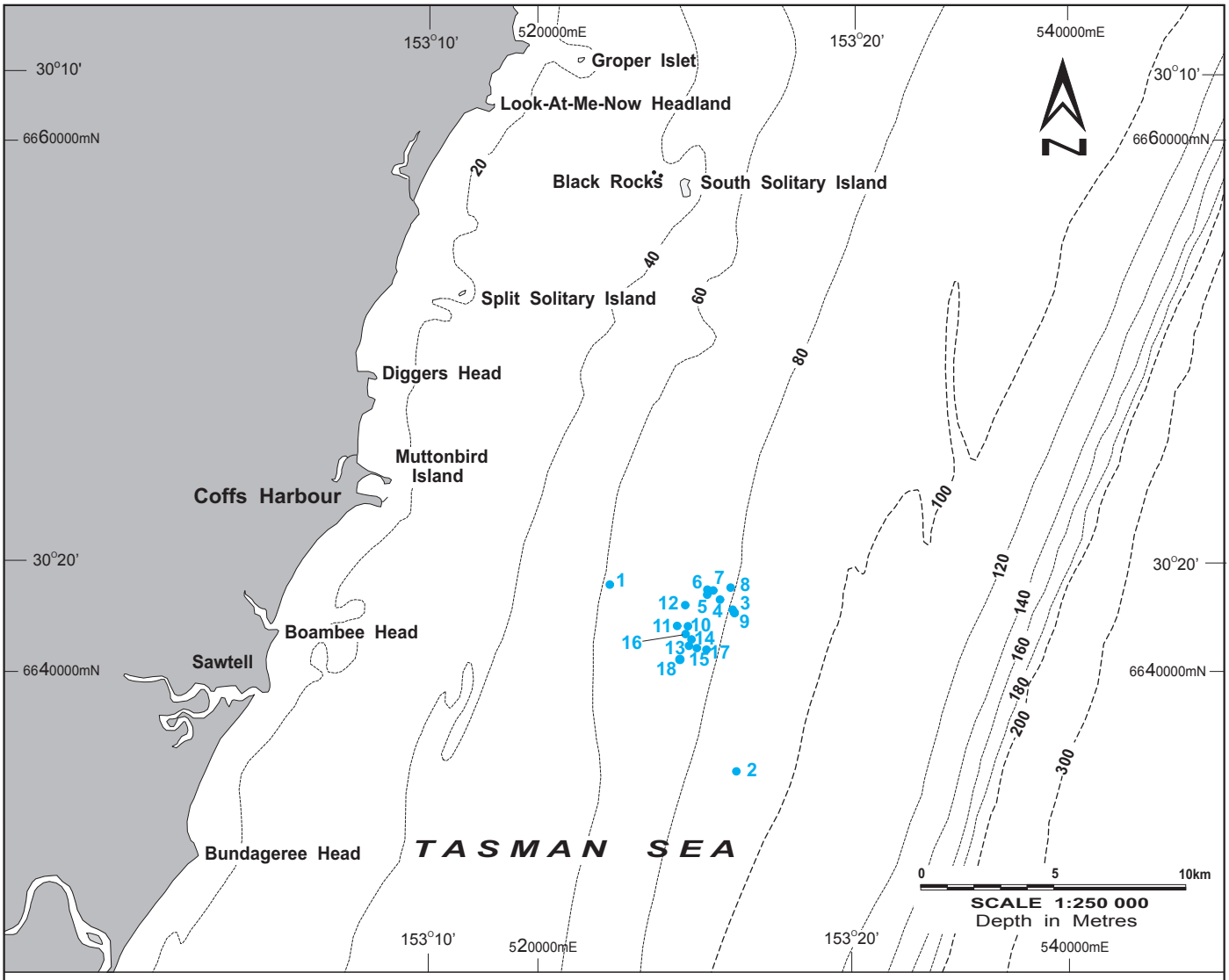
BYRON BAY WAVERIDER BUOY - 2012-2013
SIGNIFICANT WAVE HEIGHT AND WAVE DIRECTION TIME HISTORY

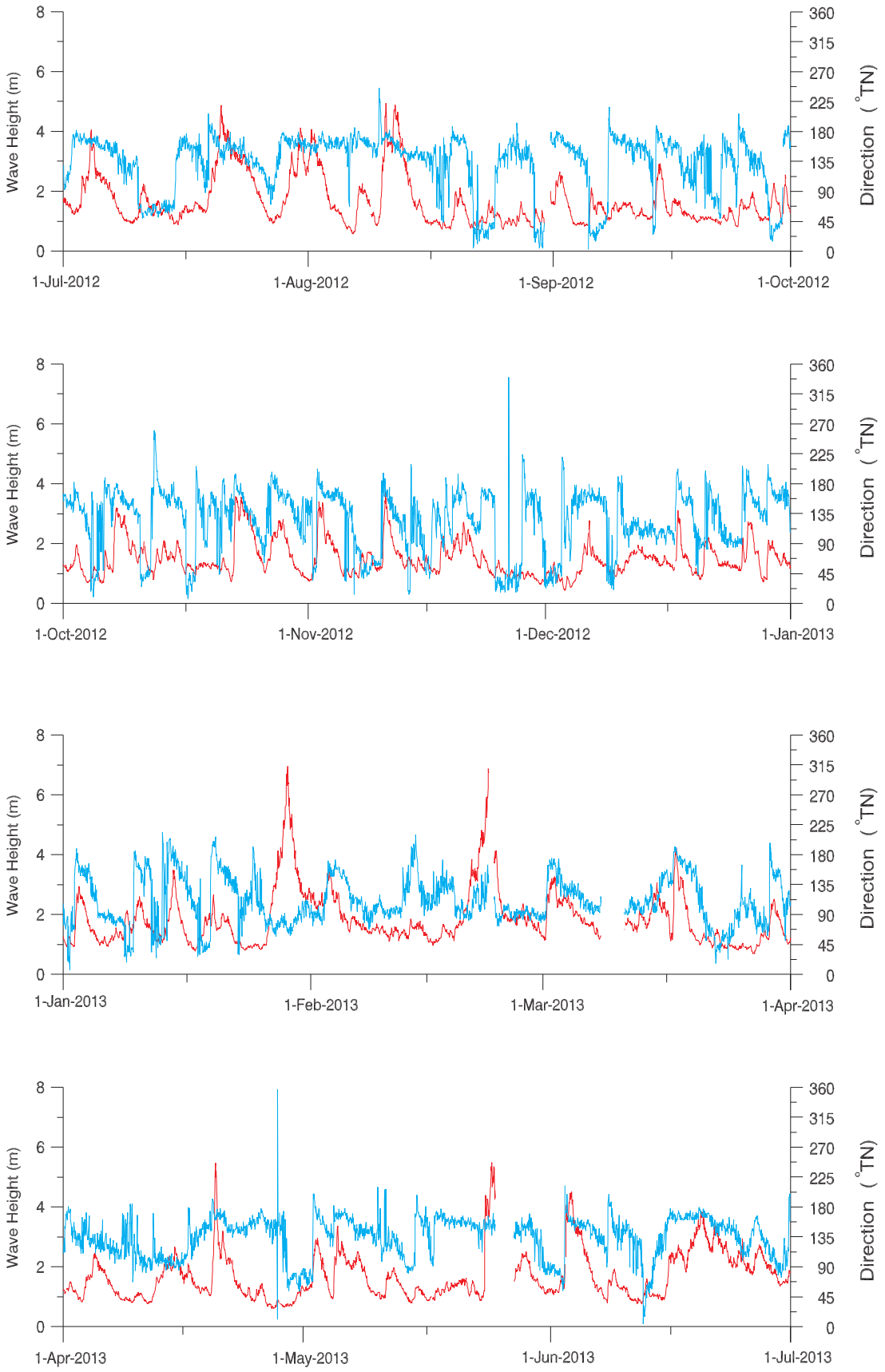
MHL Report 2221

Figure 5.2

DRAWING 2221-05-02.cdr



DEPLOYMENT LOCATION	LOCATION DETAILS				WATER DEPTH (m)	DEPLOYMENT PERIOD	
	Latitude (S)	Longitude (E)	GDA (Zone 56) Easting	GDA (Zone 56) Northing		First Date	Last Date
1	30°20'30"	153°14'12"	522750	6643320	60	26-May-1976	18-Aug-1983
2	30°24'18"	153°17'12"	527540	6636290	80	18-Aug-1983	20-Dec-1983
3	30°21'00"	153°17'06"	527390	6642380	80	20-Dec-1983	07-Mar-1984
4	30°20'48"	153°16'48"	526910	6642760	79	07-Mar-1984	12-Apr-1985
5	30°20'42"	153°16'30"	526430	6642940	77	12-Apr-1985	09-Jul-1985
6	30°20'36"	153°16'30"	526430	6643130	77	13-Aug-1985	29-Oct-1985
7	30°20'37"	153°16'38"	526640	6643100	77	05-Nov-1985	08-Oct-1987
8	30°20'34"	153°17'03"	527300	6643200	80	08-Oct-1987	25-Sep-1989
9	30°21'04"	153°17'08"	527450	6642250	82	25-Sep-1989	06-Dec-1989
10	30°21'21"	153°16'03"	525700	6641750	71	19-Dec-1989	11-Apr-1990
11	30°21'20"	153°15'48"	525300	6641770	73	11-Apr-1990	22-Feb-1991
12	30°20'55"	153°15'59"	525600	6642550	73	22-Feb-1991	02-Jul-1996
13	30°21'46"	153°16'04"	525730	6640970	74	26-Jul-1996	06-Dec-1997
14	30°21'37"	153°16'09"	525870	6641250	72	18-Jan-1998	07-Nov-2002
15	30°21'36"	153°16'22"	526210	6641280	72	23-Nov-2002	11-Mar-2005
16	30°21'25"	153°16'07"	525920	6641810	72	01-Apr-2005	19-Oct-2009
17	30°21'41"	153°16'11"	525920	6641140	72	19-Oct-2009	13-Feb-2012
18	30°22'22"	153°15'32"	524880	6639880	72	13-Feb-2012	Present



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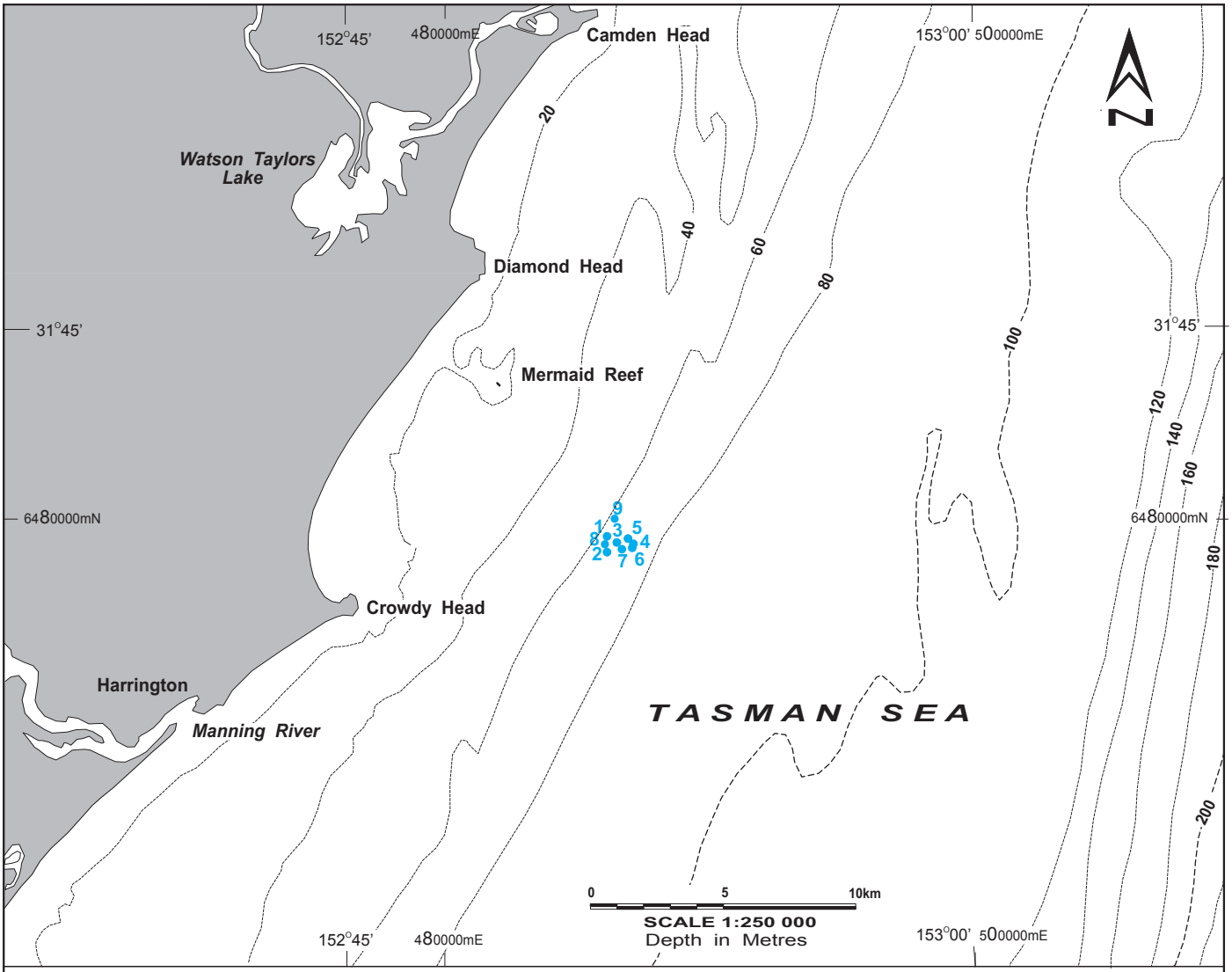
COFFS HARBOUR WAVERIDER BUOY - 2012-2013
SIGNIFICANT WAVE HEIGHT AND WAVE DIRECTION TIME HISTORY

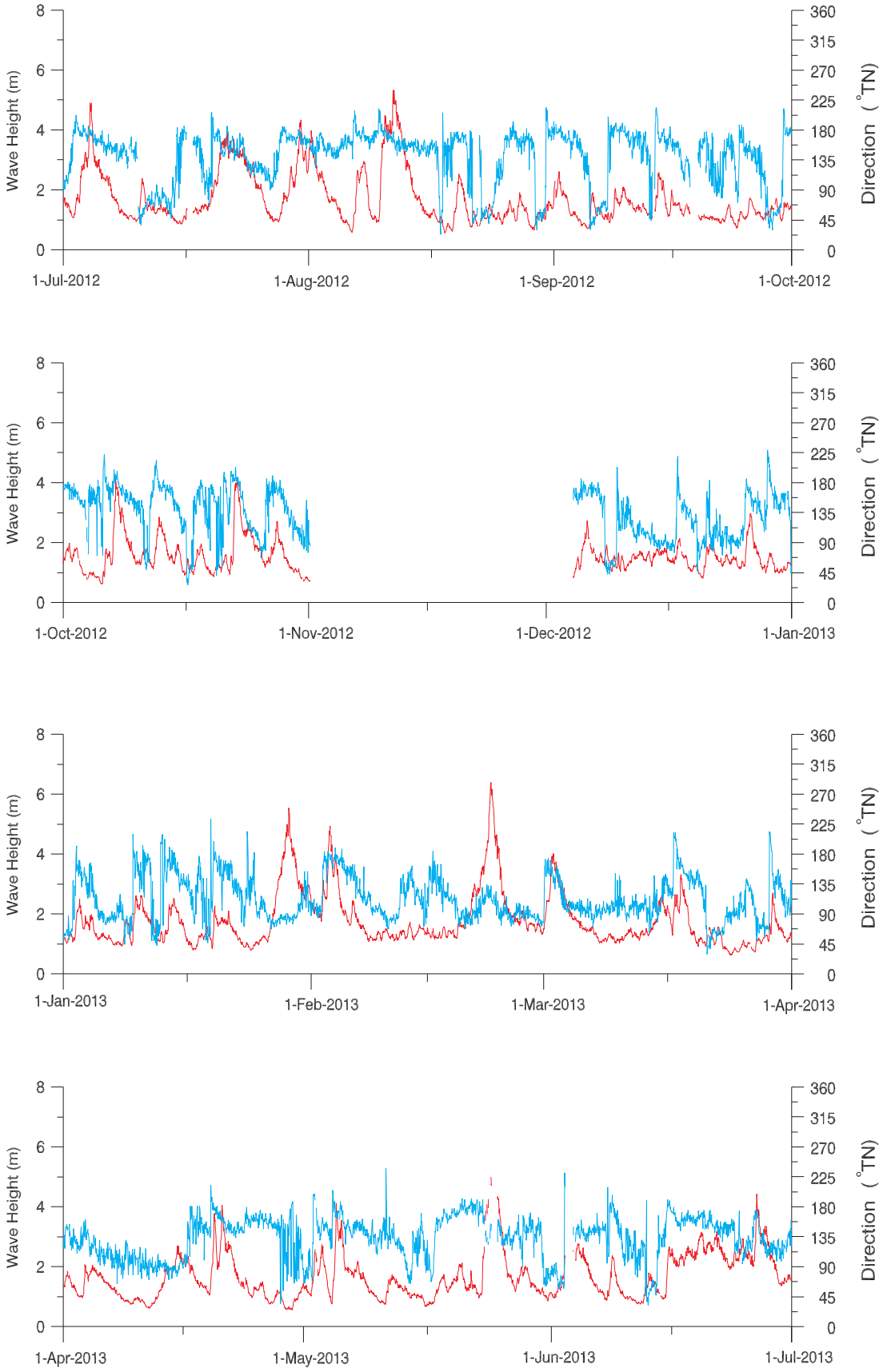
MHL Report 2221

Figure 5.4

DRAWING 2221-05-04.cdr



DEPLOYMENT LOCATION	LOCATION DETAILS				WATER DEPTH (m)	DEPLOYMENT PERIOD	
	Latitude (S)	Longitude (E)	GDA (Zone 56) Easting	Northing		First Date	Last Date
1	31°49'37"	152°51'12"	486110	6478730	77	10-Oct-1985	11-Nov-1986
2	31°49'17"	152°51'12"	486110	6479330	77	11-Nov-1986	20-Oct-1987
3	31°49'25"	152°51'26"	486480	6479100	80	20-Oct-1987	08-Aug-1989
4	31°49'26"	152°51'49"	487100	6479050	79	08-Aug-1989	17-Jul-1990
5	31°49'20"	152°51'42"	486900	6479250	77	17-Jul-1990	20-Apr-1993
6	31°49'31"	152°51'47"	487050	6478900	79	20-Apr-1993	21-Nov-1997
7	31°49'31"	152°51'35"	486720	6478910	79	21-Nov-1997	31-Oct-2012
8	31°49'26"	152°51'08"	485910	6479140	79	30-Oct-2012	04-Jul-2013
9	31°48'50"	152°51'22"	486380	6480180	79	10-Jul-2013	Present



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CROWDY HEAD WAVERIDER BUOY - 2012-2013
SIGNIFICANT WAVE HEIGHT AND WAVE DIRECTION TIME HISTORY

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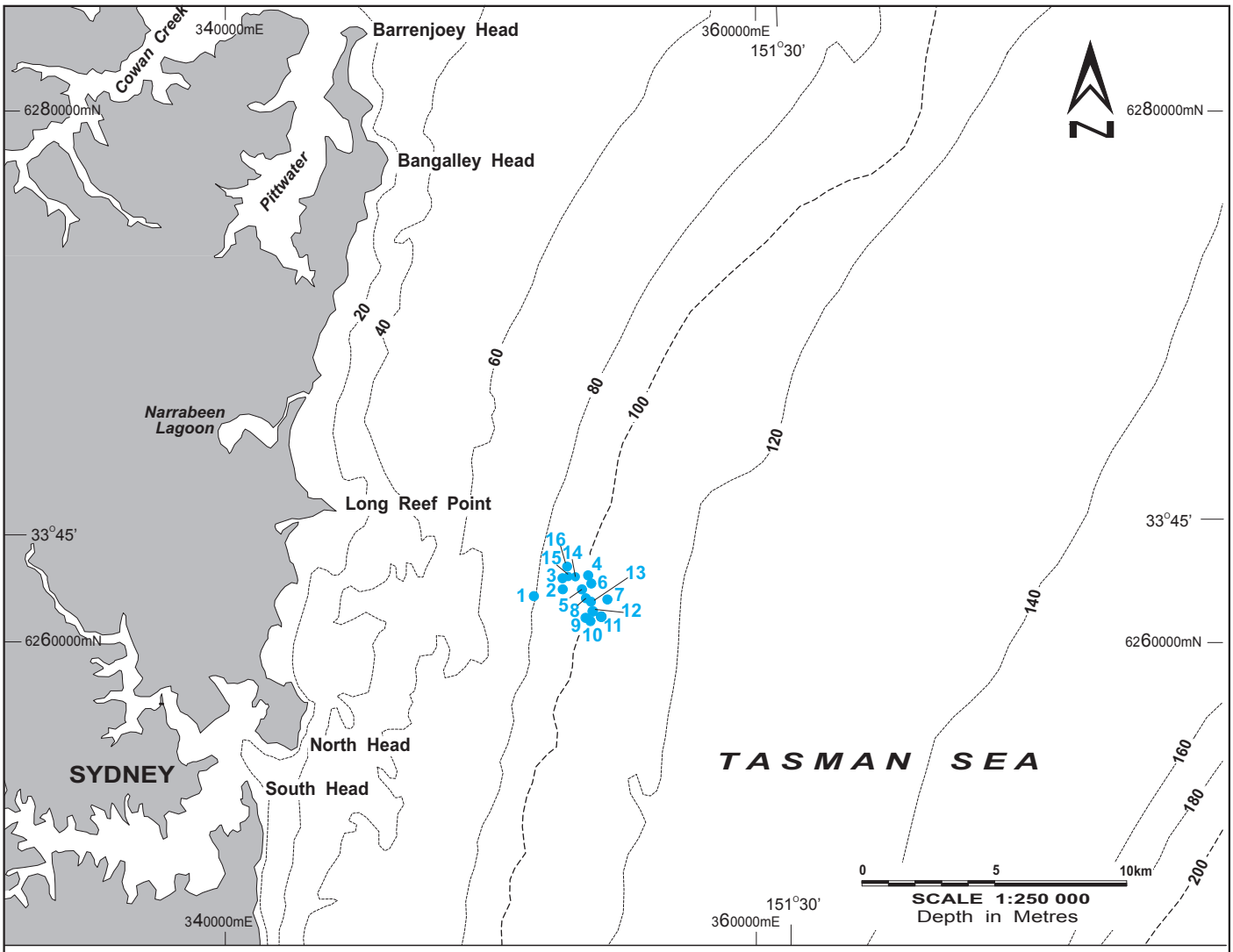
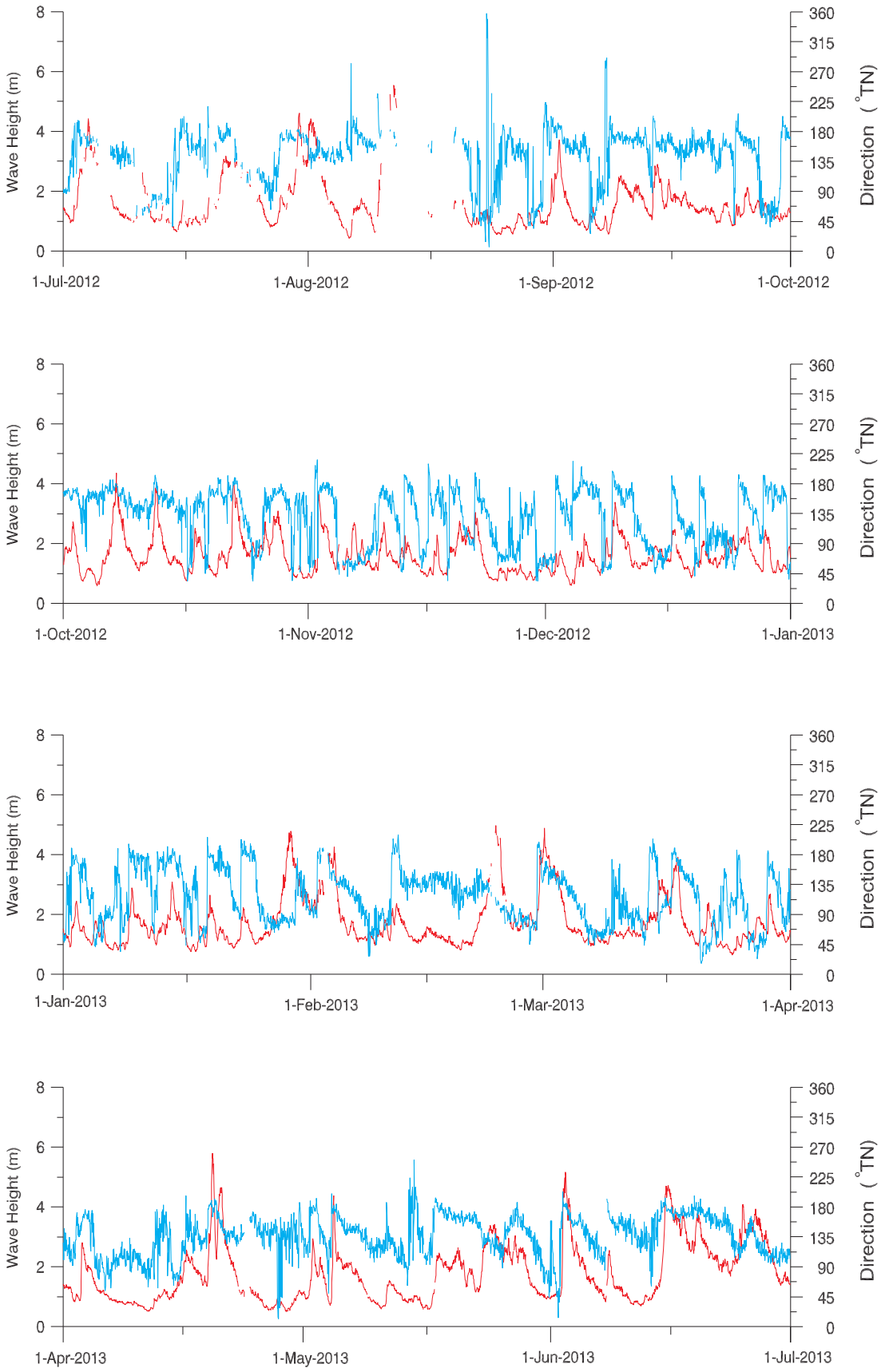
Figure 5.6

DRAWING 2221-05-06.cdr



DEPLOYMENT LOCATION	LOCATION DETAILS				WATER DEPTH (m)	DEPLOYMENT PERIOD	
	Latitude (S)	Longitude (E)	GDA (Zone 56) Easting	Northing		First Date	Last Date
1	33°46'26"	151°23'52"	351650	6261750	82	03-Mar-1992	05-Apr-1993
2	33°46'18"	151°24'35"	352740	6262010	85	22-Jun-1993	17-Nov-1993
3	33°46'04"	151°24'36"	352760	6262440	85	17-Nov-1993	01-Dec-1993
4	33°46'02"	151°25'13"	353710	6262520	85	18-Dec-1993	16-Feb-1994
5	33°46'17"	151°25'03"	353460	6262050	85	22-Mar-1994	25-Feb-1995
6	33°46'11"	151°25'18"	353840	6262230	87	25-Feb-1995	11-Feb-1998
7	33°46'31"	151°25'39"	354400	6261640	87	11-Feb-1998	01-Oct-1998
8	33°46'29"	151°25'07"	353570	6261680	85	01-Oct-1998	07-Feb-1999
9	33°46'53"	151°25'09"	353630	6260940	85	26-Mar-1999	23-Nov-1999
10	33°46'57"	151°25'17"	353830	6260840	85	23-Nov-1999	20-Jul-2001
11	33°46'54"	151°25'29"	354160	6260930	85	11-Sep-2001	18-May-2004
12	33°46'45"	151°25'15"	354160	6260930	85	18-May-2004	15-Jan-2005
13	33°46'31"	151°25'04"	353490	6261620	85	15-Feb-2005	13-Mar-2008
14	33°46'18"	151°24'59"	353360	6262020	92	13-Mar-2008	25-Nov-2009
15	33°46'08"	151°24'43"	352940	6262340	92	25-Nov-2009	21-Aug-2012
15	33°45'56"	151°24'39"	352830	6262710	92	21-Aug-2012	Present



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SYDNEY WAVERIDER BUOY - 2012-2013
SIGNIFICANT WAVE HEIGHT AND WAVE DIRECTION TIME HISTORY

