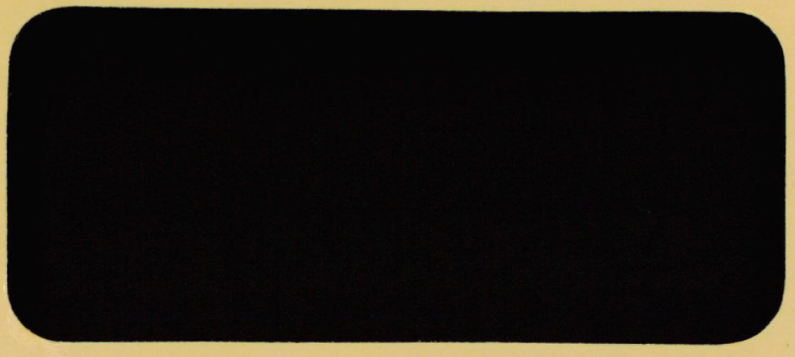

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LAWSON AND TRELOAR PTY. LTD.
COASTAL, OCEAN AND PORT CONSULTING ENGINEERS

ANALYSIS OF CURRENT AND TIDE DATA

NORTH-EAST CHANNEL MORETON BAY, QLD

Report prepared for

Port of Brisbane Authority

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Table of Contents

1 INTRODUCTION.....1

2 INSTRUMENTS.....1

3 DATA RETURN.....2

4 CURRENT DATA ANALYSIS.....3
4.1 Time History Plots.....4
4.2 Current Speed - Direction Frequency.....4
4.3 Current Speed Probability of Exceedance.....5
4.4 Progressive Vector Plot.....5
4.5 Harmonic Analysis of Tidal Currents.....6
4.6 Maximum Average Currents in a Tide Cycle.....7
4.7 One Second Currents.....8

5 ANALYSIS OF TIDES.....8

6 CONCLUSIONS.....9

7 REFERENCES.....10

LIST OF TABLES

Deployment Periods 1

CURRENT ANALYSIS AT NE8
- Speed - Direction Frequency Matrix 2
- Maximum Average Current - Tidal Range Frequency Matrix 3
- Tidal Current Harmonic Constants (North-South) 4a
- Tidal Current Harmonic Constants (East-West) 4b
- Listing of Maximum Average Current - Tidal Range (Flood) ... 5a
- Listing of Maximum Average Current - Tidal Range (Ebb) 5b

CURRENT ANALYSIS AT NE6
- Speed - Direction Frequency Matrix 6
- Maximum Average Current - Tidal Range Frequency Matrix 7
- Tidal Current Harmonic Constants (North South) 8a
- Tidal Current Harmonic Constant (East-West) 8b
- Listing of Maximum Average Current - Tidal Range (Flood) ... 9a
- Listing of Maximum Average Current - Tidal Range (Ebb) 9b

CURRENT ANALYSIS AT NE4
- Speed - Direction Frequency Matrix 10
- Maximum Average Current - Tidal Range Frequency Matrix 11
- Tidal Current Harmonic Constants (North-South) 12a
- Tidal Current Harmonic Constants (East-West) 12b
- Listing of Maximum Average Current - Tidal Range (Flood) ... 13a
- Listing of Maximum Average Current - Tidal Range (Ebb) 13b

TIDAL ANALYSIS
- Harmonic Constants at NE8 14
- Harmonic Constants at NE6 15
- Harmonic Constants at NE4 16

LIST OF FIGURES

Location 1
Locality 2

CURRENT ANALYSIS NE8
Speed - Direction Time History ..... 3 - 11
Speed - Direction Frequency Rose 12
Speed Probability of Exceedance 13
Progressive Vector Plot 14
Tidal Currents, North-South (Measured - Predicted) ..... 15 - 19
Tidal Currents, East-West (Measured - Predicted) ..... 20 - 24
Maximum Average Speed - Tidal Range 25
One Second Currents - Flood 26
One Second Currents - Ebb 27

CURRENT ANALYSIS NE6
Speed - Direction Time History ..... 28 - 32
Speed - Direction Frequency Rose 33
Speed Probability of Exceedance 34
Progressive Vector Plot 35
Tidal Currents, North-South (Measured - Predicted) ..... 36 - 38
Tidal Currents, East-West (Measured - Predicted) ..... 39 - 41
Maximum Average Speed - Tidal Range 42
One Second Currents - Flood 43
One Second Currents - Ebb 43