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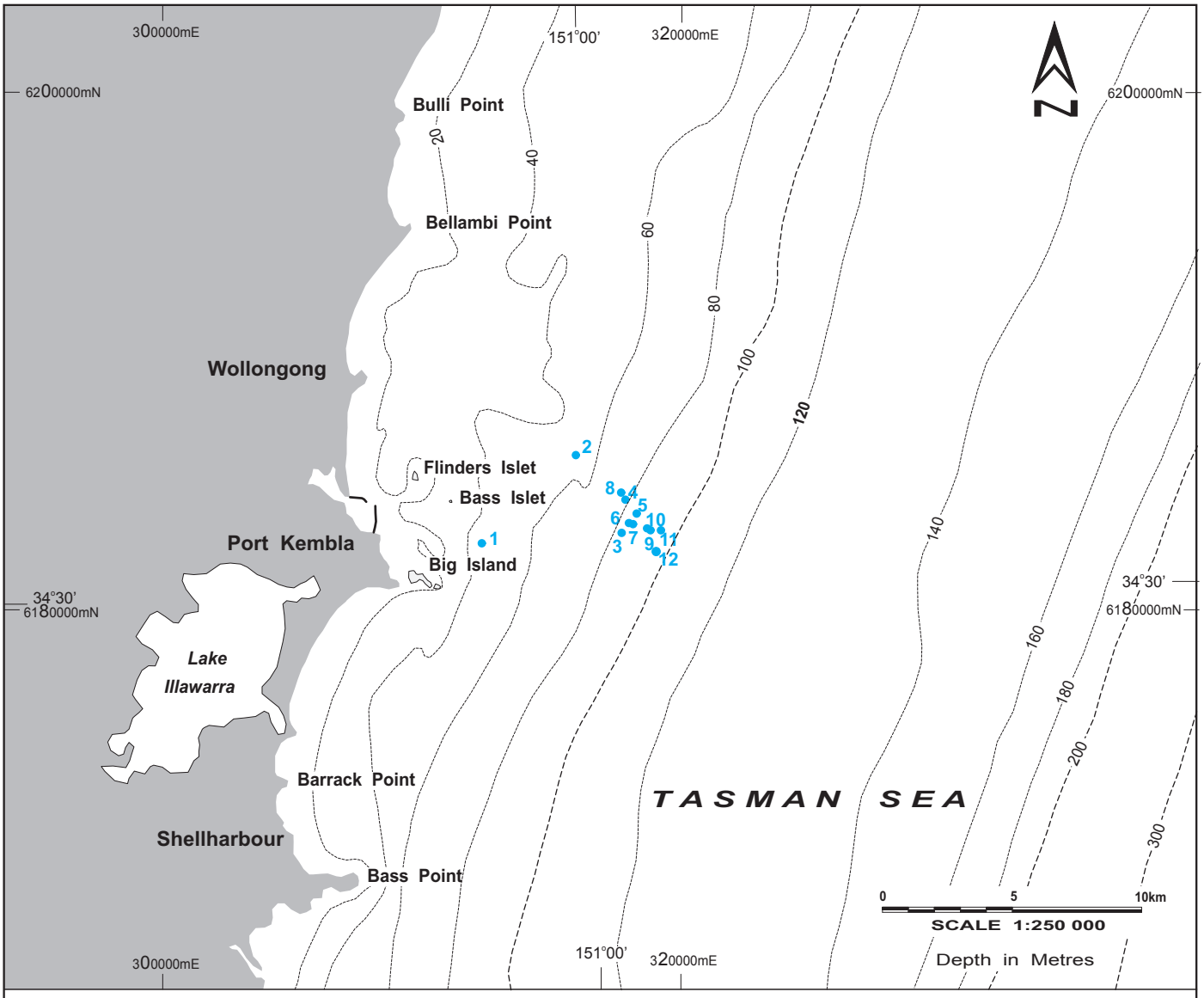
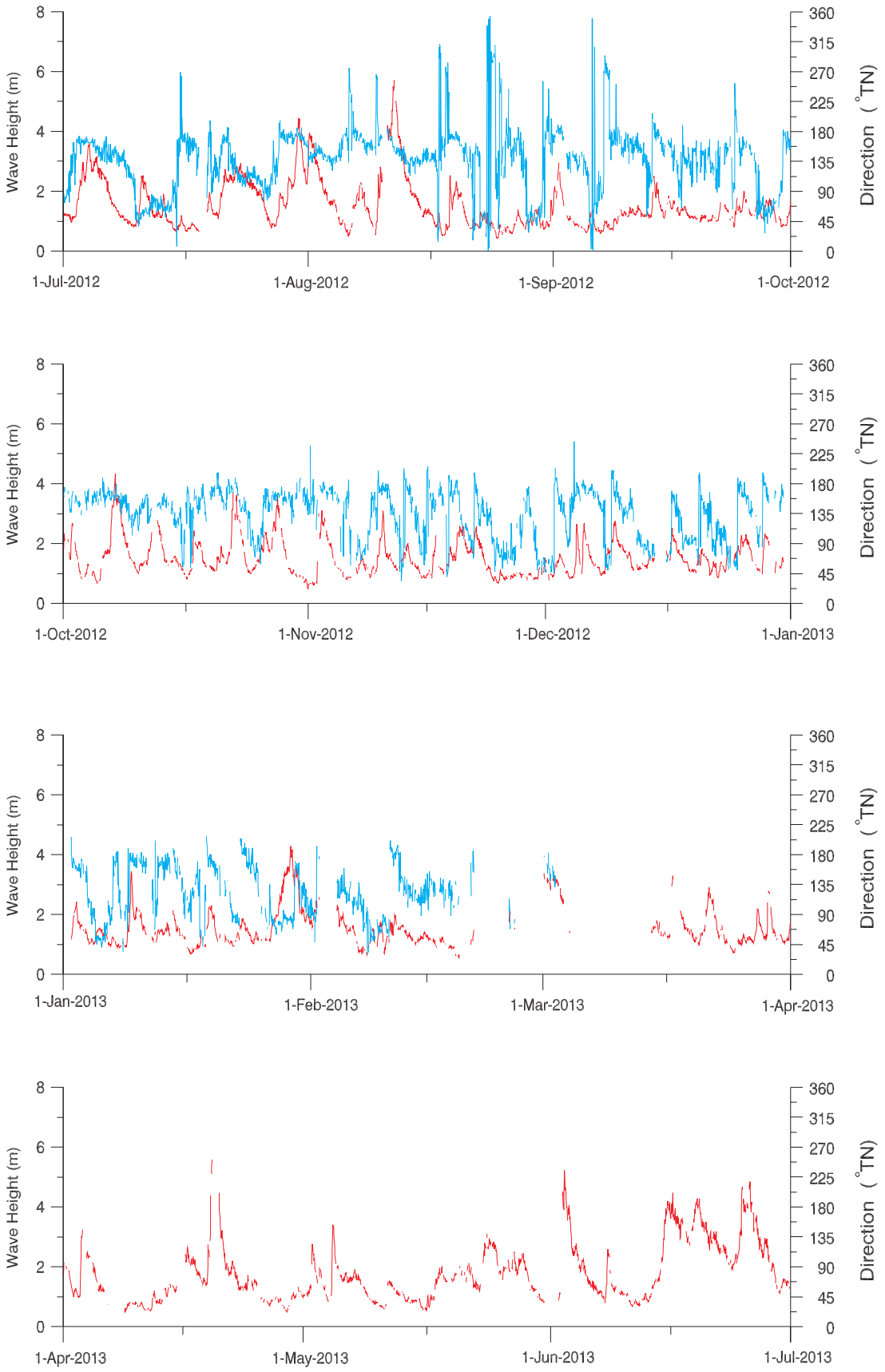
Figure 5.8

DRAWING 2221-05-08.cdr



DEPLOYMENT LOCATION	LOCATION DETAILS				WATER DEPTH (m)	DEPLOYMENT PERIOD	
	Latitude (S)	Longitude (E)	GDA (Zone 56) Easting	Northing		First Date	Last Date
1	34°28'52"	150°57'22"	312310	6182590	40	07-Feb-1974	25-Oct-1976
2	34°27'04"	150°59'47"	315940	6185990	50	25-Oct-1976	16-Nov-1983
3	34°28'42"	151°00'54"	317710	6183000	82	16-Nov-1983	14-Jun-1984
4	34°28'01"	151°01'00"	317850	6184280	76	14-Jun-1984	27-May-1988
5	34°28'18"	151°01'18"	318300	6183750	73	01-Jun-1988	19-Dec-1988
6	34°28'30"	151°01'06"	318000	6183380	73	19-Jan-1989	25-Jan-1990
7	34°28'32"	151°01'12"	318150	6183330	77	25-Jan-1990	24-Oct-1991
8	34°27'52"	151°00'55"	317700	6184550	82	24-Oct-1991	24-Jun-1992
9	34°28'24"	151°01'23"	318820	6183090	77	24-Jun-1992	28-Jul-1994
10	34°28'38"	151°01'31"	318650	6183150	78	28-Jul-1994	10-Jun-2003
11	34°28'28"	151°01'34"	318720	6183460	80	25-Jun-2003	15-Jun-2012
12	34°28'19"	151°01'18"	318310	6183740	80	15-Jun-2012	Present



Note: No wave direction data available from 2/3/13 to 30/6/13 due to faulty Waverider buoy compass

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PORT KEMBLA WAVERIDER BUOY - 2012-2013
SIGNIFICANT WAVE HEIGHT AND WAVE DIRECTION TIME HISTORY

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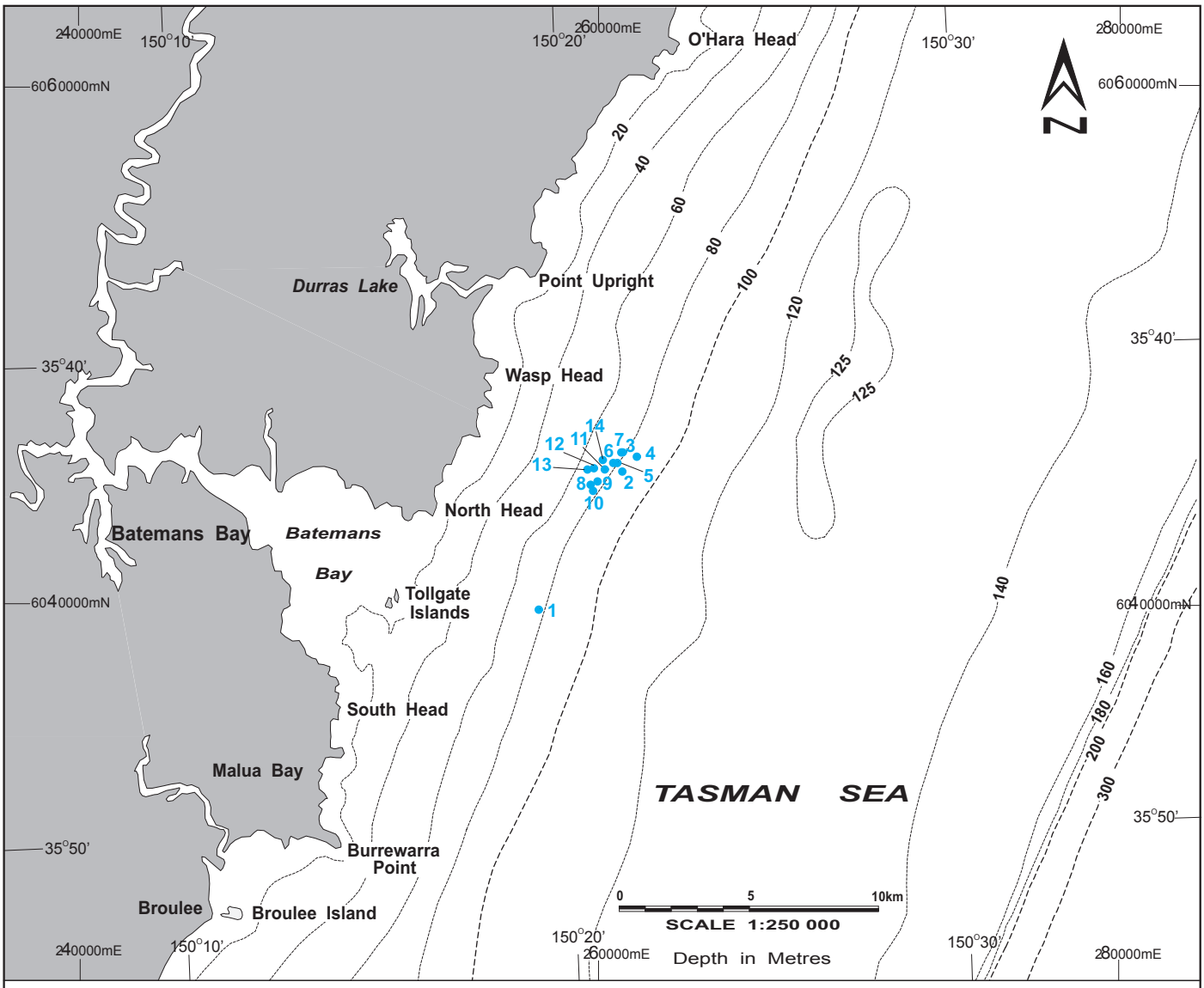
Figure 5.10

DRAWING 2221-05-10.cdr



DEPLOYMENT LOCATION	LOCATION DETAILS				WATER DEPTH (m)	DEPLOYMENT PERIOD	
	Latitude (S)	Longitude (E)	GDA (Zone 56) Easting	Northing		First Date	Last Date
1	35°45'19"	150°19'11"	257650	6039860	79	27-May-1986	02-Jun-1986
2	35°42'29"	150°21'25"	260880	6045200	75	02-Jun-1986	30-Sep-1987
3	35°42'05"	150°21'24"	260850	6045950	75	01-Oct-1987	29-Jun-1988
4	35°42'12"	150°21'47"	261430	6045750	84	30-Jun-1988	07-Feb-1989
5	35°42'18"	150°21'18"	260700	6045530	80	07-Feb-1989	19-Mar-1989
6	35°42'18"	150°21'12"	260550	6045530	73	11-Apr-1989	24-Oct-1989
7	35°42'05"	150°21'26"	260900	6045950	75	25-Oct-1989	09-Nov-1989
8	35°42'44"	150°20'35"	259650	6044700	73	22-Nov-1989	26-Apr-1990
9	35°42'40"	150°20'47"	259950	6044830	73	09-May-1990	19-Oct-1990
10	35°42'52"	150°20'39"	259750	6044450	73	13-Nov-1990	05-Jan-1997
11	35°42'26"	150°20'58"	260200	6045270	75	05-Jan-1997	28-Mar-1998
12	35°42'24"	150°20'41"	259780	6045320	73	29-Apr-1998	30-Jul-2004
13	35°42'26"	150°20'55"	260030	6045090	73	30-Jul-2004	18-Dec-2007
14	35°42'11"	150°20'38"	259680	6045740	73	25-Jan-2008	Present

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BATEMANS BAY WAVERIDER BUOY LOCATION HISTORY

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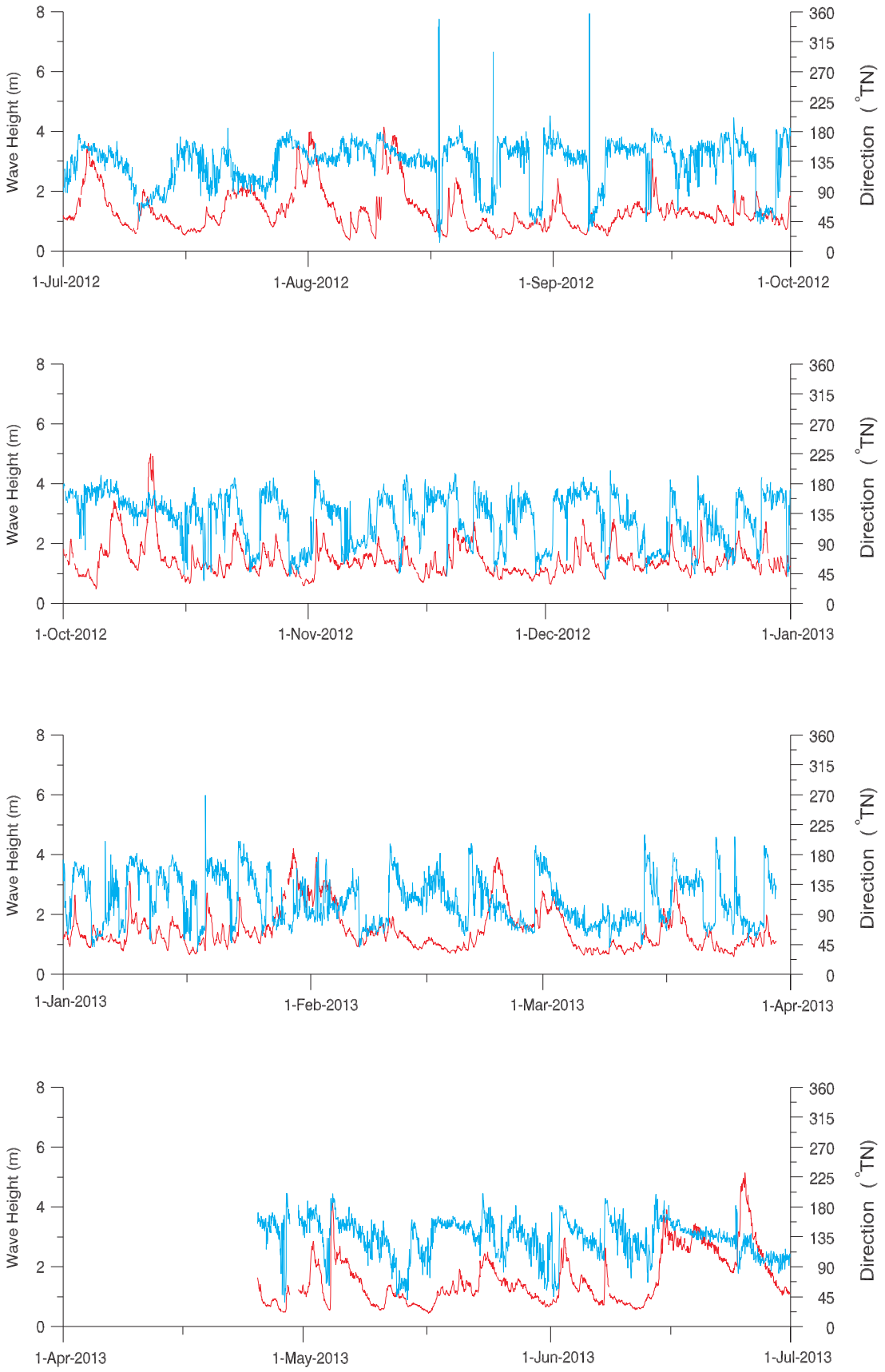
Figure 5.11

DRAWING 2221-05-11.cdr



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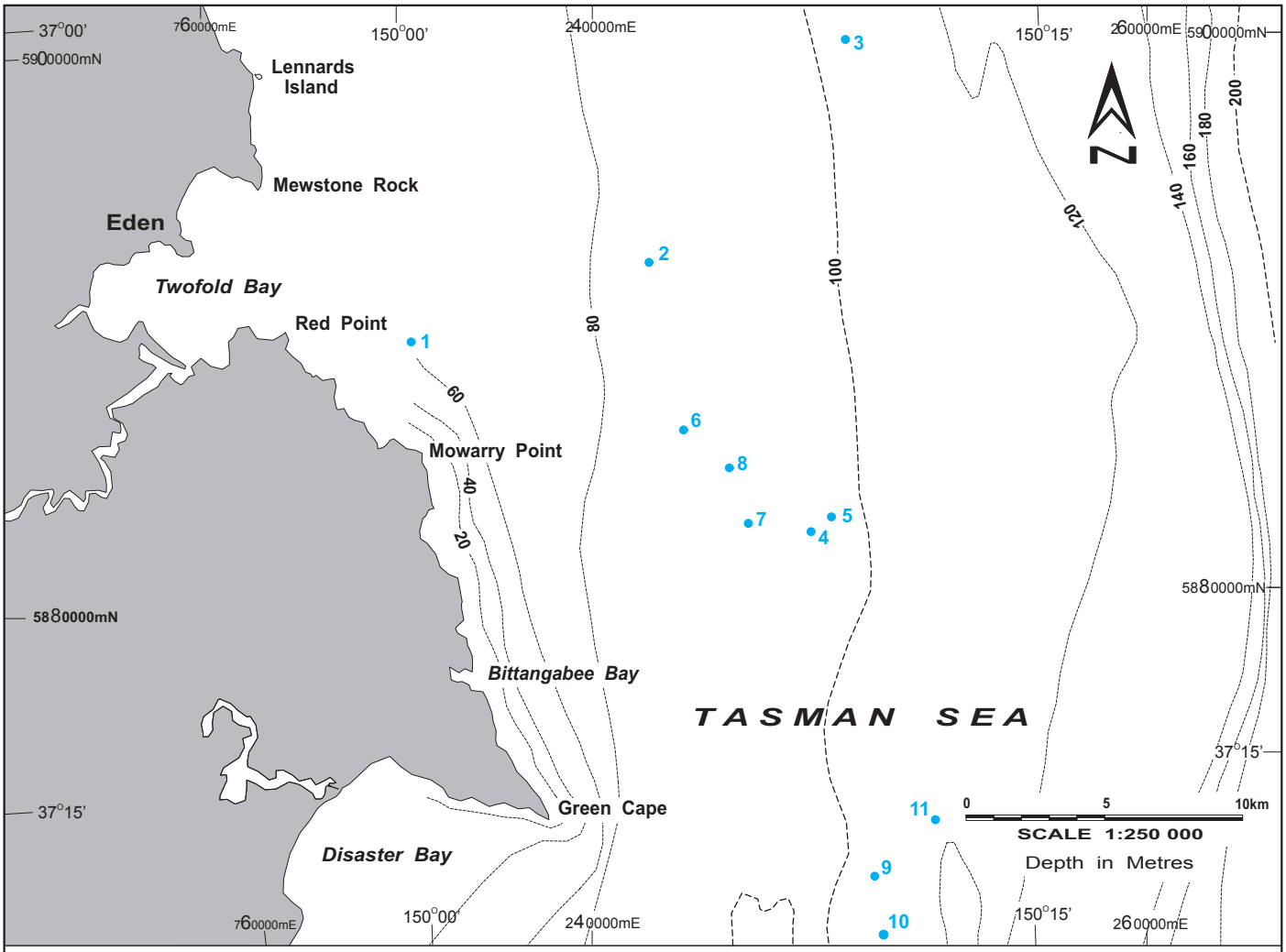
BATEMANS BAY WAVERIDER BUOY - 2012-2013
SIGNIFICANT WAVE HEIGHT AND WAVE DIRECTION TIME HISTORY

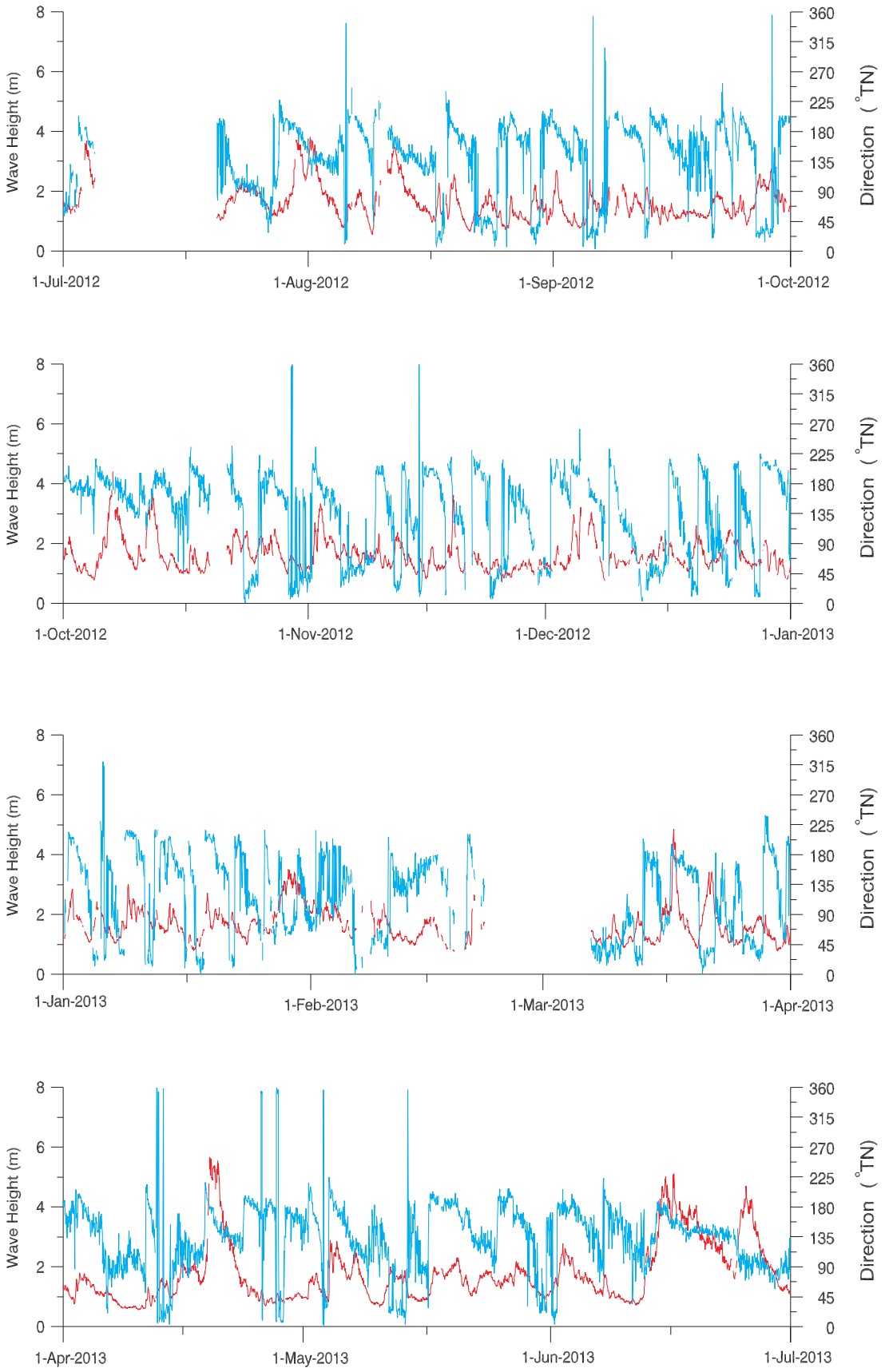
MHL Report 2221

Figure 5.12

DRAWING 2221-05-12.cdr



DEPLOYMENT LOCATION	LOCATION DETAILS				WATER DEPTH (m)	DEPLOYMENT PERIOD	
	Latitude (S)	Longitude (E)	GDA (Zone 56) Easting	GDA (Zone 56) Northing		First Date	Last Date
1	37°06'36"	150°00'00"	233420	5888700	55	08-Feb-1978	21-Sep-1983
2	37°05'12"	150°05'48"	241930	5891550	79	21-Sep-1983	22-Sep-1984
3	37°01'00"	150°10'42"	248960	5899540	104	10-Oct-1984	23-Oct-1984
4	37°10'30"	150°09'30"	247710	5881920	86	21-Mar-1985	15-Oct-1986
5	37°10'13"	150°10'01"	248450	5882450	95	15-Oct-1986	04-Feb-1987
6	37°08'28"	150°06'30"	243150	5885550	80	04-Feb-1987	10-Feb-1987
7	37°10'18"	150°08'00"	245480	5882220	90	23-Apr-1987	04-Feb-1988
8	37°09'12"	150°07'35"	244800	5884200	90	04-Feb-1988	07-Mar-1989
9	37°17'12"	150°10'48"	250000	5869580	110	07-Mar-1989	14-Sep-2000
10	37°18'06"	150°11'06"	250500	5866890	100	14-Sep-2000	05-Jul-2012
11	37°15'57"	150°11'36"	251120	5871940	100	20-Jul-2012	Present



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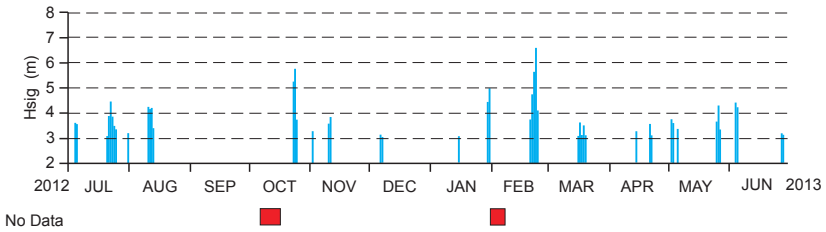
EDEN WAVERIDER BUOY - 2012-2013
SIGNIFICANT WAVE HEIGHT AND WAVE DIRECTION TIME HISTORY

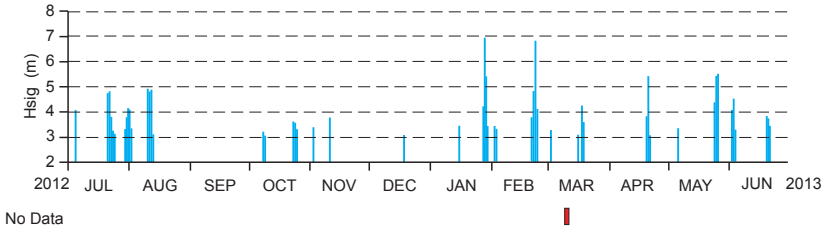
MHL Report 2221

Figure 5.14

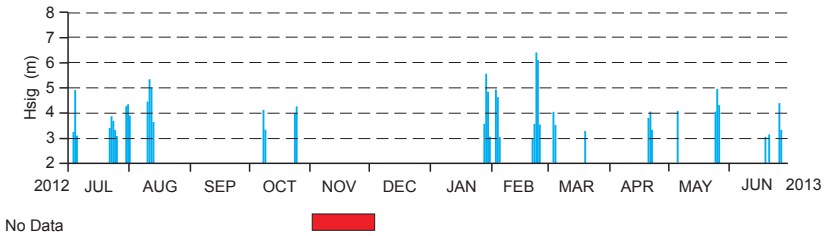
DRAWING 2221-05-14.cdr



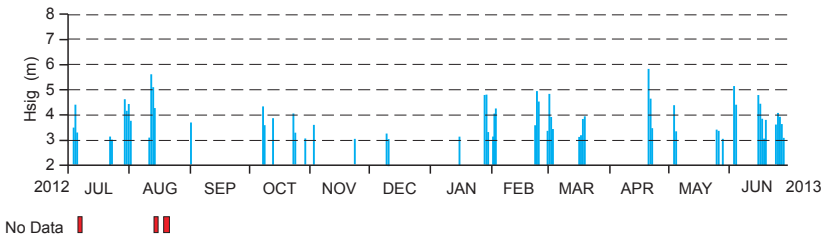
Byron Bay



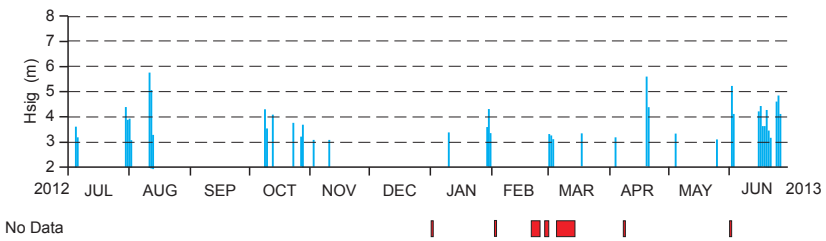
Coffs Harbour



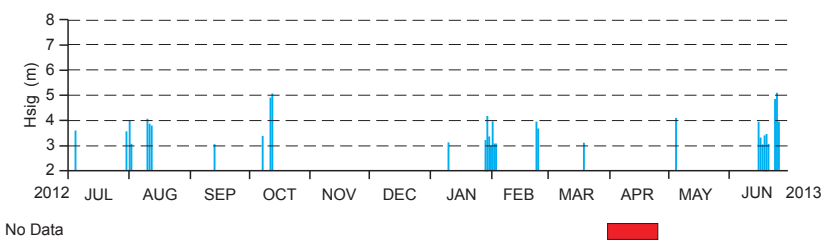
Crowdy Head



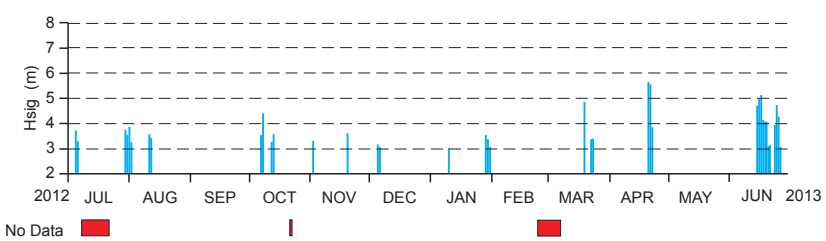
Sydney



Port Kembla



Batemans Bay



Eden

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STORM HISTORY AND WAVERIDER SYSTEM DOWNTIME SUMMARY 2012-2013

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Figure 5.15

DRAWING 2221-05-15.cdr

6. Wave Data Capture and Analysis

All analysed wave data from the offshore sites is archived on the Laboratory's central computer. This data set includes selected hand-analysed results for installations operational before 1978 that recorded data on strip chart. Analysed data for all sites is resident on hard disk, however due to storage restrictions raw time series data is archived on an optical disk system. If required, raw wave data can be recovered from the optical disk system for further analysis.

6.1 Non–Directional Wave Analysis

The first non-directional Waverider buoy was deployed by Manly Hydraulics Laboratory in February 1974 and initially recorded raw wave data traces on paper strip chart every six hours. In 1978 the introduction of the first electronic data loggers allowed more complete analysis but the record interval remained at six hours due to the limited memory capacity of these early loggers. In mid-1984 data logging and analysis was significantly enhanced with the introduction of the Manly Hydraulics Laboratory-developed programmable LSI-11 data logger. The LSI-11 data logger software was upgraded for the introduction of Directional Waverider buoys in March 1992. After over 20 years of service the LSI-11 system was phased out between October 2005 and December 2007 and was replaced with the current *MetOcean* PC data logging, processing and telemetry system.

The recorded 2048-second bursts (34 minutes) at each site are digitised at 2 Hz (0.5-second) intervals and the data is conditioned to remove erroneous data points. The data is then analysed using the standard zero crossing and spectral methods. This section briefly outlines the terminology associated with these two methods.

It should be noted that in addition to the offshore network the Laboratory undertakes site specific wave data capture programs associated with particular projects, such as breakwater design/construction, harbour design/construction, beach erosion studies, etc. A range of instruments can be used to obtain wave information.

In general, the following instruments/applications are employed:

- Directional Waverider buoys in deep or intermediate water depth to provide wave height, period and direction spectral information
- Waverider buoys in deep or intermediate water depth to provide wave height, period and spectral information
- Electromagnetic wave and tide monitoring systems (EWS) in shallow water to provide wave height, period, spectral and tidal information

- From 1979 to 1989 Marsh McBirney and InterOcean S4 electromagnetic adaptive current meters were used to provide XY current information over the whole spectrum. The wave components are analysed and stored in a similar fashion to the Waverider and EWS data. Additionally, the current meters can provide wave direction information. When combined with an EWS or pressure sensor, estimates of the directional spectrum can be obtained.
- Teledyne RD Instruments Acoustic Doppler Current Profiler (ADCP) deployed on the seabed in shallow water to capture wave height, period and spectral information. The ADCP provides a comprehensive data set that can be processed to provide data on water level, wave conditions and current speed and direction through the water column above the instrument.

Site specific studies utilise the same software/hardware for record analysis as the offshore network and provide additional inshore information at specific sites. For this reason, a list of these study sites and their operational status has been included in Section 7.

6.1.1 Zero Crossing Analysis

A direct, repeatable and widely accepted method to extract representative statistics from the wave traces is the zero crossing method (Figure 6.1). For this method, a 'wave' is defined as the portion of record between two successive zero upcrossings. The waves are ranked (with their corresponding periods), and the following statistics computed:

H_{sig} : significant wave height = average height of the waves which comprise the top 33%

H_{10} : average height of the waves which comprise the top 10%

H_{max} : maximum wave height in a record

H_{rms} : root mean square wave height

H_{mean} : mean wave height

T_z : zero crossing period = mean period

T_{sig} : significant period = average period of the waves used to define H_{sig}

T_c : crest period = average time between successive crests (this involves a different definition of wave)

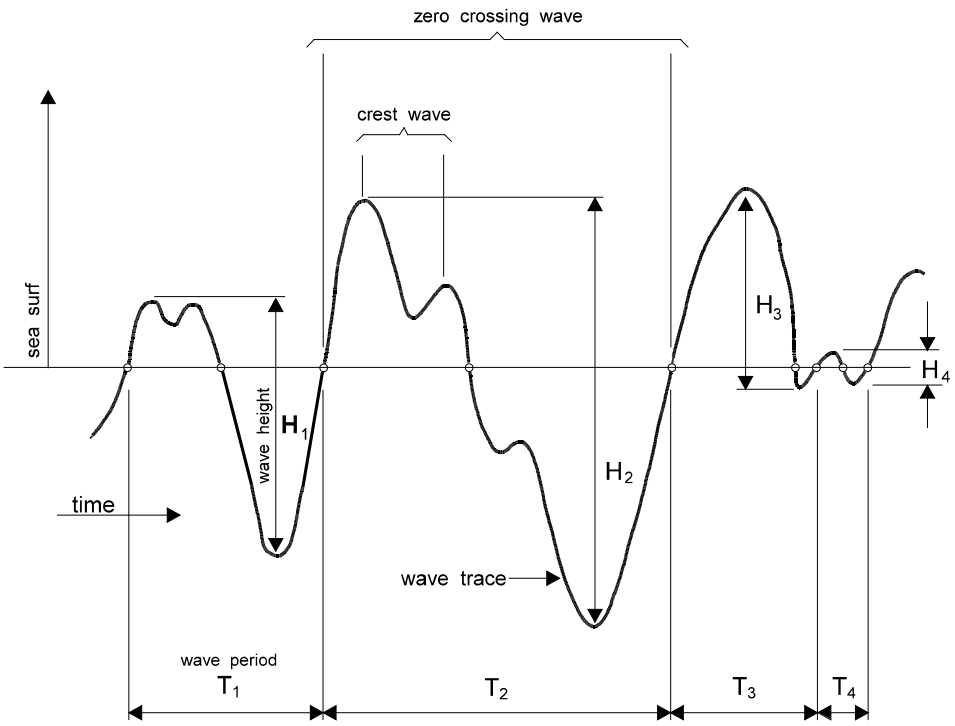


Figure 6.1 Zero Crossing Wave

6.1.2 Spectral Analysis

The sea's motion at a point can be thought of as being composed of the sum of an infinite number of sine waves, each with its own amplitude (*a*), frequency (*f*) and phase (*f*).

$$h(t) = \int_{o}^{oo} a(f) \sin[2\pi ft - f(f)]\, df$$

Spectral analysis using the Fast Fourier Transform technique provides estimates of the components. Rather than plotting the amplitudes, it is conventional to plot the energy density, E (effectively a^2/df).

For convenience, and because users are often interested in the shape of spectra, the values are scaled to give unity area.

The following statistics are computed from the spectrum:

T_{P1}	:	Period of highest peak
T_{P2}	:	Period of second highest peak
Y_{rms}	:	Root mean square surface vertical displacement

M_0, M_1, M_2, M_3 : Spectral moments - $M_n = \int f^n \, df$

These provide parameters describing the shape of the spectrum. Spectral moments can also be related statistically to the zero crossing parameters:

$H_{rms} \approx 2\sqrt{2M_0} = 2\sqrt{2}Y_{rms}$, where $M_0 = Y_{rms}^2$

$H_{sig} \approx 4\sqrt{M_0} = 4Y_{rms} = \sqrt{2}H_{rms}$

$H_{10} \approx 5.1\sqrt{M_0} = 5.1Y_{rms}$

$H_1 \approx 6.68\sqrt{M_0} = 6.68\ Y_{rms}$

$H_{mean} \approx 2.5\sqrt{M_0} = 2.5\ Y_{rms} = 0.886\ H_{rms}$

An example of a spectral diagram is presented in Figure 6.2.

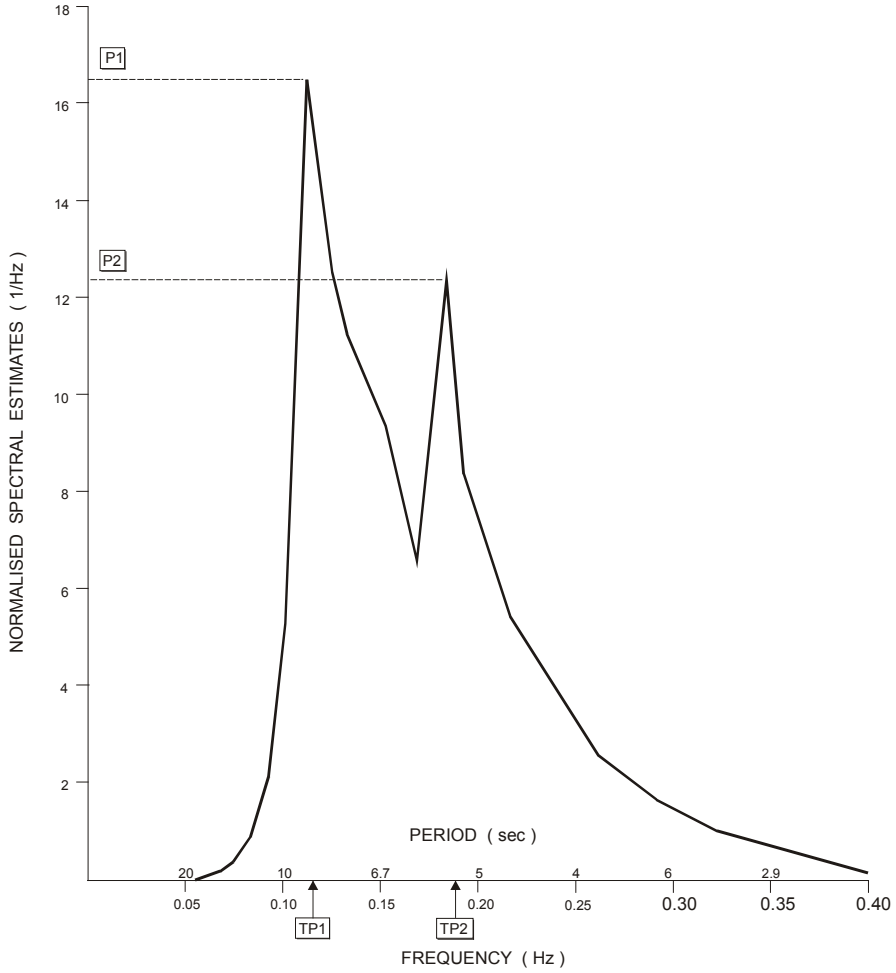


Figure 6.2 Spectral Diagram

6.2 The Directional Waverider Buoy

Manly Hydraulics Laboratory uses Directional Waverider buoys to monitor wave height, period and direction at the seven NSW offshore wave monitoring stations. The original Mark I version of the Directional Waverider buoy was introduced by Datawell in early 1990, followed by the Mark II buoy in mid-1995. The Mark III Directional Waverider buoy, introduced in the mid-2000s, represented a significant upgrade and included a GPS receiver to continuously report its location to the shore station enabling the buoy location to be tracked should it go adrift. At present, a mix of Mark II and Mark III buoys are used in the NSW Waverider buoy network.

The Directional Waverider buoy utilises a heave-pitch-roll sensor, two fixed 'X' and 'Y' accelerometers and a three axis fluxgate compass to measure both vertical and horizontal motion at a sample rate of 1.28 Hz (0.78 seconds). A single point mooring is used, with horizontal freedom ensured by the inclusion of a 30 m rubber shock cord in the mooring system. An on-board processor converts the buoy motion to three orthogonal (vertical, north-south, east-west) translation signals that are telemetered to the shore station. The directional spectrum is also routinely calculated by the buoy and transmitted to the receiving station for reformatting and storage prior to transfer to Manly Hydraulics Laboratory via the *MetOcean* email system.

Detailed information on the directional data analysis undertaken by the Directional Waverider buoy can be found in the Datawell Waverider Reference Manual, 2007.

7. Wave Data Index

Since 1974 wave data have been collected at over 40 locations along the NSW coast using a variety of wave motion sensors. This section includes a catalogue of all wave data stored on the Manly Hydraulics Laboratory central computer. Details of analysed wave data available are presented in three tables grouped according to the following categories:

- Table 7.1: Offshore Stations - Waverider buoys deployed to provide deepwater wave data. The buoys are typically moored in a water depth of 80 m between 6 and 12 km from the shoreline. At the buoy location the water is sufficiently deep that wave refraction, diffraction, shoaling and friction attenuation effects are minimal
- Table 7.2: Site Specific Stations - wave data collected by a variety of sensors in intermediate or shallow water. These stations gather wave data for particular projects such as breakwater design/construction, harbour design/construction, beach erosion studies, etc. The wave characteristics at these inshore locations may be significantly affected by refraction, diffraction, shoaling and friction attenuation
- Table 7.3: Long Wave Stations - water level data collected at selected EWS stations are filtered and analysed to provide long wave statistics. Long waves have periods that range from 30 seconds to several minutes and are often associated with storm wave activity off the NSW coast.

Due to limited storage capacity on the computer raw time series wave data is archived on optical disk. Table 7.4 provides an index of raw data stored on optical disk. Prior to mid-2006, at most sites raw data was normally saved twice per day at 0900 and 2100 hours and every second hour during storm events (H_{sig} greater than 3 m for offshore sites). Since 2006, with the introduction of the *MetOcean* system, raw data is archived hourly for all wave data collection stations.

It should be noted that raw data is not available for all sites or before January 1981.

Table 7.1 Analysed Wave Data at Manly Hydraulics Laboratory: Offshore Stations - June 2013

Wave Data Site	Instrument	GDA Location (Zone 56)		Water Depth (m)	Data Available		Record Length (years)	Data Capture (%)
		Easting	Northing		First Date	Last Date		
Byron Bay	Waverider buoy	572 700	6 822 180	72	14-Oct-1976	26-Oct-1999	36.73	73.5
Byron Bay	Directional Waverider buoy	568 270	6 806 650	62	26-Oct-1999	Present		
Coffs Harbour	Waverider buoy	525 920	6 641 140	72	26-May-1976	13-Feb-2012	37.12	85.1
Coffs Harbour	Directional Waverider buoy	524 880	6 639 880	72	14-Feb-2012	Present		
Crowdy Head	Waverider buoy	486 720	6 478 910	79	10-Oct-1985	19-Aug-2011	27.74	85.6
Crowdy Head	Directional Waverider buoy	486 720	6 478 910	79	19-Aug-2011	Present		
Sydney	Waverider buoy	353 490	6 261 200	85	17-Jul-1987	04-Oct-2000	13.23	92.2
Sydney Directional	Directional Waverider buoy	352 940	6 262 340	92	03-Mar-1992	Present	21.34	86.3
Port Kembla	Waverider buoy	318 720	6 183 460	80	07-Feb-1974	14-May-2012	39.42	83.4
Port Kembla	Directional Waverider buoy	318 310	6 183 740	80	20-Jun-2012	Present		
Batemans Bay	Waverider buoy	259 780	6 045 320	73	27-May-1986	23-Feb-2001	27.11	90.3
Batemans Bay	Directional Waverider buoy	259 080	6 045 190	73	23-Feb-2001	Present		
Eden	Waverider buoy	250 500	5 866 890	100	08-Feb-1978	16-Dec-2011	35.41	83.4
Eden	Directional Waverider buoy	251 120	5 871 940	100	16-Dec-2011	Present		

Table 7.2 Analysed Wave Data at Manly Hydraulics Laboratory: Site Specific Stations - June 2013

Wave Data Site	Instrument	GDA Location (Zone 56)		Water Depth (m)	Data Available		Record Length (years)	Data Capture (%)
		Easting	Northing		First Date	Last Date		
Tweed River	EWS	553 860	6 883 725	4	20-Jan-1995	27-Nov-2008	13.86	68.4
Tweed Heads Inshore	Waverider buoy	555 294	6 883 017	13	21-Apr-1989	08-Nov-1989	0.55	97.0
Tweed Heads	Marsh McBirney	555 294	6 883 017	13	09-Jun-1988	10-Oct-1989	1.34	61.6
Cook Island	Marsh McBirney / S4	556 003	6 881 182	12	09-Jun-1988	25-Oct-1989	1.38	40.8
Fingal Head	Marsh McBirney / S4	556 079	6 879 564	12	09-Jun-1988	25-Oct-1989	1.38	30.7
Coffs Harbour Entrance	Marsh McBirney	514 665	6 646 863	9	04-Dec-1986	31-Oct-1987	0.91	52.9
Coffs Harbour Jetty	EWS	513 840	6 647 148	7	05-Nov-1986	15-Jan-1996	9.20	83.7
Coffs Harbour Jetty MMcB	Marsh McBirney	513 840	6 647 148	7	04-Dec-1986	20-Jan-1987	0.13	97.2
Coffs Harbour Boat Ramp	Marsh McBirney	513 674	6 646 699	6	21-Jan-1987	08-Mar-1987	0.13	90.6
Coffs Harbour Quarry	Marsh McBirney	514 163	6 646 618	6	10-Mar-1987	27-Apr-1987	0.13	84.1
Muttonbird Island West	Marsh McBirney	514 110	6 647 040	6	29-Apr-1987	17-Jun-1987	0.13	81.6
Coffs Inner Hbr Entrance	Marsh McBirney	513 790	6 647 313	4	19-Jun-1987	04-Aug-1987	0.13	89.2
Muttonbird Island East	Marsh McBirney	514 790	6 647 105	11	14-Aug-1987	06-Oct-1987	0.15	62.1
Muttonbird Island South	Marsh McBirney	514 415	6 647 000	7	07-Oct-1987	31-Oct-1987	0.07	96.0
Coffs Harbour Central	Marsh McBirney	513 927	6 646 790	8	05-Nov-1987	25-Nov-1987	0.06	96.4
Coffs Inner Harbour	EWS	513 920	6 647 470	4	16-Jan-1996	08-Oct-2011	15.74	83.8
Crowdy Head Harbour	EWS	476 318	6 477 138	2	07-Nov-1986	16-Jul-2012	25.71	75.5
Jimmys Beach	EWS	421 665	6 383 610	3	16-Dec-1983	08-Oct-1985	1.82	86.0
Nelson Bay	EWS	419 720	6 379 447	6	20-Jan-1981	18-Jun-1986	4.92	36.1
Nelson Bay West Point	EWS	419 470	6 379 465	5	19-Jun-1986	20-Apr-1988	1.84	87.6
Swansea	EWS	375 079	6 338 043	2	17-Dec-1987	12-Apr-1991	3.32	98.6
Wamberal Beach	Direction Waverider	356 089	6 299 724	11	05-Aug-2011	16-Mar-2012	0.61	92.7
Broken Bay	Waverider buoy	346 190	6 285 235	24	30-Jan-1981	02-Jun-1983	2.34	53.1
Palm Beach	Marsh McBirney	345 650	6 281 755	24	19-Jun-1981	14-Sep-1982	1.24	41.1
Broken Bay Current	Marsh McBirney	346 190	6 284 795	24	23-Nov-1979	15-Feb-1983	3.23	71.7
Mackerel Beach	EWS	342 270	6 281 775	2	17-Aug-1988	15-Oct-1989	1.16	97.1
Narrabeen Beach	Direction Waverider	342 875	6 267 444	10	27-Jul-2011	14-Nov-2011	0.30	96.4
Long Reef	Waverider buoy	344 749	6 266 181	21	27-Jul-2011	14-Nov-2011	0.30	98.9
Melrose Park	EWS	321 365	6 255 975	2	24-Mar-1988	20-Jul-1988	0.32	81.7
Chiswick	EWS	327 650	6 253 076	2	28-Mar-1988	20-Jul-1988	0.31	74.6
Port Hacking Seaward	EWS	328 830	6 227 575	3	06-Sep-1983	Present	28.84	78.2
Deeban Spit	EWS	327 850	6 227 474	2	15-Sep-1983	03-Oct-1986	3.05	51.4
Port Hacking S'ward MMcB	Marsh McBirney	328 830	6 227 575	3	06-Sep-1983	17-Nov-1986	3.20	56.6
Deeban Spit MMcB	Marsh McBirney	327 850	6 227 474	2	06-Sep-1983	28-May-1985	1.73	60.5
Burraneer Point MMcB	Marsh McBirney	327 763	6 227 931	6	06-Sep-1983	16-Dec-1985	2.28	53.8
Port Kembla Inshore	Waverider buoy	307 990	6 184 970	18	31-May-1978	26-Jul-1982	4.16	72.3
Jervis Bay North	EWS	287 850	6 120 050	6	11-Nov-1981	03-Jul-1989	7.65	62.4

Wave Data Site	Instrument	GDA Location (Zone 56)		Water Depth (m)	Data Available		Record Length (years)	Data Capture (%)
		Easting	Northing		First Date	Last Date		
Jervis Bay South	EWS	288 500	6 118 800	8	01-Sep-1981	18-Oct-1983	2.13	35.4
Batemans Bay Inshore	EWS	247 792	6 043 097	7	26-Feb-1987	08-Dec-1990	3.78	94.1
Eden Inshore *	Waverider buoy	758 230	5 892 820	9	24-Nov-1984	11-May-1987	2.46	75.8
Eden Harbour *	EWS	758 324	5 892 999	4	24-Nov-1984	13-Nov-2012	27.97	85.1

* Location is relative to origin of Zone 55

Table 7.3 Analysed Wave Data at Manly Hydraulics Laboratory: Long Wave Stations - June 2013

Wave Data Site	Instrument	GDA Location (Zone 56)		Water Depth (m)	Data Available		Record Length (years)	Data Capture (%)
		Easting	Northing		First Date	Last Date		
Tweed River	EWS	553 860	6 883 725	4	20-Jan-1995	02-May-2005	10.29	78.8
Coffs Harbour Jetty	EWS	513 840	6 647 148	7	13-Jul-1987	15-Jan-1996	8.52	86.6
Coffs Inner Harbour	EWS	513 920	6 647 470	4	16-Jan-1996	04-Apr-2006	10.22	87.5
Crowdy Head Harbour	EWS	476 318	6 477 138	2	24-Jul-1987	07-Jan-2004	16.47	83.9
Swansea	EWS	375 079	6 338 043	2	09-Sep-1988	12-Apr-1991	2.59	98.3
Mackerel Beach	EWS	342 270	6 281 775	2	17-Aug-1988	15-Oct-1989	1.16	96.4
Port Hacking	EWS	328 830	6 227 575	3	20-Nov-1987	13-Apr-2004	16.41	87.6
Jervis Bay North	EWS	287 850	6 120 050	6	30-Jul-1987	03-Jul-1989	1.93	87.0
Batemans Bay	EWS	247 792	6 043 097	7	26-Aug-1987	08-Dec-1990	3.29	95.3
Eden Harbour *	EWS	758 324	5 892 999	4	28-Jul-1987	28-Feb-2006	18.60	90.4

* Location is relative to origin of Zone 55

Table 7.4 Raw Wave Data at Manly Hydraulics Laboratory : Time Series Data Stored on Optical Disk - June 2013

Wave Data Site	Instrument	Site Category	Available Analysed Data		Available Raw Data	
			First Data	Last Date	First Date	Last Date
Tweed River	EWS	Inshore	20-Jan-1995	27-Nov-2008	20-Jan-1995	27-Nov-2008
Tweed Heads Inshore	Waverider buoy	Inshore	21-Apr-1989	08-Nov-1989	21-Apr-1989	08-Nov-1989
Byron Bay	Waverider buoy	Offshore	14-Oct-1976	26-Oct-1999	12-Aug-1983	26-Oct-1999
Byron Bay	Direct'n Waverider	Offshore	26-Oct-1999	Present	26-Oct-1999	Present
Coffs Harbour	Waverider buoy	Offshore	26-May-1976	13-Feb-2012	29-Jul-1983	13-Feb-2012
Coffs Harbour	Direct'n Waverider	Offshore	14-Feb-2012	Present	14-Feb-2012	Present
Coffs Harbour Jetty	EWS	Inshore	05-Nov-1986	15-Jan-1996	05-Nov-1986	15-Jan-1996
Coffs Inner Harbour	EWS	Inshore	16-Jan-1996	08-Oct-2011	16-Jan-1996	08-Oct-2011
Crowdy Head	Waverider buoy	Offshore	10-Oct-1985	19-Aug-2011	10-Oct-1985	19-Aug-2011
Crowdy Head	Direct'n Waverider	Offshore	19-Aug-2011	Present	19-Aug-2011	Present
Crowdy Head Harbour	EWS	Inshore	07-Nov-1986	16-Jul-2012	07-Nov-1986	16-Jul-2012
Jimmys Beach	EWS	Inshore	16-Dec-1983	08-Dec-1985	16-Dec-1983	19-Sep-1985
Nelson Bay	EWS	Inshore	20-Jan-1981	18-Jun-1986	20-Jan-1981	18-Jun-1986
Nelson Bay West Point	EWS	Inshore	19-Jun-1986	20-Apr-1988	19-Jun-1986	20-Apr-1988
Swansea	EWS	Inshore	17-Dec-1987	12-Apr-1991	17-Dec-1987	11-Apr-1991
Wamberal Beach	Direct'n Waverider	Inshore	05-Aug-2011	16-Mar-2012	05-Aug-2011	16-Mar-2012
Mackerel Beach	EWS	Inshore	17-Aug-1988	15-Oct-1989	17-Aug-1988	14-Oct-1989
Narrabeen Beach	Direct'n Waverider	Inshore	27-Jul-2011	14-Nov-2011	27-Jul-2011	14-Nov-2011
Long Reef	Waverider buoy	Inshore	27-Jul-2011	14-Nov-2011	27-Jul-2011	14-Nov-2011
Sydney	Waverider buoy	Offshore	17-Jul-1987	04-Oct-2000	17-Jul-1987	04-Oct-2000
Sydney Directional	Direct'n Waverider	Offshore	03-Mar-1992	Present	03-Mar-1992	Present
Melrose Park (Parramatta R)	EWS	River	24-Mar-1988	20-Jul-1988	24-Mar-1988	20-Jul-1988
Chiswick (Parramatta River)	EWS	River	28-Mar-1988	20-Jul-1988	28-Mar-1988	20-Jul-1988
Port Hacking Seaward	EWS	Inshore	06-Sep-1983	Present	06-Sep-1983	Present
Deeban Spit	EWS	Inshore	15-Sep-1983	03-Oct-1986	15-Sep-1983	03-Oct-1986
Port Hacking Seaward MMcB	Marsh McBirney	Inshore	06-Sep-1983	17-Nov-1986	06-Sep-1983	17-Sep-1986
Deeban Spit MMcB	Marsh McBirney	Inshore	06-Sep-1983	28-May-1985	06-Sep-1983	27-May-1985
Burraneer Point MMcB	Marsh McBirney	Inshore	06-Sep-1983	16-Dec-1985	06-Sep-1983	04-Sep-1985
Port Kembla	Waverider buoy	Offshore	07-Feb-1974	14-May-2012	31-Jul-1983	14-May-2012
Port Kembla	Direct'n Waverider	Offshore	20-Jun-2012	Present	20-Jun-2012	Present

Wave Data Site	Instrument	Site Category	Available Analysed Data		Available Raw Data	
			First Data	Last Date	First Date	Last Date
Jervis Bay North	EWS	Inshore	11-Nov-1981	03-Jul-1989	27-Dec-1982	03-Jul-1989
Jervis Bay South	EWS	Inshore	01-Sep-1981	18-Oct-1983	04-Jan-1983	18-Oct-1983
Batemans Bay	Waverider buoy	Offshore	27-May-1986	23-Feb-2001	27-May-1986	23-Feb-2001
Batemans Bay	Direct'n Waverider	Offshore	23-Feb-2001	Present	23-Feb-2001	Present
Batemans Bay Inshore	EWS	Inshore	26-Feb-1987	08-Dec-1990	26-Feb-1987	08-Dec-1990
Eden	Waverider buoy	Offshore	08-Feb-1978	16-Dec-2011	26-Jul-1983	16-Dec-2011
Eden	Direct'n Waverider	Offshore	16-Dec-2011	Present	16-Dec-2011	Present
Eden Inshore	Waverider buoy	Inshore	24-Nov-1984	11-May-1987	24-Nov-1984	11-May-1987
Eden Harbour	EWS	Inshore	24-Nov-1984	13-Nov-2012	24-Nov-1984	13-Nov-2012

8. Air Pressure Program Summary 2012-2013

8.1 Data Capture

Since the introduction of the Vaisala PTB200 digital barometers during 1999-2000, data recovery from the New South Wales coastal barometer network has been excellent. As shown in Table 8.1, during the 2012–2013 year all eight stations achieved 100 percent data recovery.

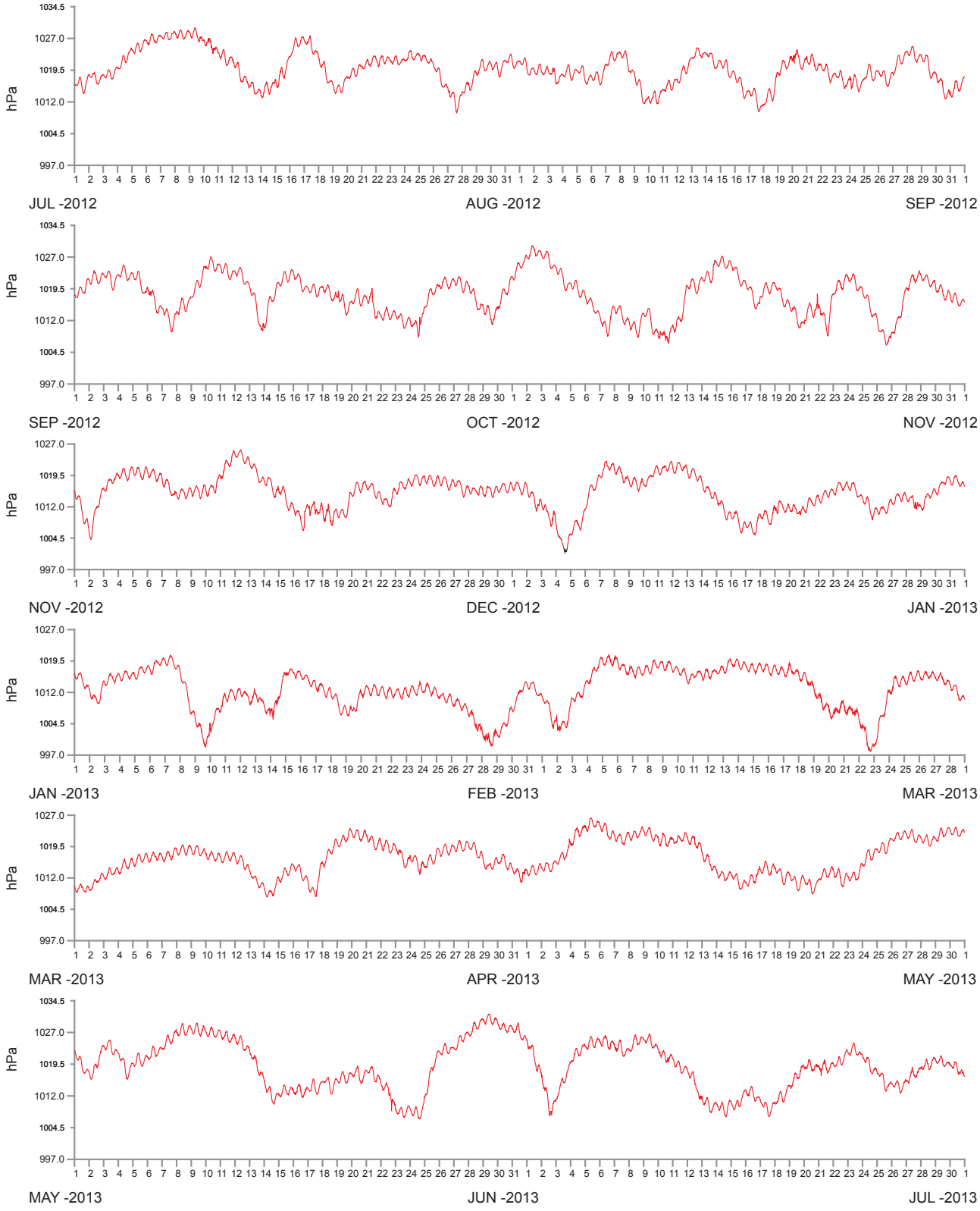
Table 8.1 New South Wales Air Pressure: 2012-2013 Data Capture

Waverider Site	Data Capture (%)												Total Year
	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	
Tweed Heads	100	100	100	100	100	100	100	100	100	100	100	100	100
Yamba	100	100	100	100	100	100	100	100	100	100	100	100	100
Port Macquarie	100	100	100	100	100	100	100	100	100	100	100	100	100
Newcastle	100	100	100	100	100	100	100	100	100	100	100	100	100
Sydney	100	100	100	100	100	100	100	100	100	100	100	100	100
Jervis Bay	100	100	100	100	100	100	100	100	100	100	100	100	100
Tuross Heads	100	100	100	100	100	100	100	100	100	100	100	100	100
Eden	100	100	100	100	100	100	100	100	100	100	100	100	100
Total Months	100	100	100	100	100	100	100	100	100	100	100	100	100

8.2 Internet Access

Air pressure data is telemetered to the Laboratory from the eight barometric stations at 0600 and 1700 hours each day. Access to a three-day time history plot of air pressure is available via the near-real time data link in the Manly Hydraulics Laboratory home page.

Plots of air pressure over the last four days can be accessed at
http://mhl.nsw.gov.au/data/realtime/barometric/



BAROMETRIC PRESSURE REFERENCED TO MEAN SEA LEVEL

DATALOSS

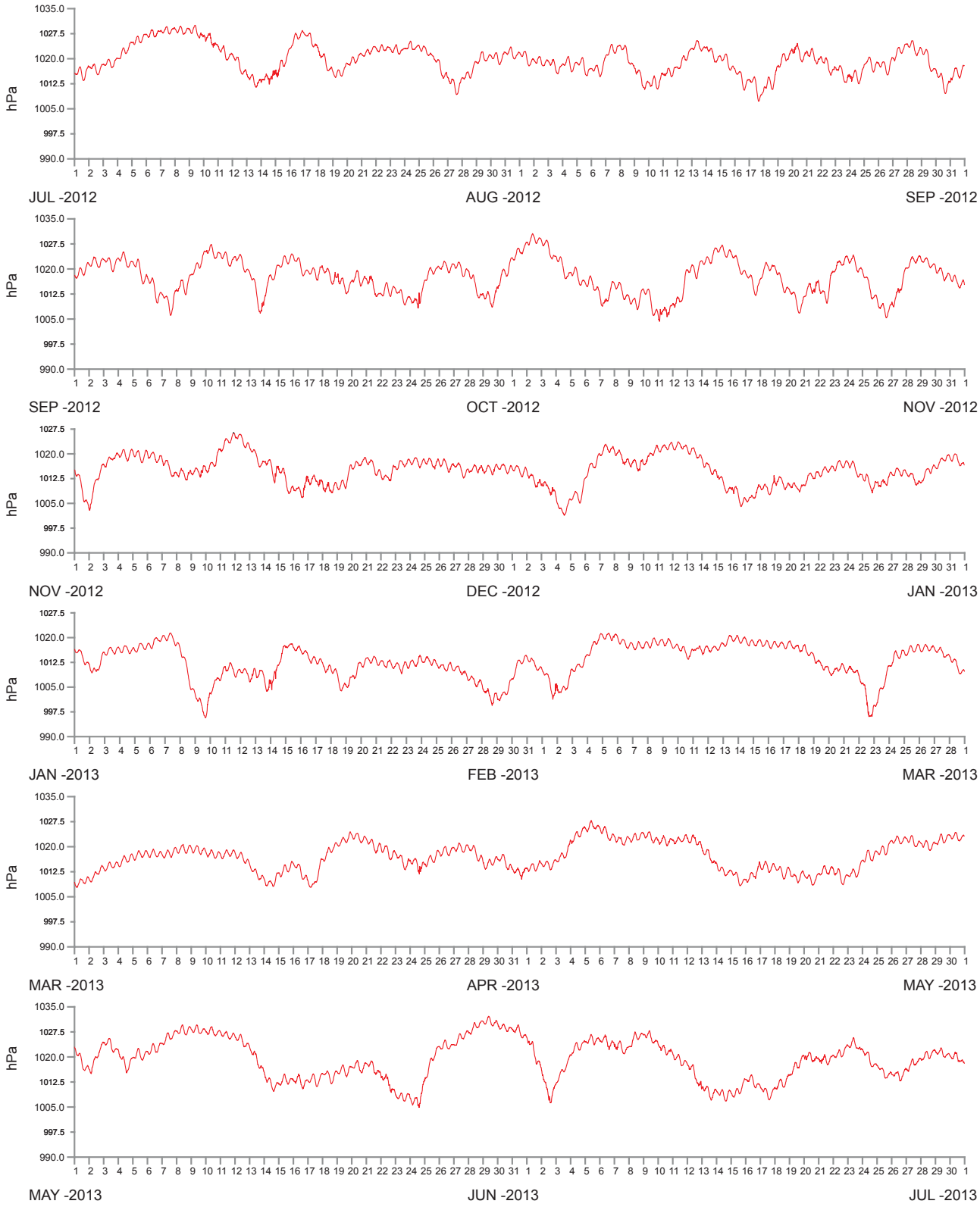
Public Works
Manly Hydraulics Laboratory

TWEED HEADS BAROMETER
2012-2013 AIR PRESSURE

MHL Report 2221

Figure 8.1

DRAWING 2221-08-01.cdr



BAROMETRIC PRESSURE REFERENCED TO MEAN SEA LEVEL

DATALOSS

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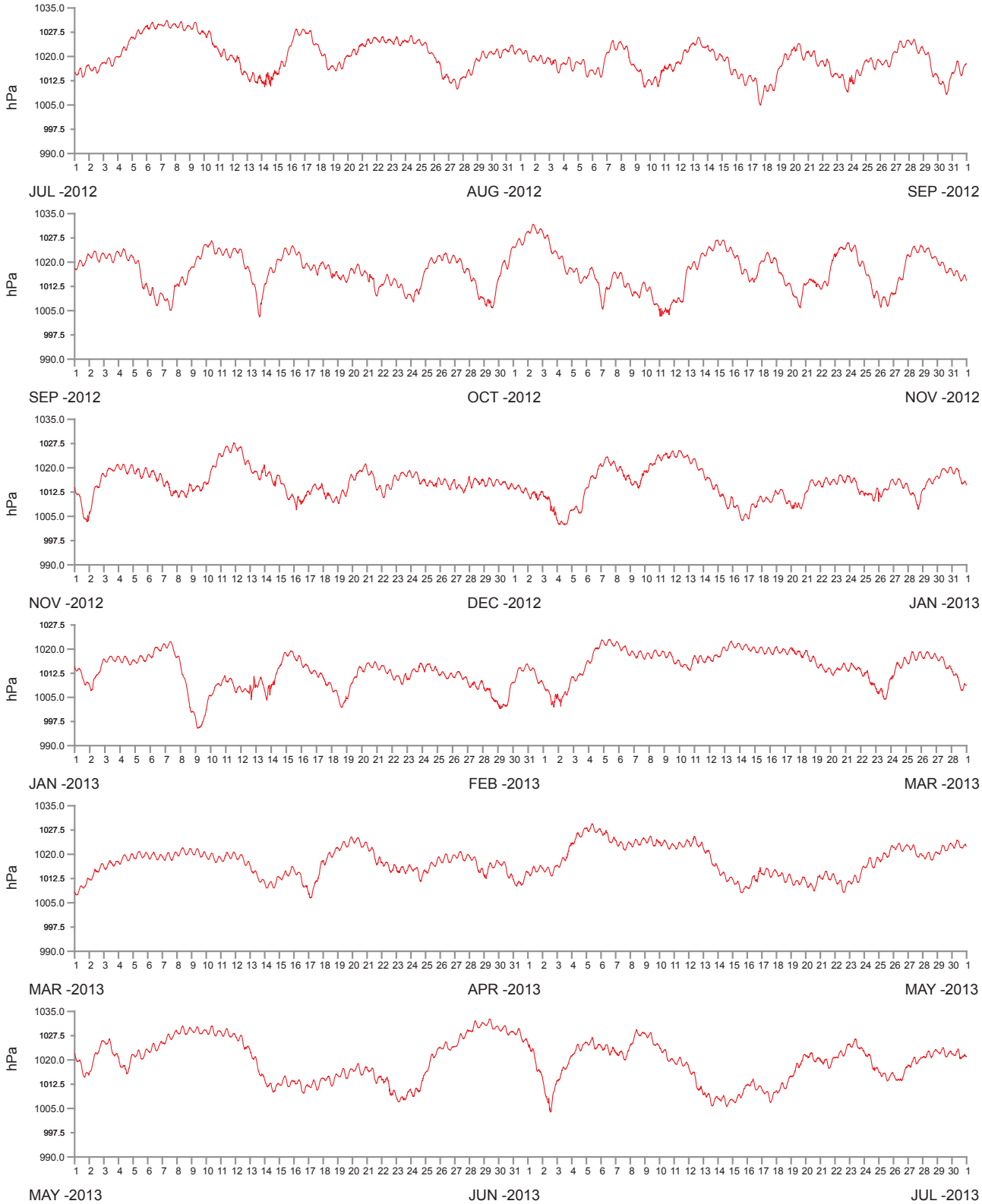
Manly Hydraulics Laboratory

YAMBA BAROMETER
2012-2013 AIR PRESSURE

MHL Report 2221

Figure 8.2

DRAWING 2221-08-02.cdr



BAROMETRIC PRESSURE REFERENCED TO MEAN SEA LEVEL

DATALOSS

Public Works
Manly Hydraulics Laboratory

PORT MACQUARIE BAROMETER
2012-2013 AIR PRESSURE

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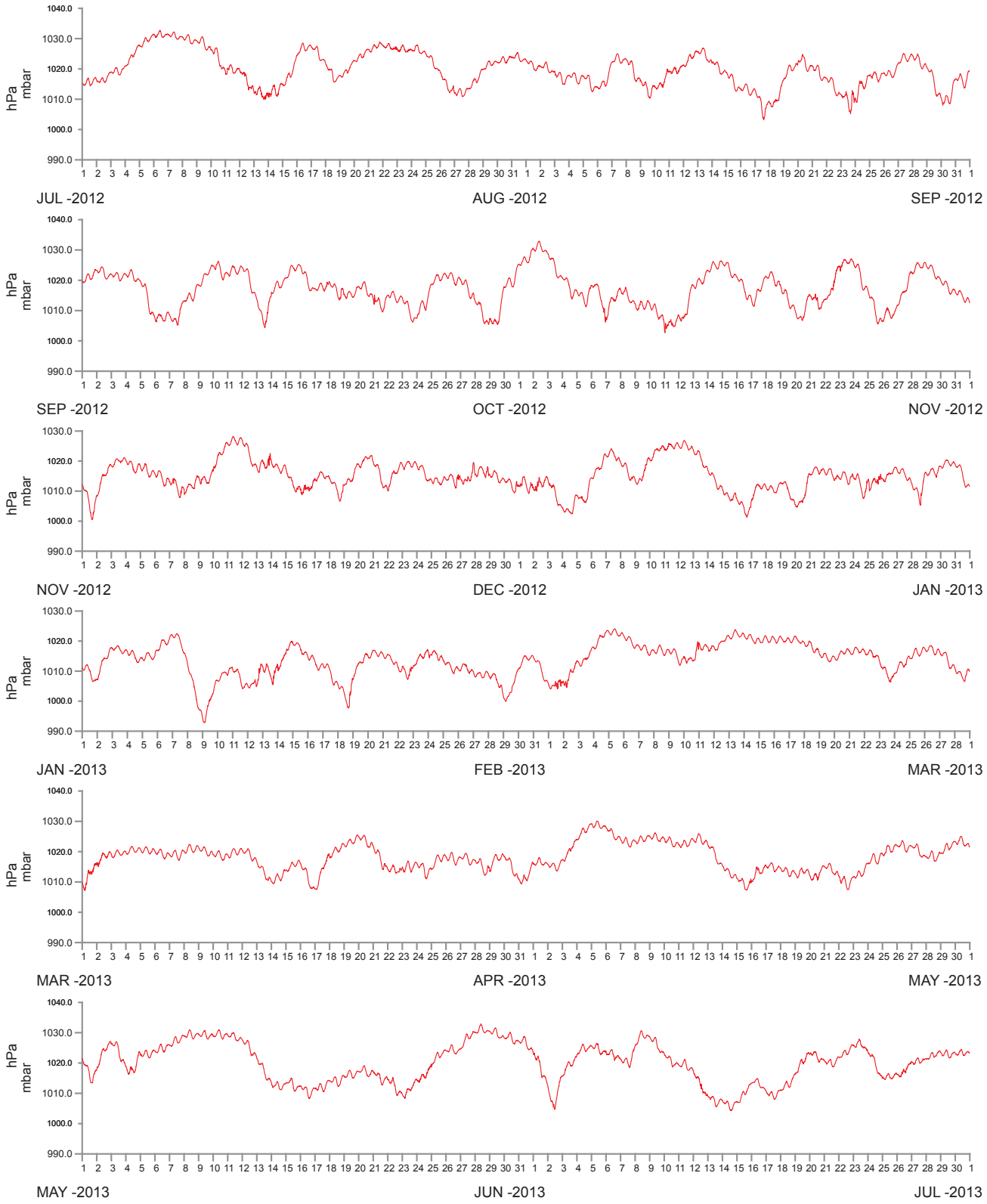
Figure 8.3

DRAWING 2221-08-03.cdr



BAROMETRIC PRESSURE REFERENCED TO MEAN SEA LEVEL

DATALOSS

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NEWCASTLE BAROMETER
2012-2013 AIR PRESSURE

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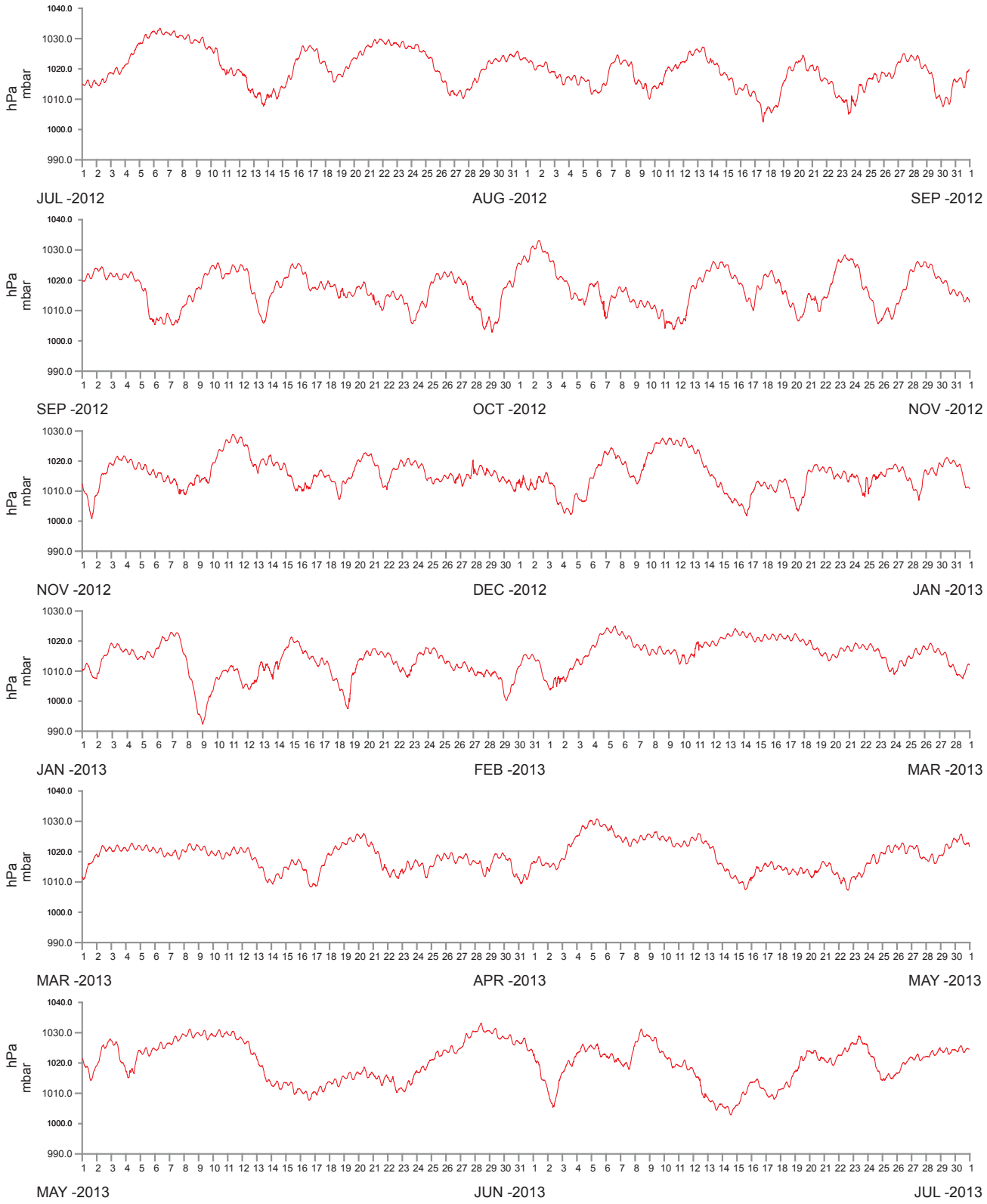
Figure 8.4

DRAWING 2221-08-04.cdr



BAROMETRIC PRESSURE REFERENCED TO MEAN SEA LEVEL

DATALOSS

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SYDNEY BAROMETER
2012-2013 AIR PRESSURE

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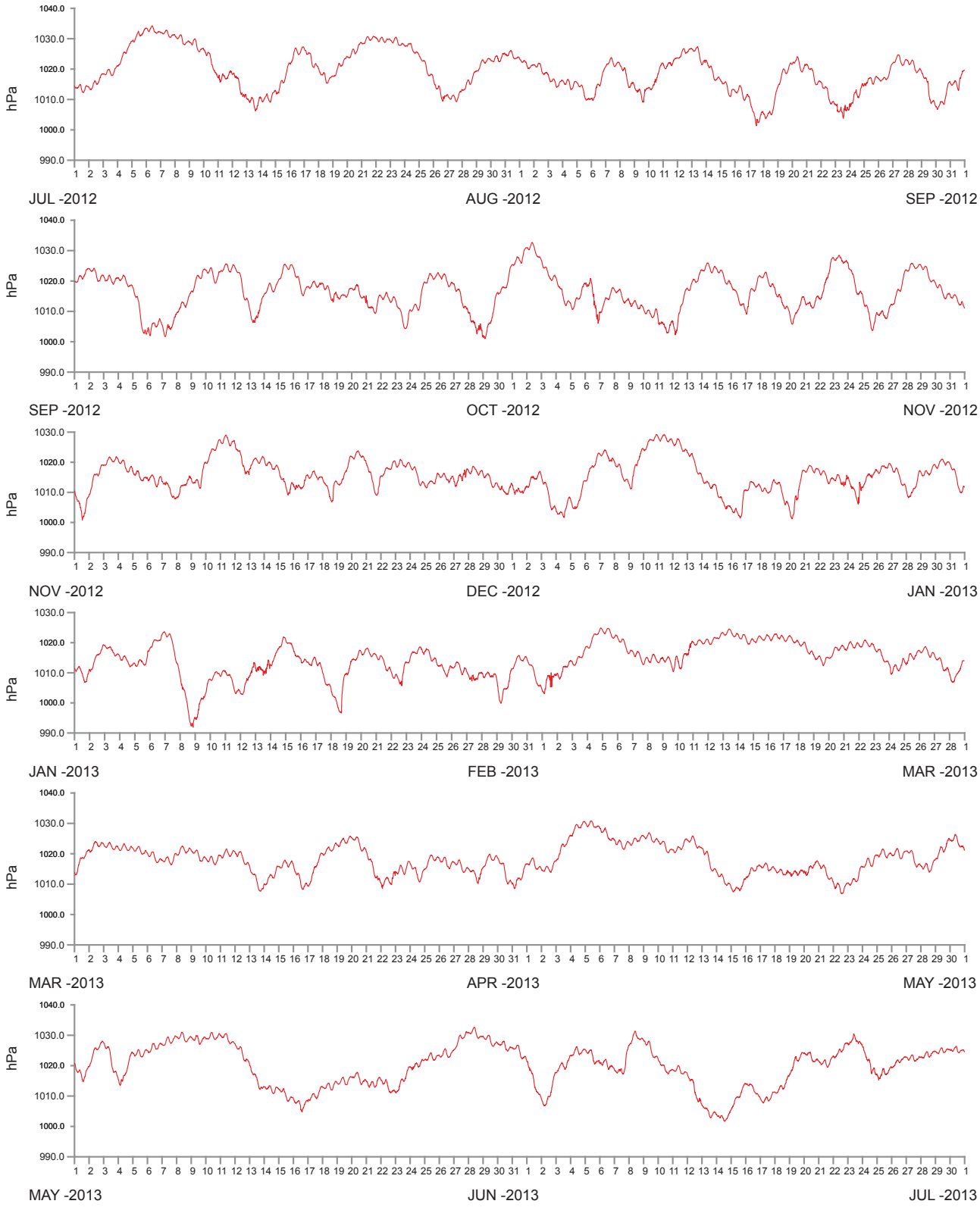
Figure 8.5

DRAWING 2221-08-05.cdr



BAROMETRIC PRESSURE REFERENCED TO MEAN SEA LEVEL

DATALOSS

NSW GOVERNMENT
Public Works
Manly Hydraulics Laboratory

JERVIS BAY BAROMETER
2012-2013 AIR PRESSURE

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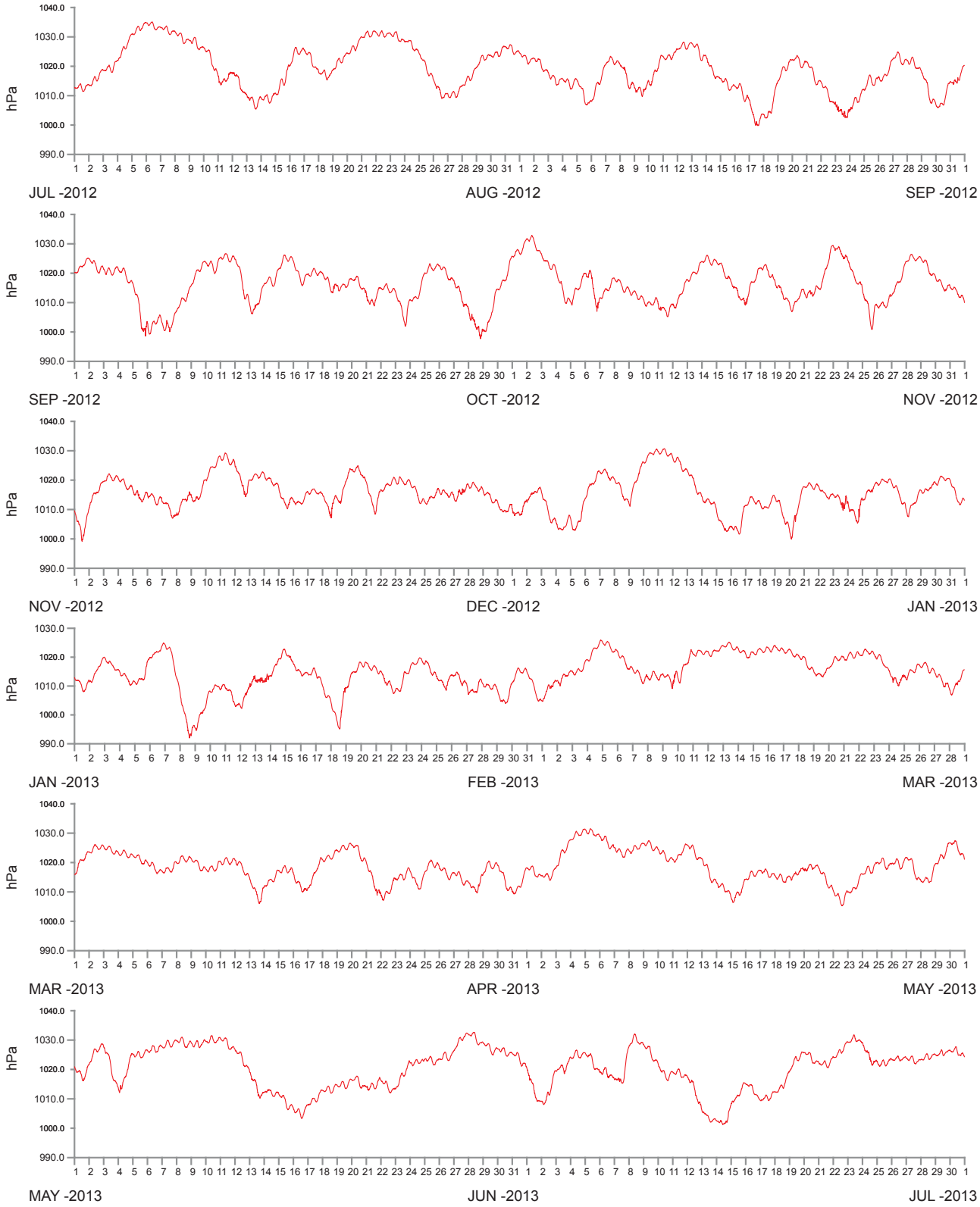
Figure 8.6

DRAWING 2221-08-06.cdr



BAROMETRIC PRESSURE REFERENCED TO MEAN SEA LEVEL

DATALOSS

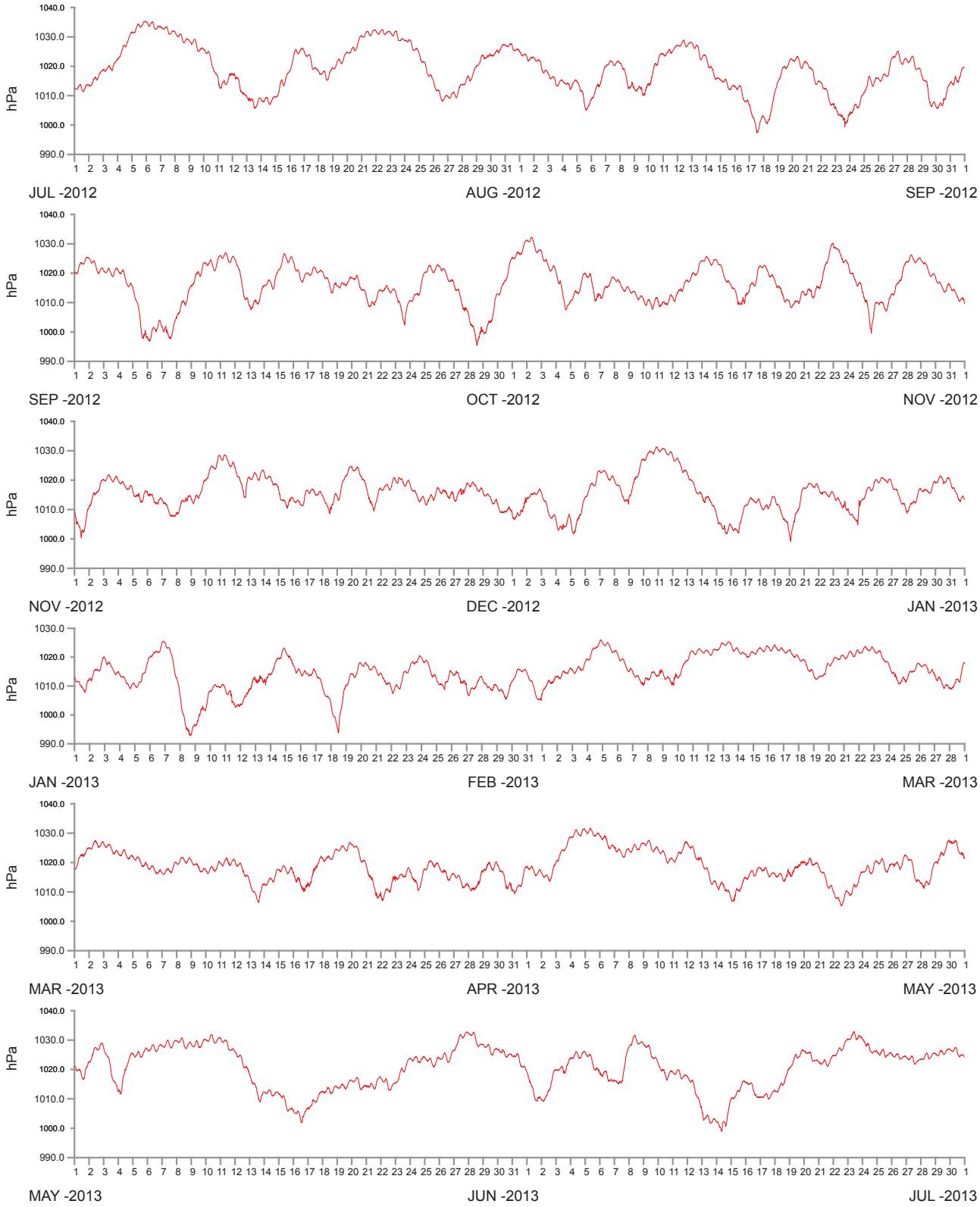
NSW GOVERNMENT
Public Works
Manly Hydraulics Laboratory

TUROSS HEADS BAROMETER
2012-2013 AIR PRESSURE

MHL Report 2221

Figure 8.7

DRAWING 2221-08-07.cdr



BAROMETRIC PRESSURE REFERENCED TO MEAN SEA LEVEL

DATALOSS

Public Works
Manly Hydraulics Laboratory

EDEN BAROMETER
2012-2013 AIR PRESSURE

MHL Report 2221

Figure 8.8

DRAWING 2221-08-08.cdr

9. Air Pressure Data Index

Since 1987 air pressure data has been collected at 15 locations along the New South Wales coast. Table 9.1 presents a summary of the barometer stations for which data has been quality controlled and referenced to mean sea level. Where possible, gaps in the barometer datasets have been patched using information recorded by nearby barometers operated by the Bureau of Meteorology.

Table 9.1 Air Pressure Data at Manly Hydraulics Laboratory – June 2013

Barometer Site	Instrument	GDA Location (Zone 56)		Barometer Height	Data Available		Record Length	Data Capture
		Easting	Northing	(m, MSL)	First Date	Last Date	(years)	(%)
Tweed Heads	MHL SPX100	554 010	6 884 210	20.0	06-Jun-1990	16-Dec-1994	4.53	100.0
Tweed Heads	Vaisala PTB 200	556 889	6 873 602	3.5	14-Oct-1999	Present	13.71	100.0
Byron Bay	MHL SPX100	562 040	6 831 590	100.0	22-Jul-1987	30-Sep-1999	12.19	100.0
Yamba (Palmers Is)	Vaisala PTB 200	529 490	6 739 613	3.7	24-Oct-1999	27-Sep-2009	9.93	100.0
Yamba	Vaisala PTB 200	530 459	6 739 060	3.2	27-Sep-2009	Present	3.76	100.0
Coffs Harbour	MHL SPX100	513 080	6 647 390	8.0	13-Jul-1987	30-Jun-1999	11.96	100.0
Port Macquarie	Vaisala PTB 200	490 494	6 525 126	3.0	15-Sep-1999	Present	13.79	100.0
Crowdy Head	MHL SPX100	476 344	6 477 095	4.0	24-Jul-1987	17-Jan-2000	12.49	100.0
Newcastle	Vaisala PTB 200	386 190	6 360 977	4.5	24-Feb-2000	Present	13.35	100.0
Sydney	Vaisala PTB 200	343 060	6 268 300	3.0	05-Aug-1999	Present	13.90	100.0
Sydney	MHL SPX100	338 590	6 260 600	25.0	08-May-1992	18-Oct-2000	8.45	100.0
Jervis Bay	Vaisala PTB 200	300 969	6 122 843	2.0	08-Feb-2000	Present	13.39	100.0
Tuross Heads	Vaisala PTB 200	240 879	6 005 121	3.5	22-Aug-2008	Present	4.86	100.0
Narooma	Vaisala PTB 200	242 095	5 988 377	2.3	09-Feb-2000	22-Aug-2008	8.53	99.7
Eden *	Vaisala PTB 200	759 050	5 873 050	2.6	10-Feb-2000	Present	13.38	99.4

* Location is relative to origin of Zone 55

Appendix A

Sample Data Presentation Formats

WAVE ANALYSIS STATISTICS

- all analysed data between nominated dates / times
- spectral peak period (T_{P1}) is included for convenience
- for explanation of statistics see Glossary

WAVE ANALYSIS STATISTICS

NSW Public Works
Manly Hydraulics Laboratory
110B King Street
MANLY VALE NSW 2093

SITE NAME : Coffs Harbour
SITE CODE : COFHOW
CATEGORY : Offshore
INSTRUMENT : Waverider Buoy

DATE	TIME (EST)	LEN (s)	WAVE HEIGHTS (m) H sig	H 10	H rms	H mean	H max	WAVE PERIODS (s) T z	T c	T sig	T P1
20-May-2001	00:00	2059	1.94	2.46	1.36	1.19	3.62	5.0	2.8	7.1	10.2
20-May-2001	01:00	2059	1.85	2.38	1.29	1.13	3.32	4.7	2.7	6.8	9.5
20-May-2001	02:00	2059	2.00	2.54	1.39	1.21	3.31	4.9	2.7	6.9	10.2
20-May-2001	03:00	2059	1.92	2.40	1.34	1.18	3.16	4.8	2.8	6.8	7.7
20-May-2001	04:00	2059	1.89	2.32	1.34	1.19	2.95	4.7	2.9	6.5	8.8
20-May-2001	05:00	2059	1.96	2.48	1.37	1.20	3.48	4.9	2.9	6.6	9.5
20-May-2001	06:00	2059	1.91	2.39	1.35	1.20	4.01	4.8	2.9	6.4	7.3
20-May-2001	07:00	2059	1.88	2.41	1.35	1.20	3.15	4.5	2.8	5.9	10.2
20-May-2001	08:00	2059	1.94	2.45	1.36	1.20	3.67	4.4	2.8	6.0	6.9
20-May-2001	09:00	2059	1.82	2.33	1.27	1.11	3.29	4.6	2.7	6.4	7.7
20-May-2001	10:00	2059	1.83	2.31	1.31	1.18	2.86	5.1	2.9	6.8	7.7
20-May-2001	11:00	2059	1.91	2.47	1.33	1.16	3.41	4.7	2.9	6.6	9.5
20-May-2001	12:00	2059	1.93	2.47	1.36	1.20	3.54	5.1	2.8	6.8	7.7
20-May-2001	13:00	2059	1.90	2.35	1.34	1.19	3.25	5.1	2.9	7.0	7.3
20-May-2001	14:00	2059	1.85	2.40	1.30	1.14	3.47	4.7	2.9	6.4	6.5
20-May-2001	15:00	2059	1.87	2.34	1.31	1.15	3.14	4.7	2.9	6.3	6.5
20-May-2001	16:00	2059	1.98	2.45	1.40	1.24	3.62	4.8	3.1	6.3	6.5
20-May-2001	17:00	2059	1.87	2.33	1.31	1.15	3.35	4.7	3.1	6.3	8.2
20-May-2001	18:00	2059	1.88	2.40	1.31	1.14	3.31	4.9	3.1	6.5	7.3
20-May-2001	19:00	2059	2.02	2.58	1.42	1.25	3.57	4.9	3.1	6.4	6.5
20-May-2001	20:00	2059	2.05	2.59	1.44	1.28	3.69	5.1	3.2	6.7	9.5
20-May-2001	21:00	2059	2.01	2.47	1.44	1.29	3.62	5.5	3.3	6.8	6.9
20-May-2001	22:00	2059	1.98	2.50	1.39	1.22	3.18	5.3	3.2	7.1	8.8
20-May-2001	23:00	2059	1.99	2.49	1.41	1.25	3.56	5.5	3.2	7.5	7.3
21-May-2001	00:00	2059	2.02	2.60	1.42	1.25	3.14	5.5	3.2	7.5	6.5

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SUMMARY WAVE STATISTICS

- all analysed data between nominated dates / times
- spectral peak period (T_{P1}) and wave power are included for convenience
- principal wave direction is included if available
- for explanation of statistics see Glossary

SUMMARY WAVE STATISTICS

NSW Public Works
Manly Hydraulics Laboratory
110B King Street
MANLY VALE NSW 2093

SITE NAME : Batemans Bay
SITE CODE : BATBOW
CATEGORY : Offshore
INSTRUMENT : Waverider Buoy

DATE	TIME (EST)	LEN (s)	HEIGHTS (m) H sig	H rms	H max	PERIODS (s) T z	T sig	T P1	WAVE POWER (kW/m)	WAVE DIRN (TN)
15-Jun-2001	00:00	2038	1.44	1.01	2.44	4.9	6.2	6.5	7.2	164
15-Jun-2001	01:00	2038	1.35	0.96	2.24	4.9	6.0	6.5	6.4	174
15-Jun-2001	02:00	2038	1.20	0.85	2.11	4.6	5.9	6.2	5.0	173
15-Jun-2001	03:00	2038	1.16	0.84	1.96	4.7	5.6	5.6	4.8	169
15-Jun-2001	04:00	2038	0.97	0.71	1.55	4.8	6.0	5.6	3.7	164
15-Jun-2001	05:00	2038	1.07	0.75	1.80	5.0	6.5	6.2	4.4	162
15-Jun-2001	06:00	2038	1.21	0.87	2.27	5.4	6.9	8.8	6.2	152
15-Jun-2001	07:00	2038	1.30	0.92	2.01	5.5	7.1	10.2	7.3	166
15-Jun-2001	08:00	2038	1.46	1.02	2.78	5.7	7.3	7.7	9.3	155
15-Jun-2001	09:00	2038	1.52	1.06	2.69	6.1	8.0	11.1	11.0	163
15-Jun-2001	10:00	2038	1.60	1.12	2.38	6.2	8.1	9.4	11.6	160
15-Jun-2001	11:00	2038	1.62	1.14	2.83	6.6	8.9	11.1	13.1	167
15-Jun-2001	12:00	2038	1.80	1.28	2.81	7.0	9.5	11.1	17.3	166
15-Jun-2001	13:00	2038	1.94	1.34	3.09	6.9	9.4	11.1	19.9	162
15-Jun-2001	14:00	2038	2.06	1.48	3.29	7.3	9.1	11.1	21.7	176
15-Jun-2001	15:00	2038	2.17	1.53	3.42	6.8	9.2	11.1	24.7	164
15-Jun-2001	16:00	2038	2.45	1.75	3.93	6.9	8.9	12.2	31.9	166
15-Jun-2001	17:00	2038	2.50	1.76	4.39	6.8	9.2	11.1	33.8	167
15-Jun-2001	18:00	2038	2.66	1.85	4.15	6.7	9.3	12.2	40.2	166
15-Jun-2001	19:00	2038	2.65	1.86	4.83	7.1	9.7	12.2	40.1	164
15-Jun-2001	20:00	2038	2.51	1.74	4.23	7.1	9.6	12.2	36.2	163
15-Jun-2001	21:00	2038	2.82	1.97	4.66	7.7	9.9	13.5	46.3	163
15-Jun-2001	22:00	2038	2.86	2.02	4.63	7.7	10.1	12.2	47.1	163
15-Jun-2001	23:00	2038	2.89	2.00	5.22	7.4	10.1	12.2	49.9	163
16-Jun-2001	00:00	2038	2.93	2.05	5.35	7.4	9.9	12.2	48.7	166

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SPECTRAL ANALYSIS SUMMARY

- all analysed data between nominated dates / times
- for explanation of statistics see Glossary

SPECTRAL ANALYSIS SUMMARY

NSW Public Works
Manly Hydraulics Laboratory
110B King Street
MANLY VALE NSW 2093

SITE NAME : Port Kembla
SITE CODE : PTKMOW
CATEGORY : Offshore
INSTRUMENT : Waverider Buoy

DATE	TIME (EST)	LEN (s)	H MO (m)	Y rms (m)	T P1 (s)	T P2 (s)	P2 -- P1	SPECTRAL MOMENTS MO	M1 x10	M2 x100	M3 x1000
10-Oct-2000	00:00	2059	1.73	0.43	11.1	6.5	0.78	0.187	0.270	0.471	1.058
10-Oct-2000	01:00	2059	1.66	0.41	6.9	12.2	0.85	0.172	0.252	0.447	1.019
10-Oct-2000	02:00	2059	1.72	0.43	7.3	11.1	0.68	0.184	0.276	0.532	1.433
10-Oct-2000	03:00	2059	1.81	0.45	7.7	11.1	0.47	0.204	0.325	0.692	2.059
10-Oct-2000	04:00	2059	1.71	0.43	7.7	6.5	0.39	0.183	0.278	0.545	1.490
10-Oct-2000	05:00	2059	1.75	0.44	8.8	7.3	0.85	0.192	0.300	0.613	1.719
10-Oct-2000	06:00	2059	1.71	0.43	8.2	12.2	0.74	0.182	0.290	0.618	1.818
10-Oct-2000	07:00	2059	1.65	0.41	7.7	8.8	0.89	0.170	0.266	0.563	1.668
10-Oct-2000	08:00	2059	1.59	0.40	8.2	12.2	0.49	0.158	0.245	0.519	1.552
10-Oct-2000	09:00	2059	1.53	0.38	8.2	9.5	0.71	0.147	0.232	0.498	1.476
10-Oct-2000	10:00	2059	1.49	0.37	8.8	12.2	0.74	0.138	0.217	0.464	1.373
10-Oct-2000	11:00	2059	1.48	0.37	13.5	8.2	0.46	0.137	0.199	0.400	1.160
10-Oct-2000	12:00	2059	1.54	0.38	12.2	8.2	0.64	0.149	0.216	0.410	1.078
10-Oct-2000	13:00	2059	1.60	0.40	12.2	8.2	0.46	0.160	0.218	0.377	0.883
10-Oct-2000	14:00	2059	1.61	0.40	12.2	6.9	0.72	0.162	0.230	0.415	1.047
10-Oct-2000	15:00	2059	1.54	0.38	8.2	12.2	0.88	0.147	0.209	0.374	0.968
10-Oct-2000	16:00	2059	1.55	0.39	12.2	7.7	0.89	0.150	0.215	0.402	1.130
10-Oct-2000	17:00	2059	1.49	0.37	12.2	7.7	0.86	0.139	0.239	0.567	1.870
10-Oct-2000	18:00	2059	1.54	0.38	8.2	6.9	0.92	0.149	0.251	0.581	1.863
10-Oct-2000	19:00	2059	1.39	0.35	7.7	12.2	0.70	0.122	0.211	0.517	1.756
10-Oct-2000	20:00	2059	1.41	0.35	12.2	7.7	0.98	0.124	0.216	0.533	1.830
10-Oct-2000	21:00	2059	1.43	0.36	7.7	13.5	0.91	0.129	0.237	0.604	2.022
10-Oct-2000	22:00	2059	1.95	0.49	5.9	4.8	0.99	0.238	0.469	1.097	3.106
10-Oct-2000	23:00	2059	2.05	0.51	5.9	5.2	0.50	0.263	0.503	1.128	3.097
11-Oct-2000	00:00	2059	2.02	0.50	6.2	5.6	0.45	0.256	0.472	1.046	2.938

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FULL WAVE ANALYSIS STATISTICS

- all analysed data between nominated dates
- water depth at the sensor is included
- for explanation of statistics see Glossary

FULL WAVE ANALYSIS STATISTICS

NSW Public Works
Manly Hydraulics Laboratory
110B King Street
MANLY VALE NSW 2093

SITE NAME : Sydney Directional
SITE CODE : SYDDOW
CATEGORY : Offshore
INSTRUMENT : Directional Waverider Buoy

DATE	TIME (EST)	LEN (S)	WATER DEPTH (m)	WAVE HEIGHTS (m) H sig	H mean	H rms	H 10	H max	WAVE PERIODS (s) T z	T c	T sig	T P1	SPECTRAL MOMENTS M0	M1 x10	M2 x100	M3 x1000	WAVE POWER (kW/m)	WAVE DIRN (TN)
10-May-2001	00:00	2038	85.0	3.13	1.97	2.21	3.75	4.73	6.6	4.9	8.4	9.4	0.691	0.968	1.608	3.338	43.7	152
10-May-2001	01:00	2038	85.0	3.37	2.17	2.42	4.11	5.82	7.3	5.1	8.7	9.4	0.803	1.067	1.677	3.352	52.6	143
10-May-2001	02:00	2038	85.0	3.00	1.94	2.16	3.69	4.67	7.3	4.9	8.6	10.2	0.621	0.830	1.332	2.776	40.9	145
10-May-2001	03:00	2038	85.0	3.05	1.97	2.19	3.84	4.59	7.2	4.9	8.6	9.4	0.645	0.872	1.410	2.920	42.1	146
10-May-2001	04:00	2038	85.0	3.12	1.91	2.17	3.82	5.40	6.9	4.7	8.8	9.4	0.681	0.920	1.501	3.156	44.6	149
10-May-2001	05:00	2038	85.0	2.93	1.79	2.04	3.62	4.17	6.9	4.4	8.9	9.4	0.599	0.815	1.356	2.930	39.6	149
10-May-2001	06:00	2038	85.0	3.02	1.94	2.16	3.74	5.13	7.3	5.1	8.9	9.4	0.628	0.827	1.303	2.655	41.9	126
10-May-2001	07:00	2038	85.0	2.89	1.84	2.05	3.50	4.22	7.1	4.7	8.7	9.4	0.575	0.786	1.316	2.893	37.6	132
10-May-2001	08:00	2038	85.0	3.01	1.96	2.17	3.63	4.43	7.1	4.6	8.8	8.8	0.627	0.847	1.388	2.955	41.3	131
10-May-2001	09:00	2038	85.0	2.65	1.66	1.88	3.32	4.51	6.8	4.4	8.5	9.4	0.493	0.684	1.159	2.555	31.6	153
10-May-2001	10:00	2038	85.0	2.82	1.81	2.02	3.56	5.02	6.5	4.5	8.2	8.8	0.591	0.860	1.525	3.481	36.4	122
10-May-2001	11:00	2038	85.0	2.78	1.71	1.94	3.52	4.28	6.5	4.3	8.3	10.2	0.538	0.793	1.442	3.382	33.1	146
10-May-2001	12:00	2038	85.0	3.30	2.14	2.37	3.95	5.49	7.5	4.9	9.1	10.2	0.758	1.002	1.591	3.282	50.3	133
10-May-2001	13:00	2038	85.0	2.90	1.82	2.05	3.59	4.38	6.9	4.7	8.5	9.4	0.592	0.815	1.341	2.815	38.0	150
10-May-2001	14:00	2038	85.0	2.96	1.86	2.09	3.66	4.85	6.7	4.8	8.5	8.8	0.603	0.852	1.446	3.127	38.0	131
10-May-2001	15:00	2038	85.0	3.03	1.91	2.14	3.85	5.13	6.6	4.6	8.2	9.4	0.655	0.920	1.537	3.223	41.3	155
10-May-2001	16:00	2038	85.0	3.01	1.85	2.10	3.77	4.43	6.6	4.7	8.2	9.4	0.634	0.887	1.489	3.184	40.1	132
10-May-2001	17:00	2038	85.0	2.71	1.68	1.91	3.46	4.98	6.5	4.5	8.1	8.8	0.530	0.749	1.274	2.757	33.5	145
10-May-2001	18:00	2038	85.0	2.66	1.70	1.90	3.27	4.37	6.6	4.7	8.3	10.2	0.511	0.725	1.245	2.739	32.3	143
10-May-2001	19:00	2038	85.0	2.59	1.63	1.84	3.24	4.54	6.4	4.6	8.2	8.8	0.483	0.691	1.193	2.619	30.1	122
10-May-2001	20:00	2038	85.0	2.82	1.78	2.00	3.57	5.09	6.4	4.8	8.1	8.8	0.578	0.865	1.533	3.364	34.4	149
10-May-2001	21:00	2038	85.0	2.81	1.73	1.97	3.45	5.08	6.2	4.7	7.9	8.8	0.563	0.829	1.447	3.128	33.7	149
10-May-2001	22:00	2038	85.0	3.16	2.01	2.24	3.94	5.46	6.5	5.0	8.0	9.4	0.701	1.014	1.702	3.464	42.2	159
10-May-2001	23:00	2038	85.0	2.88	1.80	2.03	3.65	4.43	6.2	4.8	7.7	8.8	0.585	0.868	1.490	3.125	34.4	139
11-May-2001	00:00	2038	85.0	3.09	2.01	2.23	3.79	5.04	6.6	4.9	7.8	9.4	0.680	0.993	1.682	3.468	40.5	156

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FULL SPECTRAL ANALYSIS

- full spectral analysis statistics for nominated record
- the spectral estimates are normalised by M_0 i.e., to obtain the true value in m^2/Hertz multiply by M_0
- spectral significant wave height (H_{M0}) is included for convenience
- for explanation of statistics see Glossary

FULL SPECTRAL ANALYSIS

NSW Public Works Manly Hydraulics Laboratory 110B King Street MANLY VALE NSW 2093	SITE NAME : Crowdy Head SITE CODE : CRHDOW CATEGORY : Offshore INSTRUMENT : Waverider Buoy	
DATE : 09-Aug-2000 TIME (EST): 00:00 NPTS : 4118 HMO (m) : 1.75	Yrms (m) : 0.44 TP1 (s) : 6.20 TP2 (s) : 5.40 P2/P1 : 0.63	M0 : 0.19173 M1 : 0.03898 M2 : 0.00956 M3 : 0.00298

SPECTRAL ESTIMATES: E/M0

FREQ (Hz)	PERIOD (s)	SPECT EST	FREQ (Hz)	PERIOD (s)	SPECT EST	FREQ (Hz)	PERIOD (s)	SPECT EST
0.00366	273.07	0.0	0.17554	5.70	8.3	0.34741	2.88	0.7
0.01147	87.15	0.0	0.18335	5.45	8.8	0.35522	2.82	0.3
0.01929	51.85	0.0	0.19116	5.23	8.7	0.36304	2.75	0.4
0.02710	36.90	0.1	0.19897	5.03	3.6	0.37085	2.70	0.3
0.03491	28.64	0.0	0.20679	4.84	4.2	0.37866	2.64	0.3
0.04272	23.41	0.0	0.21460	4.66	5.5	0.38647	2.59	0.4
0.05054	19.79	0.1	0.22241	4.50	2.8	0.39429	2.54	0.5
0.05835	17.14	0.2	0.23022	4.34	2.2	0.40210	2.49	0.4
0.06616	15.11	0.9	0.23804	4.20	2.7	0.40991	2.44	0.3
0.07397	13.52	1.1	0.24585	4.07	1.9	0.41772	2.39	0.2
0.08179	12.23	0.8	0.25366	3.94	2.0	0.42554	2.35	0.4
0.08960	11.16	1.2	0.26147	3.82	2.1	0.43335	2.31	0.2
0.09741	10.27	2.4	0.26929	3.71	1.3	0.44116	2.27	0.2
0.10522	9.50	1.3	0.27710	3.61	1.5	0.44897	2.23	0.1
0.11304	8.85	0.7	0.28491	3.51	1.6	0.45679	2.19	0.2
0.12085	8.27	0.9	0.29272	3.42	1.2	0.46460	2.15	0.2
0.12866	7.77	2.0	0.30054	3.33	1.8	0.47241	2.12	0.2
0.13647	7.33	4.4	0.30835	3.24	0.9	0.48022	2.08	0.2
0.14429	6.93	5.6	0.31616	3.16	1.0	0.48804	2.05	0.2
0.15210	6.57	11.9	0.32397	3.09	0.5	0.49585	2.02	0.1
0.15991	6.25	13.8	0.33179	3.01	0.3			
0.16772	5.96	8.2	0.33960	2.94	0.5			

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FULL DIRECTIONAL SPECTRAL ANALYSIS

- full directional spectral analysis statistics recorded by Directional Waverider buoy for nominated record
- the spectral estimates are normalised, i.e., to obtain the true value in m^2/Hertz multiply by the Maximum Spectral Density
- spectral significant wave height (H_{M0}) is included for convenience
- wave directions for spectral frequencies are in degrees relative to True North
- for explanation of statistics see Glossary

FULL DIRECTIONAL SPECTRAL ANALYSIS

NSW Public Works
Manly Hydraulics Laboratory
110B King Street
MANLY VALE NSW 2093

SITE NAME : Byron Bay
SITE CODE : BYRBOW
CATEGORY : Offshore
INSTRUMENT : Waverider Buoy

DATE : 12-Dec-2000
TIME (EST) : 00:00
LEN (s) : 2038
HMO (m) : 1.03

TMEAN (s) : 5.41
Max Spectral Density (m**2/Hz) : 1.32
TP1 (s) : 9.40
TP2 (s) : 4.40

Z ACCEL (m/s**2) : -0.132
X ACCEL (m/s**2) : -0.0213
Y ACCEL (m/s**2) : -0.0700

DIRECTIONAL SPECTRAL ANALYSIS

FREQ (Hz)	PERIOD (s)	SPECT	DIRN (deg)	SPREAD (deg)	SKEWNESS	CURTOSIS	FREQ (Hz)	PERIOD (s)	SPECT	DIRN (deg)	SPREAD (deg)	SKEWNESS	CURTOSIS
0.025	40.00	0.001	349	71	0.26	1.62	0.270	3.70	0.064	34	40	-0.94	3.46
0.030	33.33	0.003	326	72	0.99	1.84	0.280	3.57	0.047	32	43	-1.09	3.30
0.035	28.57	0.001	357	77	0.72	1.27	0.290	3.45	0.034	21	50	-0.54	2.22
0.040	25.00	0.004	312	59	4.07	2.78	0.300	3.33	0.058	18	43	-0.48	2.58
0.045	22.22	0.003	308	66	1.27	2.14	0.310	3.23	0.033	17	47	0.00	2.05
0.050	20.00	0.003	306	69	1.72	2.01	0.320	3.12	0.044	22	39	-0.15	4.49
0.055	18.18	0.004	256	73	-0.72	1.55	0.330	3.03	0.035	32	39	-0.40	4.20
0.060	16.67	0.016	76	63	0.03	2.17	0.340	2.94	0.046	24	39	0.24	3.83
0.065	15.38	0.030	125	73	-0.16	1.96	0.350	2.86	0.025	28	43	-0.33	4.07
0.070	14.29	0.037	80	69	4.36	2.34	0.360	2.78	0.016	15	43	-0.67	3.51
0.075	13.33	0.072	198	59	0.00	1.61	0.370	2.70	0.015	21	46	0.55	3.24
0.080	12.50	0.165	145	57	-0.20	2.87	0.380	2.63	0.018	15	42	0.19	4.03
0.085	11.76	0.224	119	51	-0.81	3.76	0.390	2.56	0.016	14	43	0.05	3.37
0.090	11.11	0.592	135	49	-1.13	4.18	0.400	2.50	0.017	13	41	-0.88	4.00
0.095	10.53	0.571	135	60	-0.57	2.40	0.410	2.44	0.016	14	42	-0.07	4.09
0.100	10.00	1.000	149	54	-1.49	2.95	0.420	2.38	0.012	15	43	0.83	3.98
0.110	9.09	0.861	146	50	-1.23	3.72	0.430	2.33	0.017	3	47	0.10	3.36
0.120	8.33	0.568	125	49	-1.48	3.44	0.440	2.27	0.010	11	48	-1.30	3.89
0.130	7.69	0.211	124	56	-0.73	2.26	0.450	2.22	0.014	8	47	-0.75	3.37
0.140	7.14	0.169	129	53	-0.06	3.24	0.460	2.17	0.008	18	49	-0.38	3.21
0.150	6.67	0.077	132	58	1.01	2.79	0.470	2.13	0.009	8	50	-0.68	3.12
0.160	6.25	0.046	126	59	0.10	2.75	0.480	2.08	0.006	10	56	-0.30	2.79
0.170	5.88	0.052	94	52	-0.72	3.00	0.490	2.04	0.006	4	52	-0.28	3.06
0.180	5.56	0.033	83	45	-0.72	3.79	0.500	2.00	0.006	357	48	0.61	3.74
0.190	5.26	0.051	60	46	-1.36	3.42	0.510	1.96	0.005	350	54	-0.21	2.67
0.200	5.00	0.074	63	46	-1.21	3.20	0.520	1.92	0.005	1	56	-0.18	2.56
0.210	4.76	0.134	42	40	-0.72	3.86	0.530	1.89	0.006	354	47	0.25	2.74
0.220	4.55	0.131	36	39	-0.06	3.64	0.540	1.85	0.004	11	60	-0.59	2.22
0.230	4.35	0.089	42	41	-0.31	2.47	0.550	1.82	0.005	4	52	1.16	3.49
0.240	4.17	0.106	39	40	-0.34	2.79	0.560	1.79	0.007	354	59	-0.34	2.75
0.250	4.00	0.072	29	42	-0.07	2.42	0.570	1.75	0.005	8	52	-1.39	3.23
0.260	3.85	0.092	36	38	-0.89	3.80	0.580	1.72	0.003	360	58	-0.41	2.48

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MISCELLANEOUS STATISTICS

- all analysed data between nominated dates / times
- air pressure from closest station in NSW coastal barometer network is included
- data codes indicate availability, quality and source of wave, air pressure and sea surface temperature data
- data quality flag indicates if record has been quality controlled; ‘Q’ for quality controlled data or ‘U’ for unchecked data.
- for explanation of statistics see Glossary

MISCELLANEOUS STATISTICS

NSW Public Works
Manly Hydraulics Laboratory
110B King Street
MANLY VALE NSW 2093

SITE NAME : Batemans Bay
SITE CODE : BATBOW
CATEGORY : Offshore
INSTRUMENT : Waverider Buoy

DATE	TIME (EST)	LEN (s)	REC INT (h)	TINC (s)	ERR	H sig (m)	T P1 (s)	WAVE POWER (Kw/m)	WAVE DIRN (TN)	GROUP FACTOR	SEA TEMP (deg.C)	AIR PRESS (hPa)	DATA CODES W S P D R G B T	DATA QUAL
01-Jan-2010	00:00	3194	1	0.78	7	1.14	6.4	4.6	75	0.83	19.75	1010.7	1 1 1 1 1 1 1 1	Q
01-Jan-2010	01:00	3194	1	0.78	2	1.13	6.2	4.5	65	0.84	19.70	1010.1	1 1 1 1 1 1 1 1	Q
01-Jan-2010	02:00	3194	1	0.78	4	1.10	6.4	4.2	69	0.93	19.70	1009.9	1 1 1 1 1 1 1 1	Q
01-Jan-2010	03:00	3194	1	0.78	6	1.09	6.6	4.2	68	0.87	19.65	1009.3	1 1 1 1 1 1 1 1	Q
01-Jan-2010	04:00	3194	1	0.78	4	1.11	6.8	4.2	68	0.87	19.75	1009.5	1 1 1 1 1 1 1 1	Q
01-Jan-2010	05:00	3194	1	0.78	7	1.17	6.2	4.8	75	0.91	19.75	1009.5	1 1 1 1 1 1 1 1	Q
01-Jan-2010	06:00	3194	1	0.78	5	1.19	6.8	4.9	68	0.96	19.55	1009.8	1 1 1 1 1 1 1 1	Q
01-Jan-2010	07:00	3194	1	0.78	3	1.23	6.8	5.5	75	0.95	19.60	1010.3	1 1 1 1 1 1 1 1	Q
01-Jan-2010	08:00	3194	1	0.78	5	1.16	6.2	4.7	71	0.90	19.90	1009.2	1 1 1 1 1 1 1 1	Q
01-Jan-2010	09:00	3194	1	0.78	3	1.19	6.8	4.8	69	0.87	19.90	1008.5	1 1 1 1 1 1 1 1	Q
01-Jan-2010	10:00	3194	1	0.78	3	1.14	6.6	4.6	79	0.92	20.00	1007.7	1 1 1 1 1 1 1 1	Q
01-Jan-2010	11:00	3194	1	0.78	1	1.08	6.4	4.1	85	0.80	20.00	1007.3	1 1 1 1 1 1 1 1	Q
01-Jan-2010	12:00	3194	1	0.78	0	1.14	6.8	4.5	73	0.79	19.85	1007.2	1 1 1 1 1 1 1 1	Q
01-Jan-2010	13:00	3194	1	0.78	8	1.18	7.0	4.9	73	0.74	20.20	1007.2	1 1 1 1 1 1 1 1	Q
01-Jan-2010	14:00	3194	1	0.78	3	1.23	7.3	5.0	75	0.88	20.40	1007.7	1 1 1 1 1 1 1 1	Q
01-Jan-2010	15:00	3194	1	0.78	6	1.26	6.6	5.5	66	0.84	20.55	1008.2	1 1 1 1 1 1 1 1	Q
01-Jan-2010	16:00	3194	1	0.78	3	1.22	6.8	5.2	64	0.84	20.45	1007.8	1 1 1 1 1 1 1 1	Q
01-Jan-2010	17:00	3194	1	0.78	12	1.19	6.4	5.2	61	0.96	20.40	1008.8	1 1 1 1 1 1 1 1	Q
01-Jan-2010	18:00	3194	1	0.78	6	1.19	7.3	5.2	64	0.89	20.10	1009.5	1 1 1 1 1 1 1 1	Q
01-Jan-2010	19:00	3194	1	0.78	4	1.13	7.3	4.6	93	0.96	19.60	1009.8	1 1 1 1 1 1 1 1	Q
01-Jan-2010	20:00	3194	1	0.78	3	1.10	7.3	4.2	92	0.89	19.65	1009.8	1 1 1 1 1 1 1 1	Q
01-Jan-2010	21:00	3194	1	0.78	4	1.03	6.8	3.6	90	0.84	19.35	1009.9	1 1 1 1 1 1 1 1	Q
01-Jan-2010	22:00	3194	1	0.78	2	1.04	7.0	3.7	95	0.80	19.25	1009.8	1 1 1 1 1 1 1 1	Q
01-Jan-2010	23:00	3194	1	0.78	9	1.10	6.4	4.2	176	0.85	18.95	1009.2	1 1 1 1 1 1 1 1	Q
02-Jan-2010	00:00	3194	1	0.78	10	1.10	7.0	4.3	165	0.83	18.95	1008.5	1 1 1 1 1 1 1 1	Q

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DAILY SUMMARY

- time series wave statistics for multiple sites between nominated dates
- wave statistics can be selected (default = H_{sig}, H_{max}, T_{sig}, T_{P1} and wave direction)
- daily offshore, inshore or long wave summaries can be selected
- data flagged as either Quality Controlled or Unchecked
- gaps appear where no data available
- for explanation of statistics see Glossary

Manly Hydraulics Laboratory | N.S.W. Wave Climate - Daily Summary | QUALITY CONTROLLED

Eastern Standard Time ; Heights (m) ; Periods (sec) ; Dir (Deg TN) ; Power (kW/m) ; Sea temp (Deg C) ; Press (HPa)

Date: 01-Sep-2003

BYRON BAY

Time	0000	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300
Hsig	0.80	0.93	0.96	1.00	1.11	1.16	1.09	1.02	0.98		1.15	1.19	1.25	1.32	1.33	1.40	1.56	1.59	1.57	1.65	1.85		1.93	1.81
Tsig	6.60	6.30	6.20	5.80	5.70	6.10	5.80	5.80	5.80		7.20	7.60	8.40	9.00	8.30	8.60	8.20	8.50	7.30	7.50	7.60		8.10	8.00
TP1	13.5	12.2	13.5	13.5	4.40	13.5	13.5	13.5	12.2		12.2	11.2	11.1	11.1	8.20	10.2	11.1	9.40	8.80	6.90	8.20		9.40	8.80
WDIR	100	128	97	105	200	114	207	129	115		143	131	160	152	155	162	145	155	173	160	155		177	159

SYDNEY DIRECTIONAL

Time	0000	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300
Hsig	1.07	0.95	1.00	0.99	1.02	1.16	1.21	1.26	1.20	1.26	1.53	1.74	2.26	2.60	2.92	3.11	3.06	2.83	2.66	2.49	2.35	2.60	2.45	2.26
Tsig	8.70	6.80	7.50	7.20	6.80	6.70	7.50	6.70	6.40	6.80	6.60	6.90	7.20	7.70	8.00	8.20	7.90	7.70	7.60	7.30	7.60	7.60	7.60	7.60
TP1	12.2	15.0	13.5	13.5	13.5	12.2	13.5	5.90	5.90	6.90	7.30	7.70	7.30	7.70	8.80	8.80	8.80	8.20	8.80	8.20	8.20	8.80	8.20	8.80
WDIR	125	166	155	149	152	159	152	155	183	180	174	178	184	180	178	183	185	185	187	187	187	178	181	176

PORT HACKING SEAWARD

Time	0000	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300
Hsig	0.17	0.18	0.17	0.20	0.18	0.16	0.16	0.16	0.17	0.19	0.20	0.20	0.25	0.25	0.31	0.31	0.28	0.26	0.25	0.21	0.22	0.22	0.22	0.23
Tsig	10.4	10.5	10.0	11.2	10.9	11.1	9.30	9.70	9.80	9.30	9.20	9.60	10.6	10.6	10.7	10.4	9.70	9.10	9.50	8.60	8.80	8.20	7.60	9.00
TP1	15.1	12.2	13.5	13.5	13.5	13.5	13.5	13.5	13.5	12.2	8.20	12.2	12.2	12.2	12.2	11.1	11.1	9.50	11.1	8.80	11.1	11.1	12.2	12.2
WDIR																								

BATEMANS BAY

Time	0000	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300
Hsig	0.84		1.01	1.13	1.40	1.62	1.67	1.76	1.93	2.31	2.15	2.06	2.09	1.96	2.18	2.32	2.28	2.05	2.15	2.02	1.95	1.74	1.71	1.74
Tsig	8.50		6.80	6.70	6.70	7.10	7.20	7.20	7.60	7.90	7.80	7.50	7.20	7.00	7.50	7.80	7.80	7.60	8.10	8.00	7.80	7.90	7.90	7.40
TP1	9.40		13.5	8.20	8.20	7.30	7.70	7.70	8.20	8.80	8.20	8.20	8.20	7.70	8.20	8.80	8.80	7.70	8.80	8.20	8.20	8.80	8.20	8.20
WDIR	107		107	138	149	162	157	167	167	160	176	173	167	173	166	163	163	167	174	167	166	177	162	169

DAILY STATISTICS

- start/end date can be nominated
- number of data records used for statistical analysis and associated data capture rate are included
- daily average, standard deviation, maximum and minimum of nominated wave data parameter can be provided

  or

  up to eight wave data parameters can be selected for a nominated statistical operator
- for explanation of statistics see Glossary

DAILY SUMMARY WAVE STATISTICS

NSW Public Works
Manly Hydraulics Laboratory
110B King Street
MANLY VALE NSW 2093

Site Name : CROWDY HEAD
Site Code : CRHDOW

Nominated Start/Finish : 24-JUN-1996 to 06-JUL-1996
Data Start/Finish : 24-JUN-1996 to 06-JUL-1996

Filename : A9A.TXT

Creation date : 15-NOV-2011

WAVE STATISTIC : Hsig(m)

DATE	NO.RECORDS	%CAPTURE	AVERAGE	STD_DEV	MAXIMUM	MINIMUM
24-JUN-1996	24	100.0	1.42	0.39	2.25	0.98
25-JUN-1996	24	100.0	1.68	0.22	1.96	1.20
26-JUN-1996	24	100.0	0.87	0.20	1.32	0.60
27-JUN-1996	24	100.0	0.91	0.11	1.06	0.72
28-JUN-1996	24	100.0	1.22	0.13	1.62	1.03
29-JUN-1996	24	100.0	1.18	0.20	1.57	0.94
30-JUN-1996	24	100.0	1.22	0.13	1.48	0.98
01-JUL-1996	24	100.0	1.35	0.15	1.64	1.11
02-JUL-1996	24	100.0	1.35	0.24	1.85	1.06
03-JUL-1996	23	95.8	1.48	0.17	1.68	1.12
04-JUL-1996	24	100.0	1.16	0.21	1.56	0.88
05-JUL-1996	24	100.0	1.02	0.11	1.27	0.85
06-JUL-1996	24	100.0	1.23	0.10	1.41	1.02
ALL DATA	311	99.7	1.24	0.29	2.25	0.60

DAILY MAXIMUM WAVE STATISTICS

NSW Public Works
Manly Hydraulics Laboratory
110B King Street
MANLY VALE NSW 2093

Site Name : CROWDY HEAD
Site Code : CRHDOW

Nominated Start/Finish : 24-JUN-1996 to 06-JUL-1996
Data Start/Finish : 24-JUN-1996 to 06-JUL-1996

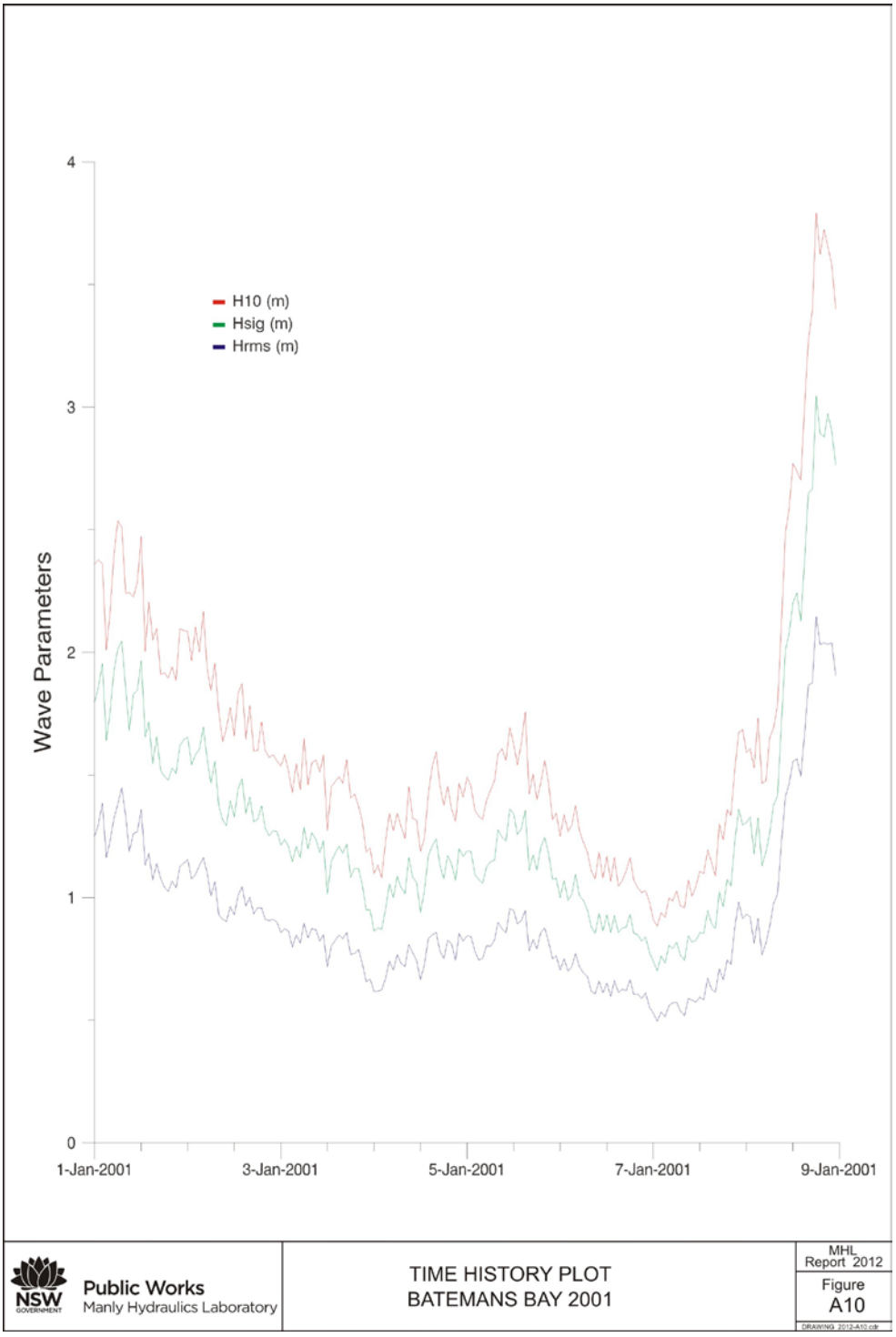
Filename : A9B.TXT

Creation date : 15-NOV-2011

DATE	Hrms (m)	Hsig (m)	H10 (m)	Tz (sec)	TP1 (sec)
24-JUN-1996	1.55	2.25	2.86	6.20	15.10
25-JUN-1996	1.38	1.96	2.58	8.10	11.10
26-JUN-1996	0.93	1.32	1.71	7.30	13.50
27-JUN-1996	0.78	1.06	1.31	4.10	12.20
28-JUN-1996	1.13	1.62	2.05	7.40	15.10
29-JUN-1996	1.09	1.57	2.00	7.20	13.50
30-JUN-1996	1.05	1.48	1.96	6.30	13.50
01-JUL-1996	1.15	1.64	2.15	6.80	11.10
02-JUL-1996	1.28	1.85	2.28	8.80	13.50
03-JUL-1996	1.17	1.68	2.19	6.40	12.20
04-JUL-1996	1.08	1.56	2.02	6.40	11.10
05-JUL-1996	0.88	1.27	1.64	6.90	12.20
06-JUL-1996	0.99	1.41	1.80	5.90	11.10
ALL DATA	1.55	2.25	2.86	8.80	15.10

TIME HISTORY PLOTS

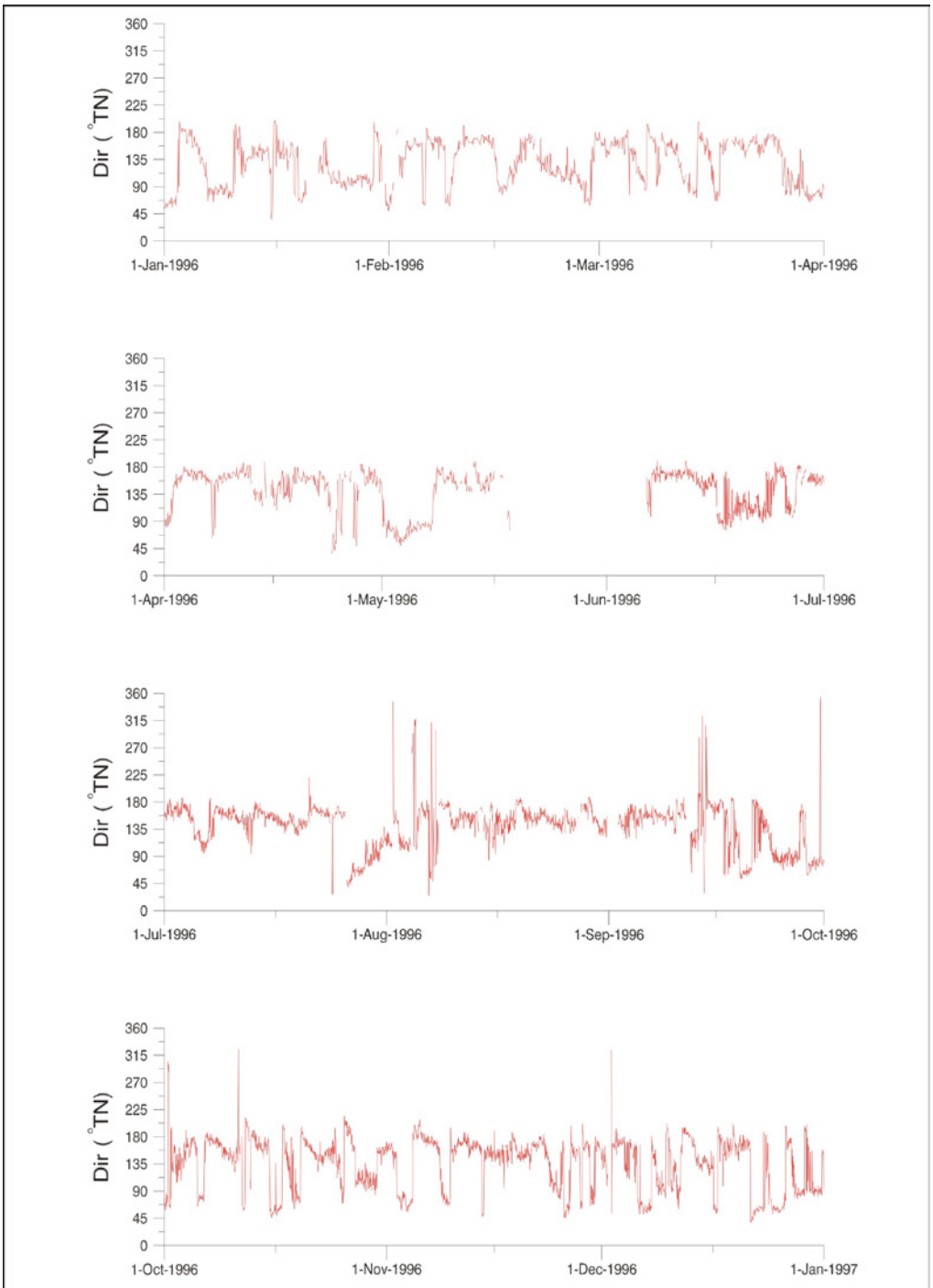
- statistics are plotted as a function of time
- start date can be any nominated date
- from one day to one year of data can be plotted
- see page A11 for example with one-year time scale
- gaps appear where no data available



TIME HISTORY PLOTS (Cont.)

One Year Time Scale

- statistics are plotted as a function of time
- start date can be any nominated date
- gaps appear where no data available



MONTHLY STATISTICS

- start/end date can be nominated
- number of data records used for statistical analysis and associated data capture rate are included
- monthly average, standard deviation, maximum and minimum of nominated wave data parameter can be provided

  or

  up to eight wave data parameters can be selected for a nominated statistical operator

- for explanation of statistics see Glossary

MONTHLY SUMMARY WAVE STATISTICS

NSW Public Works
Manly Hydraulics Laboratory
110B King Street
MANLY VALE NSW 2093

Site Name : EDEN
Site Code : EDENOW

Nominated Start/Finish : 01-FEB-1990 to 28-FEB-1991
Data Start/Finish : 01-FEB-1990 to 28-FEB-1991

Filename : A12A.TXT

Creation date : 15-NOV-2011

WAVE STATISTIC : Hsig(m)

MONTH	NO.RECORDS	%CAPTURE	AVERAGE	STD_DEV	MAXIMUM	MINIMUM
FEB-1990	489	72.8	1.79	0.80	5.46	0.77
MAR-1990	728	97.8	1.69	0.35	3.09	0.96
APR-1990	703	97.6	1.94	0.72	5.49	0.91
MAY-1990	744	100.0	1.78	0.75	4.83	0.60
JUN-1990	717	99.6	1.63	0.43	3.24	0.76
JUL-1990	733	98.5	1.51	0.49	3.15	0.66
AUG-1990	740	99.5	2.07	0.95	5.79	0.74
SEP-1990	713	99.0	1.57	0.47	3.65	0.73
OCT-1990	723	97.2	1.95	0.95	6.35	0.87
NOV-1990	720	100.0	1.62	0.60	3.87	0.58
DEC-1990	673	90.5	1.61	0.61	4.86	0.86
JAN-1991	716	96.2	1.58	0.37	2.77	0.76
FEB-1991	672	100.0	1.89	0.64	4.47	0.85
ALL DATA	9071	96.1	1.74	0.67	6.35	0.58

MONTHLY AVERAGE WAVE STATISTICS

NSW Public Works
Manly Hydraulics Laboratory
110B King Street
MANLY VALE NSW 2093

Site Name : EDEN
Site Code : EDENOW

Nominated Start/Finish : 01-FEB-1990 to 28-FEB-1991
Data Start/Finish : 01-FEB-1990 to 28-FEB-1991

Filename : A12B.TXT

Creation date : 15-NOV-2011

MONTH	Hrms (m)	Hsig (m)	Hmax (m)	Tz (sec)	Tsig (sec)
FEB-1990	1.24	1.79	3.11	5.46	7.68
MAR-1990	1.18	1.69	2.93	5.49	7.78
APR-1990	1.35	1.94	3.31	5.73	7.97
MAY-1990	1.24	1.78	3.06	5.91	8.34
JUN-1990	1.14	1.63	2.82	5.65	7.96
JUL-1990	1.06	1.51	2.59	5.73	7.95
AUG-1990	1.45	2.07	3.53	5.80	7.93
SEP-1990	1.10	1.57	2.71	5.37	7.50
OCT-1990	1.37	1.95	3.33	5.98	8.13
NOV-1990	1.14	1.62	2.80	5.19	7.05
DEC-1990	1.13	1.61	2.79	5.28	7.33
JAN-1991	1.11	1.58	2.71	5.16	7.00
FEB-1991	1.33	1.89	3.22	5.65	7.59
ALL DATA	1.22	1.74	2.99	5.58	7.71

EXCEEDANCE TABLES

- cumulative frequency distribution on any statistic for all data between nominated dates and divided into months
- total summary for all data is provided for comparison with monthly results
- record length between nominated dates and available data dates is included
- statistical grouping interval may be selected
- minimum threshold value for table can be nominated, e.g. minimum H_{sig} threshold displayed is 1.0 metre
- percentage data capture, number of data points used for statistical analysis and monthly average, maximum and minimum value are included
- record selection restrictions can be applied, e.g. only use records where H_{sig} > 3 metres, T_{P1} < 10 seconds, etc.

EXCEEDANCE STATISTICS

NSW Public Works
Manly Hydraulics Laboratory
110B King Street
MANLY VALE NSW 2093

Site Name : CROWDY HEAD
Site Code : CRHDOW

Nominated Start/Finish : 01-JAN-1987 to 31-DEC-1987, Record Length : 1.00 years
Data Start/Finish : 01-JAN-1987 to 31-DEC-1987, Record Length : 1.00 years

Filename : A13.TXT
Creation date : 15-NOV-2011

PERCENTAGE EXCEEDANCE FOR Hmean(m)

Hmean	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL	Hmean
0.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.000	0.00
0.25	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.000	0.25
0.50	93.59	96.26	99.65	100.00	96.70	96.88	96.48	98.78	96.22	97.09	96.80	95.08	96.929	0.50
0.75	56.70	72.60	78.16	85.52	86.39	68.69	68.45	84.59	68.31	75.99	57.72	67.21	72.439	0.75
1.00	23.65	26.16	39.34	58.49	44.99	31.00	32.01	47.03	41.86	52.91	25.45	38.80	38.625	1.00
1.25	10.68	6.05	15.08	28.36	25.93	11.53	9.80	26.49	21.37	36.24	13.07	18.99	18.896	1.25
1.50	2.28	1.07	5.37	8.86	14.33	0.62	6.89	13.11	12.06	20.34	6.95	4.51	8.180	1.50
1.75	0.00	0.00	1.21	5.61	6.30	0.00	2.76	1.76	5.81	8.10	3.89	0.68	3.058	1.75
2.00	0.00	0.00	0.52	3.10	3.01	0.00	0.15	0.54	2.91	3.52	3.34	0.00	1.455	2.00
2.25	0.00	0.00	0.35	2.07	0.29	0.00	0.00	0.00	1.74	1.22	2.92	0.00	0.733	2.25
2.50	0.00	0.00	0.00	0.30	0.00	0.00	0.00	0.00	1.16	0.31	2.09	0.00	0.336	2.50
2.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.00	1.53	0.00	0.162	2.75
3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.70	0.00	0.062	3.00
3.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.56	0.00	0.050	3.25
3.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.00	0.025	3.50
3.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.012	3.75
4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	4.00
Average :	0.84	0.88	0.98	1.11	1.07	0.90	0.92	1.06	1.00	1.11	0.91	0.93	0.98	
Maximum :	1.69	1.66	2.32	2.62	2.33	1.58	2.02	2.04	2.85	2.69	3.76	1.80	3.76	
Minimum :	0.35	0.41	0.49	0.55	0.31	0.40	0.44	0.45	0.40	0.41	0.38	0.39	0.31	
Number of data points used for statistical analysis:	702	562	577	677	698	642	653	740	688	654	719	732	8044	
Percent capture based on Data start/finish:	94.35	83.63	77.55	94.03	93.82	89.17	87.77	99.46	95.56	87.90	99.86	98.39	91.79	
Percent capture based on Nominated start/finish:	94.35	83.63	77.55	94.03	93.82	89.17	87.77	99.46	95.56	87.90	99.86	98.39	91.79	

OCCURRENCE TABLES

- percentage occurrence on any statistic for all data between nominated dates and divided into months
- total summary for all data is provided for comparison with monthly results
- record length between nominated dates and available data dates is included
- statistical grouping interval may be selected
- minimum threshold value for table can be nominated, e.g. minimum T_{P1} threshold displayed is 4 seconds
- percentage data capture, number of data points used for statistical analysis and monthly average, maximum and minimum value are included
- record selection restrictions can be applied, e.g. only use records where H_{sig} > 3 metres, T_{P1} < 10 seconds, etc.

OCCURRENCE STATISTICS

NSW Public Works
Manly Hydraulics Laboratory
110B King Street
MANLY VALE NSW 2093

Site Name : CROWDY HEAD
Site Code : CRHDOW

Nominated Start/Finish : 01-JAN-1987 to 31-DEC-1987, Record Length : 1.00 years
Data Start/Finish : 01-JAN-1987 to 31-DEC-1987, Record Length : 1.00 years

Filename : A14.TXT
Creation date : 15-NOV-2011

PERCENTAGE OCCURRENCE FOR TP1(sec)

TP1	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
0.00 - 0.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
1.00 - 1.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
2.00 - 2.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
3.00 - 3.99	0.00	0.18	0.17	0.30	0.14	0.00	0.00	0.14	0.29	0.15	0.70	0.41	0.211
4.00 - 4.99	0.85	3.02	0.69	1.62	0.29	0.31	0.15	0.81	1.74	0.76	3.06	2.60	1.330
5.00 - 5.99	5.27	6.76	1.39	1.18	2.58	1.40	1.23	1.89	2.91	3.06	12.66	7.38	4.040
6.00 - 6.99	15.24	12.10	3.64	2.22	2.87	6.54	4.75	3.92	1.74	4.43	7.23	12.57	6.440
7.00 - 7.99	12.68	15.66	12.65	5.91	6.59	11.99	6.74	11.08	2.91	3.21	5.42	9.29	8.541
8.00 - 8.99	14.81	23.84	18.72	11.52	23.78	24.45	10.72	23.78	4.80	21.41	14.05	12.70	16.907
9.00 - 9.99	10.26	15.30	10.92	17.13	21.06	7.94	12.25	18.38	6.69	18.65	14.33	9.97	13.613
10.00 - 10.99	9.83	12.10	11.79	19.94	19.34	8.26	16.39	11.89	11.92	17.13	16.69	13.52	14.122
11.00 - 11.99	13.11	7.12	8.32	21.27	9.46	13.55	21.90	6.76	21.51	10.24	12.80	15.03	13.513
12.00 - 12.99	13.53	2.31	10.23	10.34	9.60	12.77	14.85	4.86	24.13	10.40	5.29	10.38	10.778
13.00 - 13.99	4.27	0.00	15.77	7.09	2.01	8.10	9.49	7.84	16.42	7.95	5.01	6.15	7.471
14.00 - 14.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
15.00 - 15.99	0.14	0.18	4.85	1.48	2.29	4.52	1.53	6.62	4.07	2.60	2.78	0.00	2.598
16.00 - 16.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
17.00 - 17.99	0.00	1.42	0.87	0.00	0.00	0.16	0.00	2.03	0.87	0.00	0.00	0.00	0.435
Average :	9.23	8.56	10.32	10.19	9.71	9.98	10.42	9.99	11.15	9.98	9.16	9.25	9.83
Maximum :	15.10	17.10	17.10	15.10	15.10	17.10	15.10	17.10	17.10	15.10	15.10	13.50	17.10
Minimum :	4.30	3.60	3.40	3.70	3.90	4.60	4.80	3.50	3.70	3.90	3.60	3.70	3.40
Number of data points used for statistical analysis:	702	562	577	677	698	642	653	740	688	654	719	732	8044
Percent capture based on Data start/finish:	94.35	83.63	77.55	94.03	93.82	89.17	87.77	99.46	95.56	87.90	99.86	98.39	91.79
Percent capture based on Nominated start/finish:	94.35	83.63	77.55	94.03	93.82	89.17	87.77	99.46	95.56	87.90	99.86	98.39	91.79

WAVE DIRECTION OCCURRENCE TABLES

- percentage occurrence of 16 compass wave direction bands between nominated dates and divided into months
- total summary for all data is provided for comparison with monthly results
- record length between nominated dates and available data dates is included
- percentage data capture and average, maximum and minimum monthly wave direction are included
- record selection restrictions can be applied, e.g. only use records where H_{sig} > 3 metres, T_{P1} < 10 seconds, etc.

OCCURRENCE STATISTICS

NSW Public Works
Manly Hydraulics Laboratory
110B King Street
MANLY VALE NSW 2093

Site Name : BATEMANS BAY
Site Code : BATBOW

Nominated Start/Finish : 01-JAN-2007 to 31-DEC-2009, Record Length : 3.00 years
Data Start/Finish : 01-JAN-2007 to 31-DEC-2009, Record Length : 3.00 years

Filename : A15.TXT
Creation date : 15-NOV-2011

PERCENTAGE OCCURRENCE FOR WDIR(Deg TN)

DIRN	DEGREES	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
N	348.75 - 11.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
NNE	11.25 - 33.74	0.31	0.00	0.37	0.00	0.00	0.00	0.14	0.20	0.19	0.16	0.05	0.07	0.127
NE	33.75 - 56.24	9.66	0.81	4.66	1.01	1.72	0.29	1.27	3.05	4.91	2.30	3.42	6.18	3.140
ENE	56.25 - 78.74	28.24	9.92	13.88	2.35	4.78	7.31	3.39	5.24	14.28	10.01	17.63	15.51	10.773
E	78.75 - 101.24	15.67	14.39	12.06	24.41	10.51	10.68	6.54	8.54	14.18	8.24	15.26	8.37	12.148
ESE	101.25 - 123.74	7.86	14.80	13.37	24.28	20.93	18.95	13.41	13.68	11.51	12.04	14.32	16.75	15.069
SE	123.75 - 146.24	10.90	17.80	19.75	19.85	28.81	20.11	30.06	25.32	16.32	17.98	16.58	20.93	20.625
SSE	146.25 - 168.74	18.70	29.04	26.73	22.20	28.05	33.72	36.78	36.04	30.65	36.65	21.58	19.22	28.824
S	168.75 - 191.24	8.30	12.00	8.43	5.57	5.06	8.37	8.23	7.12	7.77	11.82	10.16	11.87	8.678
SSW	191.25 - 213.74	0.37	1.12	0.75	0.34	0.05	0.48	0.05	0.36	0.15	0.80	0.74	1.03	0.505
SW	213.75 - 236.24	0.00	0.10	0.00	0.00	0.00	0.10	0.00	0.05	0.00	0.00	0.00	0.07	0.026
WSW	236.25 - 258.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
W	258.75 - 281.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
WNW	281.25 - 303.74	0.00	0.00	0.00	0.00	0.05	0.00	0.05	0.15	0.05	0.00	0.05	0.00	0.031
NW	303.75 - 326.24	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.15	0.00	0.00	0.11	0.00	0.026
NNW	326.25 - 348.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.009
Average :		104.11	130.24	122.70	133.45	128.83	132.37	137.55	134.42	121.78	131.97	119.79	119.48	126.39
Maximum :		197.00	216.00	208.00	199.00	304.00	224.00	355.00	317.00	282.00	201.00	343.00	230.00	355.00
Minimum :		28.00	41.00	23.00	37.00	34.00	44.00	19.00	6.00	26.00	19.00	28.00	33.00	6.00
Number of data points used for statistical analysis:		1615	1966	2147	1491	2093	2079	2126	1967	2059	1869	1900	1457	22769
Percent capture based on Data start/finish:		72.36	96.42	96.19	69.03	93.77	96.25	95.25	88.13	95.32	83.74	87.96	65.28	86.64
Percent capture based on Nominated start/finish:		72.36	96.42	96.19	69.03	93.77	96.25	95.25	88.13	95.32	83.74	87.96	65.28	86.64

JOINT OCCURRENCE TABLES

One Site, Two Statistics

- joint distribution between two nominated statistics for one site for all data between nominated dates
- record length between nominated dates and available data dates is included
- statistical grouping interval for each statistic can be nominated, e.g. H_{sig} = 0.5 metres, T_{P1} = 2 seconds
- percentage data capture and number of data points used for statistical analysis are included
- record selection restrictions can be applied, e.g. only use records where H_{sig} > 3 metres, T_{P1} < 10 seconds, etc.

JOINT OCCURRENCE STATISTICS

NSW Public Works
Manly Hydraulics Laboratory
110B King Street
MANLY VALE NSW 2093

Site Name : COFFS HARBOUR
Site Code : COFHOW

Nominated Start/Finish : 01-JAN-1999 to 31-DEC-1999, Record Length : 1.00 years
Data Start/Finish : 01-JAN-1999 to 31-DEC-1999, Record Length : 1.00 years

Total Number of Records used for analysis : 8568
Recovery Rate Based on Nominated Start/Finish : 97.81 %
Recovery Rate Based on Data Start/Finish : 97.81 %

Filename : A16.TXT
Creation date : 15-NOV-2011

PERCENTAGE JOINT OCCURRENCE FOR Hsig AND TP1

TP1 (sec)	Hsig (m)														TOTAL
	0.00-0.49	0.50-0.99	1.00-1.49	1.50-1.99	2.00-2.49	2.50-2.99	3.00-3.49	3.50-3.99	4.00-4.49	4.50-4.99	5.00-5.49	5.50-5.99	6.00-6.49	6.50-6.99	(%)
0.00 - 1.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00 - 3.99	0.00	0.21	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33
4.00 - 5.99	0.00	1.33	2.61	0.79	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.76
6.00 - 7.99	0.00	2.81	5.32	3.92	1.58	0.35	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.02
8.00 - 9.99	0.00	4.96	12.50	10.36	5.60	2.59	0.65	0.13	0.02	0.00	0.00	0.00	0.00	0.00	36.82
10.00 - 11.99	0.00	3.19	8.93	8.88	4.51	2.17	1.14	0.43	0.16	0.04	0.00	0.00	0.02	0.00	29.47
12.00 - 13.99	0.00	1.17	3.14	2.99	1.86	1.12	0.88	0.97	0.32	0.32	0.09	0.05	0.02	0.01	12.92
14.00 - 15.99	0.00	0.09	0.47	0.21	0.23	0.13	0.09	0.12	0.12	0.08	0.06	0.00	0.00	0.00	1.60
16.00 - 17.99	0.00	0.01	0.01	0.02	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.07
18.00 - 19.99	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Total Percentage:	0.00	13.78	33.10	27.18	13.81	6.36	2.80	1.65	0.63	0.43	0.15	0.05	0.05	0.01	100.00

JOINT OCCURRENCE TABLES

Two Sites, One Statistic

- joint distribution for one statistic between two sites for all coincident data between nominated dates
- record length between nominated dates and available data dates is included
- statistical grouping interval for each site can be selected
- joint coincident data capture and number of data points used for statistical analysis are included
- record selection restrictions can be applied, e.g. only use records where H_{sig} > 3 metres, T_{P1} < 10 seconds, etc.

JOINT OCCURRENCE STATISTICS

NSW Public Works
Manly Hydraulics Laboratory
110B King Street
MANLY VALE NSW 2093

Site Name 1 : CROWDY HEAD Site Name 2 : SYDNEY DIRECTIONAL
Site Code 1 : CRHDOW Site Code 2 : SYDDOW

Nominated Start/Finish : 01-JAN-2002 to 31-DEC-2002, Record Length : 1.00 years
Data Start/Finish : 01-JAN-2002 to 31-DEC-2002, Record Length : 1.00 years

Total Number of Records used for analysis : 6691
Joint Recovery : 76.38

Filename : A17.TXT
Creation date : 15-NOV-2011

PERCENTAGE JOINT OCCURRENCE OF Hsig (m) FOR CRHDOW AND SYDDOW

SYDDOW Hsig (m)	CRHDOW Hsig (m) 0.00-0.49	0.50-0.99	1.00-1.49	1.50-1.99	2.00-2.49	2.50-2.99	3.00-3.49	3.50-3.99	4.00-4.49	4.50-4.99	5.00-5.49	5.50-5.99	6.00-6.49	TOTAL (%)
0.00 - 0.49	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10
0.50 - 0.99	0.00	7.97	7.35	0.72	0.18	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.26
1.00 - 1.49	0.00	4.48	20.28	8.50	1.39	0.25	0.03	0.00	0.00	0.00	0.00	0.00	0.00	34.94
1.50 - 1.99	0.00	0.78	8.16	11.64	4.81	0.55	0.12	0.00	0.00	0.00	0.00	0.00	0.00	26.06
2.00 - 2.49	0.00	0.15	3.20	4.21	3.27	1.42	0.49	0.18	0.03	0.00	0.00	0.00	0.00	12.96
2.50 - 2.99	0.00	0.04	0.64	1.60	1.51	0.90	0.43	0.10	0.10	0.00	0.00	0.00	0.00	5.34
3.00 - 3.49	0.00	0.03	0.10	0.25	0.24	0.57	0.43	0.18	0.15	0.01	0.00	0.00	0.00	1.97
3.50 - 3.99	0.00	0.00	0.01	0.06	0.10	0.16	0.21	0.16	0.15	0.03	0.01	0.00	0.00	0.91
4.00 - 4.49	0.00	0.00	0.00	0.00	0.07	0.01	0.00	0.31	0.06	0.00	0.03	0.00	0.00	0.49
4.50 - 4.99	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.18	0.03	0.00	0.01	0.03	0.01	0.30
5.00 - 5.49	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.15	0.00	0.04	0.09	0.01	0.01	0.33
5.50 - 5.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.03	0.03	0.10	0.03	0.00	0.25
6.00 - 6.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03	0.01	0.07
Total Percentage:	0.00	13.56	39.75	26.99	11.58	3.93	1.75	1.33	0.55	0.12	0.28	0.10	0.04	100.00

STORM HISTORY TABLES

Yearly Summary

- summary table available for offshore sites only
- table provides storm start and finish dates
- lists duration in hours of H_{sig} exceedance for 3 to 8 metre thresholds in 0.5 metre increments for every recorded storm
- includes peak H_{sig}, H_{max} and Wave Power, mean H_{sig}, T_{sig}, T_{P1} and Wave Power recorded during storm
- deepwater wave direction (measured, hindcast or observed) at storm peak (maximum recorded H_{sig}) is included
- asterisk indicates full duration of storm not recorded
- see pages A19 and A20 for example tables ranked by selected statistics
- for explanation of statistics see Glossary

File Name: BATBOW_STM.HIS
File Updated : 01-SEP-2010

NSW Public Works
Manly Hydraulics Laboratory
1108 King Street
MANLY VALE NSW 2093

N.S.W. WAVE CLIMATE - BATEMANS BAY STORM HISTORY

COMPUTER SITE NAME: BATBOW
INSTRUMENT: Waverider buoy
SITE COMMISSIONED: 27-MAY-1986
DATA CAPTURE: 89.6%

STORM START	STORM FINISH	DURATION (Hours) of Hsig (m) GREATER than: 3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	PEAK Hsig (m)	MEAN Hsig (m)	PEAK Hmax (m)	MEAN Tsig (s)	MEAN TP1 (s)	PEAK POWER (kW/m)	MEAN POWER (kW/m)	DEEPWATER+ DIRECTION (°T.N.)	
30-JUN-1986	01-JUL-1986	14	0	0	0	0	0	0	0	0	0	0	3.4	3.1	6.3	11.2	12.6	74.1	62.8	135	SE
10-JUL-1986	11-JUL-1986	19	2	0	0	0	0	0	0	0	0	0	3.7	3.3	6.6	10.4	11.6	84.1	61.6	157	SSE
25-JUL-1986	26-JUL-1986	17	4	1	0	0	0	0	0	0	0	0	4.2	3.4	6.9	10.7	12.4	104.2	71.1	180	S
05-AUG-1986	11-AUG-1986	100	80	71	53	15	3	0	0	0	0	0	5.6	4.4	11.2	10.1	11.7	180.9	110.3	90	E
15-AUG-1986	15-AUG-1986	3	0	0	0	0	0	0	0	0	0	0	3.4	3.3	5.9	7.3	7.5	47.8	44.3	45	NE
14-SEP-1986	15-SEP-1986	18	1	0	0	0	0	0	0	0	0	0	3.5	3.2	6.1	8.9	10.0	62.2	49.4	157	SSE
*18-NOV-1986	21-NOV-1986	60	55	52	42	22	9	1	0	0	0	0	6.0	4.8	10.3	10.5	11.7	221.1	139.0	180	S
*29-NOV-1986	30-NOV-1986	13	8	4	0	0	0	0	0	0	0	0	4.2	3.7	7.3	9.8	12.3	97.0	75.9	157	SSE
09-DEC-1986	09-DEC-1986	3	0	0	0	0	0	0	0	0	0	0	3.3	3.1	5.9	8.4	10.8	51.4	46.3	157	SSE
04-JAN-1987	05-JAN-1987	3	0	0	0	0	0	0	0	0	0	0	3.0	3.0	5.7	9.1	10.2	46.9	44.5	67	ENE
03-MAR-1987	03-MAR-1987	1	0	0	0	0	0	0	0	0	0	0	3.0	3.0	5.5	9.8	12.2	46.8	46.8	135	SE
08-APR-1987	09-APR-1987	2	0	0	0	0	0	0	0	0	0	0	3.0	3.0	5.1	7.5	9.2	40.7	37.2	157	SSE
03-MAY-1987	03-MAY-1987	2	0	0	0	0	0	0	0	0	0	0	3.1	3.1	5.9	9.8	10.2	47.3	47.1	90	E
18-MAY-1987	19-MAY-1987	28	9	1	0	0	0	0	0	0	0	0	4.0	3.4	7.4	10.4	11.5	87.2	64.3	180	S
19-AUG-1987	20-AUG-1987	16	2	0	0	0	0	0	0	0	0	0	3.6	3.3	6.5	8.1	8.0	59.3	51.6	90	E
01-SEP-1987	02-SEP-1987	28	11	5	1	0	0	0	0	0	0	0	4.7	3.5	7.1	11.3	12.5	151.2	78.2	157	SSE
30-SEP-1987	30-SEP-1987	3	1	0	0	0	0	0	0	0	0	0	3.5	3.3	6.3	7.7	8.1	50.0	44.8	180	S
21-OCT-1987	21-OCT-1987	2	0	0	0	0	0	0	0	0	0	0	3.2	3.2	5.5	7.4	8.0	42.0	38.4	157	SSE
24-NOV-1987	24-NOV-1987	5	1	0	0	0	0	0	0	0	0	0	3.7	3.3	6.2	8.9	10.0	61.3	51.2	180	S
02-DEC-1987	04-DEC-1987	35	4	0	0	0	0	0	0	0	0	0	3.8	3.3	6.4	9.8	11.3	81.4	56.9	180	S
19-DEC-1987	19-DEC-1987	1	0	0	0	0	0	0	0	0	0	0	3.0	3.0	4.9	7.2	7.3	33.7	33.7	112	ESE
21-DEC-1987	23-DEC-1987	5	0	0	0	0	0	0	0	0	0	0	3.3	3.1	7.0	7.7	10.0	52.0	44.7	157	SSE
17-JAN-1988	17-JAN-1988	2	0	0	0	0	0	0	0	0	0	0	3.1	3.1	6.4	5.7	7.8	61.5	51.6	180	S
31-JAN-1988	31-JAN-1988	4	0	0	0	0	0	0	0	0	0	0	3.3	3.2	5.7	7.8	8.5	45.9	42.0	180	S
08-FEB-1988	10-FEB-1988	29	20	14	1	0	0	0	0	0	0	0	4.5	3.8	7.9	9.6	11.3	114.5	79.5	157	SSE
14-FEB-1988	14-FEB-1988	5	0	0	0	0	0	0	0	0	0	0	3.3	3.1	5.9	7.7	8.7	43.9	39.4	157	SSE
19-FEB-1988	19-FEB-1988	3	0	0	0	0	0	0	0	0	0	0	3.2	3.1	5.0	7.9	8.7	40.5	39.7	112	ESE
07-MAR-1988	08-MAR-1988	22	4	0	0	0	0	0	0	0	0	0	3.7	3.3	6.7	12.9	15.4	111.4	86.8	90	E
14-MAR-1988	14-MAR-1988	1	0	0	0	0	0	0	0	0	0	0	3.0	3.0	5.4	7.4	7.7	36.9	36.9	157	SSE
08-APR-1988	10-APR-1988	43	29	17	1	0	0	0	0	0	0	0	4.5	3.8	8.5	9.2	11.4	106.5	74.5	180	S
16-APR-1988	16-APR-1988	5	0	0	0	0	0	0	0	0	0	0	3.4	3.2	6.0	7.6	8.2	46.4	42.1	157	SSE
28-APR-1988	02-MAY-1988	69	48	18	0	0	0	0	0	0	0	0	4.4	3.7	8.1	9.5	11.4	206.9	79.2	90	E
24-MAY-1988	26-MAY-1988	29	17	8	1	0	0	0	0	0	0	0	4.5	3.6	8.3	9.8	11.4	106.5	71.7	157	SSE
16-JUN-1988	18-JUN-1988	4	0	0	0	0	0	0	0	0	0	0	3.1	3.1	5.7	10.9	12.3	61.6	56.5	112	ESE
06-JUL-1988	07-JUL-1988	23	16	8	3	0	0	0	0	0	0	0	4.8	3.8	8.5	9.0	10.2	123.9	73.1	90	E
08-AUG-1988	09-AUG-1988	37	12	2	0	0	0	0	0	0	0	0	4.2	3.4	7.2	9.4	11.3	86.5	61.8	157	SSE
16-SEP-1988	16-SEP-1988	5	0	0	0	0	0	0	0	0	0	0	3.3	3.1	6.0	8.4	10.1	49.0	45.0	67	ENE
05-NOV-1988	05-NOV-1988	2	1	0	0	0	0	0	0	0	0	0	3.5	3.4	6.2	6.6	8.5	46.4	44.5	157	SSE
16-NOV-1988	16-NOV-1988	4	0	0	0	0	0	0	0	0	0	0	3.3	3.2	6.2	7.1	8.0	43.6	40.4	135	SE
26-DEC-1988	27-DEC-1988	6	2	0	0	0	0	0	0	0	0	0	3.8	3.4	6.4	5.2	9.1	64.5	52.4	180	S
01-FEB-1989	01-FEB-1989	1	0	0	0	0	0	0	0	0	0	0	3.0	3.0	5.5	7.3	9.5	36.1	36.1	157	SSE
21-FEB-1989	21-FEB-1989	1	0	0	0	0	0	0	0	0	0	0	3.0	3.0	5.0	10.1	12.2	51.6	51.6	112	ESE

STORM HISTORY TABLES (Cont.)

Ranked by Height, Power or Duration

- see comments on page A18
- ranked table available for offshore sites only
- start and end dates can be nominated
- storms can be ranked by any wave height, wave power or storm duration parameter
- average value for storm events listed for each parameter is included

BATEMANS BAY STORM HISTORY: STORMS RANKED by PEAK_HSIG
Nominated start/finish : 01-JUN-1986 to 10-AUG-1988
Printing date: 15-NOV-2011
Page: 1

NSW Public Works
Manly Hydraulics Laboratory
110B King Street
MANLY VALE NSW 2093

STORM START DATE	STORM END DATE	> 3.0 (h)	> 3.5 (h)	> 4.0 (h)	> 4.5 (h)	> 5.0 (h)	> 5.5 (h)	> 6.0 (h)	> 6.5 (h)	> 7.0 (h)	> 7.5 (h)	> 8.0 (h)	PEAK Hsig (m)	MEAN Hsig (m)	PEAK Hmax (m)	MEAN Tsig (s)	MEAN TP1 (s)	PEAK POWER (kW/m)	MEAN POWER (kW/m)	(°) T.N	DIR
*18-NOV-1986	21-NOV-1986	60	55	52	42	22	9	1	0	0	0	0	6.0	4.8	10.3	10.5	11.7	221.1	139.0	180	S
05-AUG-1986	11-AUG-1986	100	80	71	53	15	3	0	0	0	0	0	5.6	4.4	11.2	10.1	11.7	180.9	110.3	90	E
06-JUL-1988	07-JUL-1988	23	16	8	3	0	0	0	0	0	0	0	4.8	3.8	8.5	9.0	10.2	123.9	73.0	90	E
01-SEP-1987	02-SEP-1987	28	11	5	1	0	0	0	0	0	0	0	4.7	3.5	7.1	11.3	12.5	151.2	78.2	157	SSE
08-APR-1988	10-APR-1988	43	29	17	1	0	0	0	0	0	0	0	4.5	3.8	8.5	9.2	11.4	106.5	74.0	180	S
08-FEB-1988	10-FEB-1988	29	20	14	1	0	0	0	0	0	0	0	4.5	3.8	7.9	9.6	11.3	114.5	79.0	157	SSE
24-MAY-1988	26-MAY-1988	29	17	8	1	0	0	0	0	0	0	0	4.5	3.6	8.3	9.8	11.4	106.5	71.0	157	SSE
28-APR-1988	02-MAY-1988	69	48	18	0	0	0	0	0	0	0	0	4.4	3.7	8.1	9.5	11.4	206.9	79.0	90	E
*29-NOV-1986	30-NOV-1986	13	8	4	0	0	0	0	0	0	0	0	4.2	3.7	7.3	9.8	12.3	97.0	75.9	157	SSE
08-AUG-1988	09-AUG-1988	37	12	2	0	0	0	0	0	0	0	0	4.2	3.4	7.2	9.4	11.3	86.5	61.0	157	SSE
25-JUL-1986	26-JUL-1986	17	4	1	0	0	0	0	0	0	0	0	4.2	3.4	6.9	10.7	12.4	104.2	71.1	180	S
18-MAY-1987	19-MAY-1987	28	9	1	0	0	0	0	0	0	0	0	4.0	3.4	7.4	10.4	11.5	87.2	64.3	180	S
02-DEC-1987	04-DEC-1987	35	4	0	0	0	0	0	0	0	0	0	3.8	3.3	6.4	9.8	11.3	81.4	56.9	180	S
07-MAR-1988	08-MAR-1988	22	4	0	0	0	0	0	0	0	0	0	3.7	3.3	6.7	12.9	15.4	111.4	86.0	90	E
10-JUL-1986	11-JUL-1986	19	2	0	0	0	0	0	0	0	0	0	3.7	3.3	6.6	10.4	11.6	84.1	61.6	157	SSE
24-NOV-1987	24-NOV-1987	5	1	0	0	0	0	0	0	0	0	0	3.7	3.3	6.2	8.9	10.0	61.3	51.2	180	S
19-AUG-1987	20-AUG-1987	16	2	0	0	0	0	0	0	0	0	0	3.6	3.3	6.5	8.1	8.0	59.3	51.6	90	E
30-SEP-1987	30-SEP-1987	3	1	0	0	0	0	0	0	0	0	0	3.5	3.3	6.3	7.7	8.1	50.0	44.8	180	S
14-SEP-1986	15-SEP-1986	18	1	0	0	0	0	0	0	0	0	0	3.5	3.2	6.1	8.9	10.0	62.2	49.4	157	SSE
15-AUG-1986	15-AUG-1986	3	0	0	0	0	0	0	0	0	0	0	3.4	3.3	5.9	7.3	7.5	47.8	44.3	45	NE
16-APR-1988	16-APR-1988	5	0	0	0	0	0	0	0	0	0	0	3.4	3.2	6.0	7.6	8.2	46.4	42.0	157	SSE
30-JUN-1986	01-JUL-1986	14	0	0	0	0	0	0	0	0	0	0	3.4	3.1	6.3	11.2	12.6	74.1	62.8	135	SE
31-JAN-1988	31-JAN-1988	4	0	0	0	0	0	0	0	0	0	0	3.3	3.2	5.7	7.8	8.5	45.9	42.0	180	S
21-DEC-1987	23-DEC-1987	5	0	0	0	0	0	0	0	0	0	0	3.3	3.1	7.0	7.7	10.0	52.0	44.7	157	SSE
09-DEC-1986	09-DEC-1986	3	0	0	0	0	0	0	0	0	0	0	3.3	3.1	5.9	8.4	10.8	51.4	46.3	157	SSE
14-FEB-1988	14-FEB-1988	5	0	0	0	0	0	0	0	0	0	0	3.3	3.1	5.9	7.7	8.7	43.9	39.0	157	SSE
21-OCT-1987	21-OCT-1987	2	0	0	0	0	0	0	0	0	0	0	3.2	3.2	5.5	7.4	8.0	42.0	38.4	157	SSE
19-FEB-1988	19-FEB-1988	3	0	0	0	0	0	0	0	0	0	0	3.2	3.1	5.0	7.9	8.7	40.5	39.0	112	ESE
17-JAN-1988	17-JAN-1988	2	0	0	0	0	0	0	0	0	0	0	3.1	3.1	6.4	5.7	7.8	61.5	51.6	180	S
03-MAY-1987	03-MAY-1987	2	0	0	0	0	0	0	0	0	0	0	3.1	3.1	5.9	9.8	10.2	47.3	47.1	90	E
16-JUN-1988	18-JUN-1988	4	0	0	0	0	0	0	0	0	0	0	3.1	3.1	5.7	10.9	12.3	61.6	56.0	112	ESE
04-JAN-1987	05-JAN-1987	3	0	0	0	0	0	0	0	0	0	0	3.0	3.0	5.7	9.1	10.2	46.9	44.5	67	ENE
03-MAR-1987	03-MAR-1987	1	0	0	0	0	0	0	0	0	0	0	3.0	3.0	5.5	9.8	12.2	46.8	46.8	135	SE
14-MAR-1988	14-MAR-1988	1	0	0	0	0	0	0	0	0	0	0	3.0	3.0	5.4	7.4	7.7	36.9	36.0	157	SSE
08-APR-1987	09-APR-1987	2	0	0	0	0	0	0	0	0	0	0	3.0	3.0	5.1	7.5	9.2	40.7	37.2	157	SSE
19-DEC-1987	19-DEC-1987	1	0	0	0	0	0	0	0	0	0	0	3.0	3.0	4.9	7.2	7.3	33.7	33.7	112	ESE
avg		18	9	6	3	1	0	0	0	0	0	0	3.8	3.4	6.7	9.1	10.4	81.0	59.1		

STORM HISTORY TABLES (Cont.)

Ranked by Height/Duration or Power/Duration

- see comments on page A18
- ranked table available for offshore sites only
- start and end dates can be nominated
- storms can be ranked by duration of H_{sig} greater than 3 metres multiplied by mean H_{sig}

  or

  duration of H_{sig} greater than 3 metres multiplied by mean wave power

- average value for storm events listed for selected parameters is included

BATEMANS BAY STORM HISTORY: STORMS RANKED by DURATION of HSIG > 3.0m * MEAN_HSIG
Nominated start/finish : 01-JUN-1986 to 10-AUG-1988
Printing date: 15-NOV-2011
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110B King Street
MANLY VALE NSW 2093

STORM START DATE	STORM END DATE	> 3.0 (h)	> 3.5 (h)	> 4.0 (h)	> 4.5 (h)	> 5.0 (h)	> 5.5 (h)	> 6.0 (h)	> 6.5 (h)	> 7.0 (h)	> 7.5 (h)	> 8.0 (h)	PEAK Hsig (m)	MEAN Hsig (m)	MEAN TP1 (s)	MEAN POWER (kW/m)	DUR'N MEAN HSIG	(°) T.N	DIR
05-AUG-1986	11-AUG-1986	100	80	71	53	15	3	0	0	0	0	0	5.6	4.4	11.7	110.3	440.0	90	E
*18-NOV-1986	21-NOV-1986	60	55	52	42	22	9	1	0	0	0	0	6.0	4.8	11.7	139.0	288.0	180	S
28-APR-1988	02-MAY-1988	69	48	18	0	0	0	0	0	0	0	0	4.4	3.7	11.4	79.0	255.3	90	E
08-APR-1988	10-APR-1988	43	29	17	1	0	0	0	0	0	0	0	4.5	3.8	11.4	74.0	163.4	180	S
08-AUG-1988	09-AUG-1988	37	12	2	0	0	0	0	0	0	0	0	4.2	3.4	11.3	61.0	125.8	157	SSE
02-DEC-1987	04-DEC-1987	35	4	0	0	0	0	0	0	0	0	0	3.8	3.3	11.3	56.9	115.5	180	S
08-FEB-1988	10-FEB-1988	29	20	14	1	0	0	0	0	0	0	0	4.5	3.8	11.3	79.0	110.2	157	SSE
24-MAY-1988	26-MAY-1988	29	17	8	1	0	0	0	0	0	0	0	4.5	3.6	11.4	71.0	104.4	157	SSE
01-SEP-1987	02-SEP-1987	28	11	5	1	0	0	0	0	0	0	0	4.7	3.5	12.5	78.2	98.0	157	SSE
18-MAY-1987	19-MAY-1987	28	9	1	0	0	0	0	0	0	0	0	4.0	3.4	11.5	64.3	95.2	180	S
06-JUL-1988	07-JUL-1988	23	16	8	3	0	0	0	0	0	0	0	4.8	3.8	10.2	73.0	87.4	90	E
07-MAR-1988	08-MAR-1988	22	4	0	0	0	0	0	0	0	0	0	3.7	3.3	15.4	86.0	72.6	90	E
10-JUL-1986	11-JUL-1986	19	2	0	0	0	0	0	0	0	0	0	3.7	3.3	11.6	61.6	62.7	157	SSE
25-JUL-1986	26-JUL-1986	17	4	1	0	0	0	0	0	0	0	0	4.2	3.4	12.4	71.1	57.8	180	S
14-SEP-1986	15-SEP-1986	18	1	0	0	0	0	0	0	0	0	0	3.5	3.2	10.0	49.4	57.6	157	SSE
19-AUG-1987	20-AUG-1987	16	2	0	0	0	0	0	0	0	0	0	3.6	3.3	8.0	51.6	52.8	90	E
*29-NOV-1986	30-NOV-1986	13	8	4	0	0	0	0	0	0	0	0	4.2	3.7	12.3	75.9	48.1	157	SSE
30-JUN-1986	01-JUL-1986	14	0	0	0	0	0	0	0	0	0	0	3.4	3.1	12.6	62.8	43.4	135	SE
24-NOV-1987	24-NOV-1987	5	1	0	0	0	0	0	0	0	0	0	3.7	3.3	10.0	51.2	16.5	180	S
16-APR-1988	16-APR-1988	5	0	0	0	0	0	0	0	0	0	0	3.4	3.2	8.2	42.0	16.0	157	SSE
21-DEC-1987	23-DEC-1987	5	0	0	0	0	0	0	0	0	0	0	3.3	3.1	10.0	44.7	15.5	157	SSE
14-FEB-1988	14-FEB-1988	5	0	0	0	0	0	0	0	0	0	0	3.3	3.1	8.7	39.0	15.5	157	SSE
31-JAN-1988	31-JAN-1988	4	0	0	0	0	0	0	0	0	0	0	3.3	3.2	8.5	42.0	12.8	180	S
16-JUN-1988	18-JUN-1988	4	0	0	0	0	0	0	0	0	0	0	3.1	3.1	12.3	56.0	12.4	112	ESE
30-SEP-1987	30-SEP-1987	3	1	0	0	0	0	0	0	0	0	0	3.5	3.3	8.1	44.8	9.9	180	S
15-AUG-1986	15-AUG-1986	3	0	0	0	0	0	0	0	0	0	0	3.4	3.3	7.5	44.3	9.9	45	NE
09-DEC-1986	09-DEC-1986	3	0	0	0	0	0	0	0	0	0	0	3.3	3.1	10.8	46.3	9.3	157	SSE
19-FEB-1988	19-FEB-1988	3	0	0	0	0	0	0	0	0	0	0	3.2	3.1	8.7	39.0	9.3	112	ESE
04-JAN-1987	05-JAN-1987	3	0	0	0	0	0	0	0	0	0	0	3.0	3.0	10.2	44.5	9.0	67	ENE
21-OCT-1987	21-OCT-1987	2	0	0	0	0	0	0	0	0	0	0	3.2	3.2	8.0	38.4	6.4	157	SSE
03-MAY-1987	03-MAY-1987	2	0	0	0	0	0	0	0	0	0	0	3.1	3.1	10.2	47.1	6.2	90	E
17-JAN-1988	17-JAN-1988	2	0	0	0	0	0	0	0	0	0	0	3.1	3.1	7.8	51.6	6.2	180	S
08-APR-1987	09-APR-1987	2	0	0	0	0	0	0	0	0	0	0	3.0	3.0	9.2	37.2	6.0	157	SSE
03-MAR-1987	03-MAR-1987	1	0	0	0	0	0	0	0	0	0	0	3.0	3.0	12.2	46.8	3.0	135	SE
14-MAR-1988	14-MAR-1988	1	0	0	0	0	0	0	0	0	0	0	3.0	3.0	7.7	36.0	3.0	157	SSE
19-DEC-1987	19-DEC-1987	1	0	0	0	0	0	0	0	0	0	0	3.0	3.0	7.3	33.7	3.0	112	ESE
avg		18	9	6	3	1	0	0	0	0	0	0	3.8	3.4	10.4	59.1	68.0		

STORM WAVE HEIGHT/DIRECTION TABLES

- tables available for offshore sites only
- table generated from information in Storm History Tables (see page A18)
- start/end date can be nominated
- total number of storms or average number of storms per year can be provided
- peak H_{sig}, H_{max} and wave power, average H_{sig}, T_{sig}, T_{P1} and wave power storm statistics can be selected
- statistical grouping interval may be selected (minimum 0.1)
- number of storms per year is based on effective record length
- for explanation of statistics see Glossary

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MANLY VALE NSW 2093

Creation date: 02-SEP-2010
Program : STMANA
Page no. : 1

STORM WAVE HEIGHT -v- STORM PEAK WAVE DIRECTION

SITE CODE : SYDDOW SITE NAME: SYDNEY DIRECTIONAL
FIRST DATE : 03-MAR-1992 TOTAL RECORD LENGTH (yrs) : 17.829
LAST DATE : 31-DEC-2009 EFFECTIVE RECORD LENGTH (yrs): 15.208 *
DATA CAPTURE(%) : 85.30

Peak Hsig THRESHOLD (metres)	TOTAL NUMBER OF STORMS										
	SSW	STH	SSE	SE	ESE	EAST	ENE	NE	NNE	NTH	TOTAL
3.00	8	179	91	36	16	21	12	1	0	0	364
3.50	4	116	68	22	10	12	7	0	0	0	239
4.00	3	63	40	17	6	9	4	0	0	0	142
4.50	1	35	28	14	2	5	4	0	0	0	89
5.00	0	18	14	9	2	4	1	0	0	0	48
5.50	0	11	8	7	1	2	1	0	0	0	30
6.00	0	6	5	5	1	1	0	0	0	0	18
6.50	0	2	3	2	0	0	0	0	0	0	7
7.00	0	1	1	0	0	0	0	0	0	0	2
7.50	0	0	1	0	0	0	0	0	0	0	1
8.00	0	0	1	0	0	0	0	0	0	0	1
8.50	0	0	0	0	0	0	0	0	0	0	0

* Effective Record Length = Total Record Length x (Data Capture / 100)

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STORM WAVE HEIGHT -v- STORM PEAK WAVE DIRECTION

SITE CODE : SYDDOW SITE NAME: SYDNEY DIRECTIONAL
FIRST DATE : 03-MAR-1992 TOTAL RECORD LENGTH (yrs) : 17.829
LAST DATE : 31-DEC-2009 EFFECTIVE RECORD LENGTH (yrs): 15.208 *
DATA CAPTURE(%) : 85.30

Peak Hsig THRESHOLD (metres)	NUMBER OF STORMS PER YEAR										
	SSW	STH	SSE	SE	ESE	EAST	ENE	NE	NNE	NTH	TOTAL
3.00	0.53	11.77	5.98	2.37	1.05	1.38	0.79	0.07	0.00	0.00	23.93
3.50	0.26	7.63	4.47	1.45	0.66	0.79	0.46	0.00	0.00	0.00	15.72
4.00	0.20	4.14	2.63	1.12	0.39	0.59	0.26	0.00	0.00	0.00	9.34
4.50	0.07	2.30	1.84	0.92	0.13	0.33	0.26	0.00	0.00	0.00	5.85
5.00	0.00	1.18	0.92	0.59	0.13	0.26	0.07	0.00	0.00	0.00	3.16
5.50	0.00	0.72	0.53	0.46	0.07	0.13	0.07	0.00	0.00	0.00	1.97
6.00	0.00	0.39	0.33	0.33	0.07	0.07	0.00	0.00	0.00	0.00	1.18
6.50	0.00	0.13	0.20	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.46
7.00	0.00	0.07	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13
7.50	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07
8.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07
8.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

* Effective Record Length = Total Record Length x (Data Capture / 100)

STORM WAVE HEIGHT/DURATION TABLES

- tables available for offshore sites only
- tables generated from information in Storm History Tables (see page A18)
- start/end dates can be nominated
- lists total number of storms for peak H_{sig} exceedance for 3 to 8 metre thresholds in 0.5 metre increments and specified durations in hours
- for explanation of statistics see Glossary

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STORM WAVE HEIGHT -v- STORM DURATION

SITE CODE : SYDDOW SITE NAME: SYDNEY DIRECTIONAL

FIRST DATE : 03-MAR-1992 TOTAL RECORD LENGTH (yrs) : 17.829

LAST DATE : 31-DEC-2009 EFFECTIVE RECORD LENGTH (yrs): 15.208 *

DATA CAPTURE(%) : 85.30

Peak Hsig THRESHOLD (metres)	TOTAL NUMBER OF STORMS exceeding DURATION (hrs)																						
	1	2	3	6	9	12	18	24	30	36	42	48	54	60	72	84	96	108	120	132	144	156	168	180
3.0	364	339	319	259	219	191	150	114	78	54	46	36	24	18	10	6	2	1	1					
3.5	239	208	190	163	124	102	72	47	32	28	22	13	8	7	4									
4.0	141	111	101	87	68	54	35	25	18	13	8	5	2	1										
4.5	88	71	63	48	37	29	18	9	7	4	3	1												
5.0	48	39	29	23	19	17	8	4	3	2	1	1												
5.5	29	23	22	16	8	7	2	2	1	1														
6.0	18	13	9	5	3	3	1																	
6.5	6	3	3	2	1	1																		
7.0	2	1	1	1	1	1																		
7.5	1	1	1																					
8.0	1	1	1																					

* Effective Record Length = Total Record Length x (Data Capture / 100)

STORM WAVE HEIGHT/DURATION RETURN PERIOD TABLES

- tables available for offshore sites only
- table generated from information in Storm History Tables (see page A18)
- start/end date can be nominated
- lists storm return period in years for peak H_{sig} exceedance for 3 to 8 metre thresholds in 0.5 metre increments and specified durations in hours
- storm return period is based on effective record length
- for explanation of statistics see Glossary

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STORM WAVE HEIGHT/DURATION RETURN PERIODS

SITE CODE : SYDDOW SITE NAME: SYDNEY DIRECTIONAL

FIRST DATE : 03-MAR-1992 TOTAL RECORD LENGTH (yrs) : 17.829

LAST DATE : 31-DEC-2009 EFFECTIVE RECORD LENGTH (yrs): 15.208 *

DATA CAPTURE(%) : 85.30

Peak Hsig THRESHOLD (metres)	RETURN PERIOD (yrs) for DURATION (hrs)																		
	1	2	3	6	9	12	18	24	30	36	42	48	60	72	84	96	108	120	144	168
3.0	0.04	0.04	0.05	0.06	0.07	0.08	0.10	0.13	0.19	0.28	0.33	0.42	0.84	1.52	2.53	7.60	15.21	15.21		
3.5	0.06	0.07	0.08	0.09	0.12	0.15	0.21	0.32	0.48	0.54	0.69	1.17	2.17	3.80						
4.0	0.11	0.14	0.15	0.17	0.22	0.28	0.43	0.60	0.84	1.16	1.89	3.02	15.10							
4.5	0.17	0.21	0.24	0.31	0.41	0.52	0.84	1.67	2.15	3.76	5.01	15.04								
5.0	0.32	0.39	0.52	0.66	0.80	0.89	1.90	3.80	5.07	7.60	15.21	15.21								
5.5	0.51	0.64	0.67	0.92	1.84	2.10	7.35	7.35	14.70	14.70										
6.0	0.84	1.17	1.69	3.04	5.07	5.07	15.21													
6.5	2.17	4.35	4.35	6.52	13.04	13.04														
7.0	7.60	15.21	15.21	15.21	15.21	15.21														
7.5	15.21	15.21	15.21																	
8.0	15.21	15.21	15.21																	

* Effective Record Length = Total Record Length x (Data Capture / 100)

Appendix B

Glossary of Terms

Glossary of Terms

Air / Barometric Pressure	:	the pressure of the atmosphere at a location due to the weight of a column of air above it. Air pressure is measured in hectopascals (hPa).
Average H_{sig}	:	average significant wave height recorded during a storm event.
Average T_{P1}	:	average spectral peak period recorded during a storm event.
Average T_{sig}	:	average significant wave period recorded during a storm event.
Average Wave Power	:	average wave power level recorded during a storm event.
Barometer	:	a device used to measure variations in atmospheric pressure.
Correlation Coefficient	:	measurement (between -1 and 1) of the quality of fit of a line through a set of data points. The closer the number to ±1 the better the fit.
Data Capture / Data Recovery	:	number of records collected divided by total number of possible records. Normally expressed as a percentage.
Date / Time	:	for start of record.
Deep Water	:	water sufficiently deep that surface waves are little affected by the ocean bottom. Generally, water deeper than one-half the surface wave length is considered deep water.
Diffraction	:	the 'spreading' of waves into the lee of obstacles such as breakwaters by the transfer of wave energy along wave crests. Diffracted waves are lower in height than the incident waves.
Directional Waverider Buoy	:	a floating device used to measure ocean wave height, period and direction. It is a registered trademark of the Dutch company Datawell.
E	:	Normalised Spectral Estimate.
Effective Record Length	:	total record length multiplied by the data capture rate.
Electromagnetic Current Meter	:	a device that measures current and water pressure variations. If deployed in shallow water current and pressure data can be converted to wave height, period and direction. Current meters manufactured by the American companies Marsh McBirney and InterOcean are used by Manly Hydraulics Laboratory to collect wave data.
Electromagnetic Wave and	:	linear electromagnetic gauge fixed to a structure used to measure water
Tide Monitoring System (EWS)		level variations caused by waves and tides.
ERR	:	number of corrections or 'patches' in a record.
Fetch	:	the horizontal distance over which a wind blows in generating waves.
Filtered Data	:	raw data modified to remove wind waves, tide or some other frequency components.
Hindcast	:	the prediction of wave characteristics using meteorological information as opposed to the measurements of these features.
H_1	:	average height of the waves which comprise the top 1%.
H_{10}	:	average height of the waves which comprise the top 10%.

H_{max}	:	maximum wave height.
H_{mean}	:	mean wave height.
H_{rms}	:	root mean square wave height.
H_{sig}	:	significant wave height = average height of the waves which comprise the top 33%.
LEN	:	accepted record duration (normally in seconds).
Logger	:	device for recording digitised data.
Long Wave	:	waves with periods greater than 30 seconds. Often associated with storm wave activity along the NSW coast.
M_0, M_1, M_2, M_3	:	Spectral Moments - $M_n = S\ E\ f^n\ Df$. These provide parameters describing the shape of the spectrum.
MS	:	Mean Square displacement (= Y_{rms}^2 = M_0).
NPTS	:	number of sample points in a record.
$\frac{P2}{P1}$ or $\frac{SP2}{SP1}$	:	ratio of second highest spectral peak to the highest.
Peak H_{max}	:	highest maximum wave height recorded during a storm event.
Peak H_{sig}	:	highest significant wave height recorded during a storm event.
Peak Wave Power	:	maximum wave power level recorded during a storm event.
Percentage Exceedance	:	percentage of time that a given value is exceeded.
Percentage Occurrence	:	percentage of time that given value (or range of values) occurs.
Receiver	:	shore-based device for receiving incoming wave signals.
Record	:	burst of data from the wave measuring device (usually 2048 seconds).
Record Interval	:	time between records (usually 1 hour). Prior to June 1984 the standard for wave data collection by Manly Hydraulics Laboratory was 6 hours.
Refraction	:	the tendency of wave crests to become parallel to bottom contours as waves move into shallower waters. This effect is caused by the shoaling process which slows down waves in shallower waters.
Return Period	:	expected average interval between the occurrences of events at a particular threshold.
S	:	Spectral Estimate = E x M_0.
S.E.	:	Standard Error = rms y-deviation of data points from a fitted line.
Sample Increment	:	time between sample points measured by the transducer. Sample points are normally spaced at 0.5 second intervals for ocean wave measurement.
Sea Waves	:	waves in coastal waters resulting from the interaction of different wave trains and locally generated waves. Typically, sea waves are of short wave length and of disordered appearance.
Shallow Water	:	water of such a depth that surface waves are noticeably affected by bottom topography. Generally, water depth less than one-half the surface wave length is considered shallow water.

Shoaling	:	the influence of the seabed on wave behaviour. Such effects only become significant in water depths of 60 m or less. Manifested as a reduction in wave speed, a shortening in wave length and an increase in wave height.
Storm Event	:	period of high wave activity. For the NSW coastline is normally defined as the time when a H_{sig} greater than 3 metres is recorded at an offshore wave recording station.
Swell Waves	:	wind waves remote from the area of generation (fetch) having a uniform and orderly appearance characterised by regularly spaced wave crests.
Total Record Length	:	elapsed period from the date of commission to the end of data collection at a recording site.
T_c	:	crest period = average time between successive crests.
T_{P1}	:	peak period of the energy spectrum.
T_{P2}	:	period corresponding to the second biggest peak of the energy spectrum.
T_{sig}	:	significant period = average period of the waves used to define H_{sig}.
T_z	:	zero crossing period = mean period.
Wave Direction	:	the direction from which ocean waves approach a location. Generally, the principal wave direction is represented by the direction that corresponds to the peak period of the energy spectrum (T_{P1}).
Wave Height	:	the vertical distance between a wave trough and wave crest.
Wave Length	:	the distance between consecutive wave crest or wave troughs.
Wave Period	:	the time taken for consecutive wave crests or wave troughs to pass a given point.
Wave Power	:	the rate at which wave energy is transmitted in the direction of wave propagation. Normally expressed in kilowatts per metre of wave crest length.
Waverider Buoy	:	a floating device used to measure water level variations caused by ocean waves. It is a registered trademark of the Dutch company Datawell.
Wind Waves	:	the waves initially formed by the action of wind blowing over the sea surface. Wind waves are characterised by a range of heights, periods and wave lengths. As they leave the area of generation (fetch), wind waves develop a more ordered and uniform appearance and are referred to as swell or swell waves.
Y_{rms}	:	root mean square amplitude (not to be confused with H_{rms}).

Appendix C

Bibliography

Bibliography

1. Wave Data Collection and Analysis - General

Barstow, S.F. and Kollstad, T., Field trials of the Directional Waverider, *First International Offshore and Polar Engineering Conference,* Edinburgh, United Kingdom, August 1991.

Borgman, L.E., Confidence Intervals for Ocean Wave Spectra, *13th International Coastal Engineering Conference,* Vancouver, 1972.

CSIR, *Comparative field tests of a Datawell Directional Waverider and an Electromagnetic Current Meter Pressure Sensor Instrument*, CSIR Report EMAS-T93003, Stellenbosch, February 1993.

Datawell b.v., *Warec - PC Software*, Datawell b.v. - Laboratory for Instrumentation, October 1992.

Datawell b.v., *Manual of the Digital Waverider Receiver type DIWAR,* Datawell b.v. - Laboratory for Instrumentation, February 1998.

Datawell b.v., *Manual for the Wave Direction Receiver 'WAREC'*, Datawell b.v. - Laboratory for Instrumentation, April 1998.

Datawell b.v., *Datawell Directional Waverider Manual Mark II*, Datawell b.v. – Laboratory for Instrumentation, June 2004.

Datawell b.v., *Datawell Waverider Installation Guide,* Datawell b.v. - Laboratory for Instrumentation, June 2005.

Datawell b.v., *Datawell Waverider Receiver Manual RX-D type 2,* Datawell b.v. - Laboratory for Instrumentation, November 2005.

Datawell b.v., *Datawell Waverider Reference Manual, WR-SG, DWR-MkIII, DWR-G*, Datawell b.v. – Laboratory for Instrumentation, March 2007.

Datawell b.v., *Datawell Waverider Reference Manual (including FB2 electronics unit) WR-SG, DWR-MkIII*, Datawell b.v. – Laboratory for Instrumentation, June 2011.

Draper L., The Analysis and Presentation of Wave Data - A Plea for Uniformity, *10th International Coastal Engineering Conference,* Japan, September 1966.

Goda, Y., Wave Measurements and Utilisation of Wave Data, *6th Australian Conference on Coastal and Ocean Engineering,* Brisbane, Institution of Engineers, Australia, July 1983.

Hamilton, L.J*., Bibliography of Wind-Wave Data and Publications for the Coastal Regions of Australia*, Department of Defence, Defence Science and Technology Organisation, Report DSTO-GD-0116, February 1997.

Harris, D.L., Analysis of Wave Records, *12th International Coastal Engineering Conference,* Washington, September 1970.

Harris, D.L., Finite Spectrum Analysis of Wave Records, *International Symposium on Ocean Wave Measurement and Analysis*, New Orleans, September 1974.

Kuik, A.J. and Holthuijsen, L.H., Buoy Observation of Directional Wave Parameters, *Conference on Directional Wave Spectra Applications,* Berkeley, California, American Society of Civil Engineers, September 1981.

Kuik, A.J. and van Vledder, G., Proposed Method for the Routine Analysis of Pitch-Roll Buoy Data, *Symposium on Description and Modelling of Directional Seas*, Denmark, Danish Hydraulic Institute and Danish Maritime Institute, June 1984.

Lawson, N.V., Rice, R.A. and Szylkarski, S.P., World Satellite Altimeter Wave Data Base, *11th Australasian Conference on Coastal and Ocean Engineering*, Townsville, Institution of Engineers, Australia, August 1993.

MacLaren Plansearch Limited, *Evaluation/Validation of the new Datawell Directional Waverider Buoy*, Report 05889SRE.001, Nova Scotia, Canada, 1991.

Mansard, E.P.D. and Funke, E.R., A Comprehensive Wave Data Analysis Package, *International Conference on Measuring Techniques of Hydraulic Phenomena in Offshore, Coastal and Inland Waters,* London, BHRA, The Fluid Engineering Centre, April 1986.

Oceanographic Company of Norway A/S., *Field Trials of the Directional Waverider*, Trondheim, Norway.

Pitt, E.C. Pascall, R.W. and van Heteren, J., A Comparison of the Measurements made by two Pitch-Roll Buoys during the NURWEC Project*, Ocean-Data Conference - Evaluation, Comparison and Calibration of Ocean Instruments*, London, 1985.

Reid, J.S., Some Comments on Ocean Wave Statistics, *9th Australasian Conference on Coastal and Ocean Engineering,* Adelaide, Institution of Engineers, Australia, December 1989.

Siefert, W., Shallow Water Wave Characteristics, *13th International Coastal Engineering Conference,* Vancouver, 1972.

Tremarfon Pty Ltd, *Ocean Wave Data Collection System Software Guide*, Tremarfon Pty Ltd for Manly Hydraulics Laboratory, September 2006.

Thompson, W.G., Swell and Storm Characteristics from Coastal Wave Records, *12th International Coastal Engineering Conference,* Washington, September 1970.

Tucker, M.J., *Waves in Ocean Engineering, measurement, analysis and interpretation*, Ellis Horwood Limited, 1991.

Tucker, M.J., *Recommended Standard for Wave Data Sampling and Near Real-time Processing*, Oil Industry International Exploration and Production Forum, London, Report No. 3.14/186, June 1992.

van der Vlugt, A.J.M., Kuik, A.J. and Holthuijsen, The Wavec Directional Buoy under Development, *Conference on Directional Wave Spectra Applications*, Berkeley, California, American Society of Civil Engineers, September 1981.

van der Vlugt, A.J.M., The Wavec Buoy for Routinely Measuring the Direction of Sea Waves, *International Conference on Wave and Wind Directionality Applications to the Design of Structures,* Paris, September 1981.

van der Vlugt, A.J.M., Experience with the Wavec Buoy, *Symposium on Description and Modelling of Directional Seas*, Denmark, Danish Hydraulic Institute and Danish Maritime Institute, June 1984.

Wang, S. and Le Mehaute, B., Duration of Measurements and Long-Term Wave Statistics, *Journal of Waterway Port Coastal and Ocean Engineering,* Vol. 109 No. 2, American Society of Civil Engineers, May 1983.

Waters, C.B., Experiences in the Operation of Waverider Buoys, *16th Congress International Association for Hydraulic Research,* Brazil, 1975.

Wilson, J.R. and Baird, W.F., A Discussion of Some Measured Wave Data, *13th International Coastal Engineering Conference,* Vancouver, 1972.

2. Wave Data Collection and Analysis - New South Wales

Abernethy, C.L. and Lawson, N.V., Statistical Distributions of Wave Parameters off Botany Bay, *1st Australian Conference on Coastal Engineering*, Sydney, Institution of Engineers, Australia, May 1973.

Allan, A.J., Bolton, A.W. and Webb, A.T., A Second Generation Wave Recording Network, *International Conference on Measuring Techniques of Hydraulic Phenomena in Offshore, Coastal and Inland Waters,* London. BHRA, The Fluid Engineering Centre, April 1986.

Australian Water and Coastal Studies Pty Ltd, *DWAVE - Wave Data Software Wave Power Statistics User's Guide,* Report No. 90/07, July 1990.

Australian Water and Coastal Studies Pty Ltd, *Wave Power Study for Selected Sites along the New South Wales Coastline,* Report No. 91/08, May 1991.

Australian Water and Coastal Studies Pty Ltd, *Sydney Deepwater Outfalls Environmental Monitoring Program, Post Commissioning Phase, An Examination of Ocean Reference Station Wind and Wave Data*, Interim Report 93/01/14, December 1995.

Coghlan, I., Mole, M., Shand, T., Carley, J., Peirson, W., Miller, B., Kulmar, M., Couriel, E., Modra, B. and You, Z.J., *High Resolution Wave Modelling (HI-WAM) for Batemans Bay Detailed Wave Study*, Coasts and Ports 2011 Conference, Perth, Australia, September 2011.

Department of Finance and Services, *Batemans Bay Wave Climate Study*, Manly Hydraulics Laboratory, Report MHL2003, December 2010.

Department of Public Works and Services, *New South Wales Central Coast 1995 Wave Data Analysis*, Manly Hydraulics Laboratory, Report MHL754, June 1997.

Department of Public Works and Services, *New South Wales Coast May 1997 Storm Analysis*, Manly Hydraulics Laboratory, Report MHL886, December 1997.

Foster, D., Gordon, A.D. and Lawson, N.V., The Storms of May-June 1974, Sydney, NSW, *2nd Australian Conference on Coastal and Ocean Engineering,* Gold Coast, Institution of Engineers, Australia, April 1975.

Gordon, A.D., Beach Fluctuations and Shoreline Change, *8th Australasian Conference on Coastal and Ocean Engineering,* Launceston, Institution of Engineers, Australia, December 1987.

Jayewardene, I.F.W., Haradasa, D.K.C. and Tainsh, J., Analysis of Wave Groupiness, *11th Australasian Conference on Coastal and Ocean Engineering,* Townsville, Institution of Engineers, Australia, August 1993.

Kemp, R., Gage, B., Moodie, N. and Kulmar, M., Climatology of Large Wave Events and Associated Weather Systems Along the NSW Coast, *16th Australasian Coastal and Ocean Engineering Conference*, Institution of Engineers, Australia, Auckland, NZ, September 2003.

Kulmar, M.A., Wave Direction Distributions off Sydney, New South Wales, *12th Australasian Coastal and Ocean Engineering Conference*, Melbourne, Institution of Engineers, Australia, May 1995.

Kulmar, M., Lord, D. and Sanderson, B., Future Directions for Wave Data Collection in New South Wales, *17th Australasian Conference on Coastal and Ocean Engineering*, Adelaide, Engineers Australia, September 2005.

Kulmar, M., Modra, B. and Fitzhenry, M., The New South Wales Wave Climate – Improved Understanding through the Introduction of Directional Wave Monitoring Buoys, *2013 Australasian Coasts and Ports Conference*, Sydney, Engineers Australia, September 2013.

Lawson, N.V. and Abernethy, C.L., Long Term Wave Statistics off Botany Bay, *2nd Australian Conference on Coastal and Ocean Engineering,* Gold Coast, Institution of Engineers, Australia, April 1975.

Lawson, N.V., McCowan, A.D. and Treloar, P.D., Inter-Relationships between Wave Periods for the NSW, Australia Coast, *8th Australasian Conference on Coastal and Ocean Engineering,* Launceston, Institution of Engineers, Australia, December 1987.

Lawson, N.V. and Youll, P.H., Storm Duration and Return Interval for Waves off the Central NSW Coast, *3rd Australian Conference on Coastal and Ocean Engineering,* Melbourne, Institution of Engineers, Australia, April 1977.

Lawson, N.V. and Youll, P.H., Realtime Wave Analysis, Newcastle, Australia, *17th International Conference on Coastal Engineering,* Sydney, Institution of Engineers, Australia, March 1980.

Lord, D. and Kulmar, M.A., The 1974 Storms Revisited: 25 years Experience in Ocean Wave Measurement along the South-East Australian Coast, *27th International Conference on Coastal Engineering*, Sydney, Institution of Engineers, Australia, July 2000.

McMonagle, C.J. and Fidge, B.L., A Study of Extreme Values of Water Level and Wave Height at Coffs Harbour, *5th Australian Conference on Coastal and Ocean Engineering,* Perth, Institution of Engineers, Australia, November 1981.

NSW Public Works, *Waverider User Manual*, Manly Hydraulics Laboratory, Version 3.4, June 1993.

NSW Public Works, *Wave Direction Study - Satellite Imagery Progress Report No.2*, Manly Hydraulics Laboratory, Report MHL641, March 1993.

NSW Public Works, *Sydney Directional Waverider Buoy*, Manly Hydraulics Laboratory, Interim Report MHL656, April 1995.

NSW Public Works, *Batemans Bay Wave Climate Study*, Manly Hydraulics Laboratory, Draft Report MHL2003, October 2010.

Public Works Department, NSW, *Wave Data Collection at Manly Laboratory,* Manly Hydraulics Laboratory, Report MHL311, April 1982.

Public Works Department, NSW, *Wave Statistics for Port Kembla,* Manly Hydraulics Laboratory, Report MHL416, August 1984.

Public Works Department, NSW, *Comparison of Wave Statistics between Byron Bay and Coffs Harbour,* Manly Hydraulics Laboratory, Report MHL422, November 1984.

Public Works Department, NSW, *DWAVE Data Presentation,* Manly Hydraulics Laboratory, Report MHL427, September 1985.

Public Works Department, NSW, *Wave Data Conditioning,* Manly Hydraulics Laboratory, Report MHL436, August 1985.

Public Works Department, NSW, *Hand Reduction of Wave Data for Port Kembla, 1974-1983,* Manly Hydraulics Laboratory, Report MHL442, November, 1985.

Public Works Department, NSW, *Elevated Ocean Levels - Storms Affecting the NSW Coast 1880-1980,* Coastal Branch, Report No. 85041, December 1985.

Public Works Department, NSW, *Development of a Radar Facility to Measure Wave Direction and Currents,* Manly Hydraulics Laboratory, Report MHL456, April 1986.

Public Works Department, NSW, *Elevated Ocean Levels - Storms Affecting the NSW Coast 1980-1985,* Coastal Branch, Report No. 86026, August 1986.

Public Works Department, NSW, *DWAVE - Wave Data Software*, Manly Hydraulics Laboratory, Report MHL399, July 1987.

Public Works Department, NSW, *Zwarts User's Manual*, Manly Hydraulics Laboratory, Report MHL406, Revised Edition, July 1987.

Public Works Department, NSW, *Jervis Bay Wave and Tide Data,* Manly Hydraulics Laboratory, Report MHL476, June 1988.

Public Works Department, NSW, *Nelson Bay Wave Data,* Manly Hydraulics Laboratory, Report MHL543, July 1988.

Public Works Department, NSW, *Eden Wave Data Collection Network,* Manly Hydraulics Laboratory, Report MHL542, November 1988.

Public Works Department, NSW, *Batemans Bay Oceanographic and Meteorological Data 1986-89*, Manly Hydraulics Laboratory, Report MHL556, August 1990.

Public Works Department, NSW, *Storm Surges Monitored along the NSW Coast March - April 1990,* Manly Hydraulics Laboratory, Report MHL591, November 1991.

Short, A.D., *Beaches of the New South Wales Coast - a Guide to their Nature, Characteristics, Surf and Safety*, Australian Beach Safety and Management Program, 1993.

Tremarfon Pty Ltd, *Ocean Wave Data Collection System Software Guide*, September 2010.

Trenaman, N.L. and Short, A.D., *Deepwater and Breaker Wave Climate of the Sydney Region New South Wales 1971-1985,* Coastal Studies Unit, The University of Sydney, Report No. 87/1, December 1987.

University of New South Wales, *NSW Coastal Inundation Hazard Study: Coastal Storms and Extreme Waves,* Water Research Laboratory and Macquarie University, WRL Technical Report 2010/16, January 2011.

Watson, P., Lord, D., Kulmar, M., McLuckie, D. and James, J., Analysis of a Storm – June 2007, *16th NSW Coastal Conference,* Yamba, Clarence Valley Council, November 2007.

Webb, A.T., Wave Climate of the New South Wales Coast, *6th Australian Conference on Coastal and Ocean Engineering,* Gold Coast, Institution of Engineers, Australia, July 1983.

Webb, A.T. and Bolton, A.W., Wave Data on Tap, *8th Australasian Conference on Coastal Engineering,* Launceston, Institution of Engineers, Australia, December 1987.

Webb, A.T. and Kulmar, M.A., Coastal Wave Climate of New South Wales - An Update, *9th Australasian Conference on Coastal and Ocean Engineering,* Adelaide, Institution of Engineers, Australia, December 1989.

Wyllie, S.J., Kulmar, M.A. and Davidson, P.J., Development of Design Offshore Wave and Ocean Level Conditions for the New South Wales Coastal Zone, *2nd Coastal Management Conference,* Kiama, Kiama Municipal Council, November 1992.

Wyllie, S.J. and Kulmar, M.A., Coastal Wave Monitoring, *Australian Marine Data Collection and Management Guidelines Workshop*, Hobart, Environmental Resources Information Network, December 1995.

Willoughby, M.A., NSW Central Coast Wave Climate - 1995 Update, *12th Australasian Coastal and Ocean Engineering Conference*, Melbourne, Institution of Engineers, Australia, May 1995.

You, Z.J. and Jayewardene, I., The Occurrence of Extreme Coastal Storms Along the NSW Coast, *National Environment Conference*, Brisbane, 2003.

You, Z.J. and Lord, D., Influence of the El Nino Southern Oscillation on the NSW Coastal Storm Severity, *Journal of Coastal Research*, 24: 203-207, 2008.

You, Z.J., Extrapolation of extreme wave height with a proper probability distribution function, *Australasian Coasts and Ports Conference*, 17-20 July, Melbourne, 2008.

Youll, P.H., Botany Bay Waverider System - Ten Years of Records, *5th Australian Conference on Coastal and Ocean Engineering,* Perth, Institution of Engineers, Australia, November 1981.

3. New South Wales Wave Climate Annual Summaries

Public Works Department, NSW, *New South Wales Wave Climate Annual Summary 1985/86*, Manly Hydraulics Laboratory, Report MHL465, September 1986.

Public Works Department, NSW, *New South Wales Wave Climate Annual Summary 1986/87*, Manly Hydraulics Laboratory, Report MHL520, October 1987.

Public Works Department, NSW, *New South Wales Wave Climate Annual Summary 1987/88*, Manly Hydraulics Laboratory, Report MHL547, October 1986.

Public Works Department, NSW, *New South Wales Wave Climate Annual Summary 1988/89*, Manly Hydraulics Laboratory, Report MHL560, November 1989.

Public Works Department, NSW, *New South Wales Wave Climate Annual Summary 1989/90*, Manly Hydraulics Laboratory, Report MHL581, October 1990.

Public Works Department, NSW, *New South Wales Wave Climate Annual Summary 1990/91*, Manly Hydraulics Laboratory, Report MHL600, September 1991.

Public Works Department, NSW, *New South Wales Wave Climate Annual Summary 1991/92*, Manly Hydraulics Laboratory, Report MHL627, October 1992.

NSW Public Works, *New South Wales Wave Climate Annual Summary 1992/93,* Manly Hydraulics Laboratory, Report MHL655, September 1993.

NSW Public Works, *New South Wales Wave Climate Annual Summary 1993/94,* Manly Hydraulics Laboratory, Report MHL695, October 1994.

Department of Public Works and Services, *New South Wales Wave Climate Annual Summary 1994/95,* Manly Hydraulics Laboratory, Report MHL733, November 1995.

Department of Public Works and Services, *New South Wales Wave Climate Annual Summary 1995/96,* Manly Hydraulics Laboratory, Report MHL779, August 1996.

Department of Public Works and Services, *New South Wales Wave Climate Annual Summary 1996-97,* Manly Hydraulics Laboratory, Report MHL877, September 1997.

Department of Public Works and Services, *New South Wales Wave Climate Annual Summary 1997-98*, Manly Hydraulics Laboratory, Report MHL948, October 1998.

Department of Public Works and Services, *New South Wales Wave Climate Annual Summary 1998-99*, Manly Hydraulics Laboratory, Report MHL1016, September 1999.

Department of Public Works and Services, *New South Wales Wave Climate and Coastal Air Pressure Annual Summary 1999-2000*, Manly Hydraulics Laboratory, Report MHL1072, October 2000.

Department of Public Works and Services, *New South Wales Wave Climate and Coastal Air Pressure Annual Summary 2000-2001*, Manly Hydraulics Laboratory, Report MHL1132, October 2001.

Department of Public Works and Services, *New South Wales Wave Climate and Coastal Air Pressure Annual Summary 2001-2002*, Manly Hydraulics Laboratory, Report MHL1208, March 2003.

Department of Commerce, *New South Wales Wave Climate and Coastal Air Pressure Annual Summary 2002-2003*, Manly Hydraulics Laboratory, Report MHL1279, October 2003.

Department of Commerce, *New South Wales Wave Climate and Coastal Air Pressure Annual Summary 2003-2004*, Manly Hydraulics Laboratory, Report MHL1349, October 2004.

Department of Commerce, *New South Wales Wave Climate and Coastal Air Pressure Annual Summary 2004-2005*, Manly Hydraulics Laboratory, Report MHL1425, November 2005.

Department of Commerce, *New South Wales Wave Climate and Coastal Air Pressure Annual Summary 2005-2006*, Manly Hydraulics Laboratory, Report MHL1514, March 2007.

Department of Commerce, *New South Wales Wave Climate and Coastal Air Pressure Annual Summary 2006-2007*, Manly Hydraulics Laboratory, Report MHL1766, March 2008.

Department of Commerce, *New South Wales Wave Climate and Coastal Air Pressure Annual Summary 2007-2008*, Manly Hydraulics Laboratory, Report MHL1850, September 2008.

Department of Commerce, *New South Wales Wave Climate and Coastal Air Pressure Annual Summary 2008-2009*, Manly Hydraulics Laboratory, Report MHL1935, November 2009.

Department of Services, Technology and Administration, *New South Wales Wave Climate and Coastal Air Pressure Annual Summary 2009-2010*, Manly Hydraulics Laboratory, Report MHL2012, November 2010.

Department of Finance and Services, *New South Wales Wave Climate and Coastal Air Pressure Annual Summary 2010-2011*, Manly Hydraulics Laboratory, Report MHL2091, December 2011.

Department of Finance and Services, *New South Wales Wave Climate and Coastal Air Pressure Annual Summary 2011-2012*, Manly Hydraulics Laboratory, Report MHL2160, November 2012.

4. Air Pressure

Vaisala, *Operating Manual PTB 200 Digital Barometers*, Vaisala Oyj, February 1993.

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