CURRENT ANALYSIS NE4
Speed - Direction Time History ..... 45 - 51
Speed - Direction Frequency Rose 52
Speed Probability of Exceedance 53
Progressive Vector Plot 54
Tidal Currents, North-South (Measured - Predicted) ..... 55 - 58
Tidal Currents, East-West (Measured - Predicted) ..... 59 - 62
Maximum Average Speed - Tidal Range 63
One Second Currents - Flood 64
One Second Currents - Ebb 65

TIDAL ANALYSIS
Tidal Water Levels (Measured - Predicted) NE8 ..... 66 - 69
Water Level Probability of Exceedance NE8 70
Tidal Water Levels (Measured - Predicted) NE6 ..... 71 - 73
Water Level Probability of Exceedance NE6 74
Tidal Water Levels (Measured - Predicted) NE4 ..... 75 - 77
Water Level Probability of Exceedance NE4 78

1 INTRODUCTION

This report is in response to a request by the Port of Brisbane Authority (PBA) to Lawson and Treloar Pty Ltd for the gathering and analysis of current and tide data at three sites along the North East Channel. The sites were (AMG co-ordinates):

NE8 : 533 650 E (Approx. 409 metres bearing 262 from buoy NE8)
7 009 015 N

NE6 : 533 605 E (Approx. 341 metres bearing 236 from buoy NE6)
7 011 520 N

NE4 : 533 336 E (Approx. 512 metres bearing 279 from buoy NE4)
7 015 099 N

The Port of Brisbane Authority has a long term objective of providing an approach channel within Moreton Bay of up to 20 metres depth. As part of this work alternate routes which are shorter than the present are being considered, the most attractive being the upgrading of the North East Channel.

From June 1984 to July 1985, current, tide and wave data (including wave direction) was recorded at the seaward end of the North East Channel at NE2. This work was carried out by Lawson and Treloar and the results presented in their Report 1099, August 1985.

The aim of the present study was to monitor currents close to the bed at the three sites along the channel. Of particular interest were the oscillations around the net current. A Sea Data 620A current meter was installed sequentially at each site for a minimum of one month. A Sea Data 635-11L wave and tide gauge was deployed concurrently to record tide data. Table 1 shows the period of each deployment. Figures 1 and 2 show the location of the North East Channel and the recording sites.

2 INSTRUMENTS

The Sea Data 620A current meter carries out full vector averaging internally. Current speeds are measured using a Marsh McBirney X-Y Electromagnetic Flow Sensor. Currents are measured in two orthogonal directions by using the Faraday Principle. An internal compass measures the instrument direction. Speeds in the orthogonal directions can be resolved into a speed - direction pair using the compass heading. The current sensor has no moving parts. A specification is included in Appendix A.

The following recording parameters were used:

Mode:	Burst Only
Burst Interval:	30 Minutes
Scans/Burst:	128
Scan Interval:	1 second

The 620A was moored using a steel railway wheel as a mooring weight and a Viny 18 GA subsurface buoy for floatation. The instrument sensor was at a height of approximately 0.6m above the sea bed. The subsurface buoy gave a net lift of 72 kilograms which was needed to keep the instrument as near the vertical as possible in the expected currents of up to 2 knots.

The Sea Data 635-11L wave and tide gauge uses the Paros Scientific quartz pressure sensor which has an accuracy of 1 cm and a resolution of 0.1 cm of water. The 635-11L was bolted vertically to a post on a separate railway wheel placed nearby the current meter. The 635-11L was set to record waves as well as tides, however, no wave analysis has been undertaken.

The following recording parameters were used:

Tides:	64 averages/hour
Waves-burst Interval:	6 hours
Scans/Burst:	1040
Scan Interval:	1 second

Both instruments were extensively checked before and after the study period and operated within specification. Between deployments the internal cassette tape was changed and basic electronic checks carried out. No malfunction occurred in either instrument.

3 DATA RETURN

A total of 58 bursts of current data were lost due to unrecoverable tape reading errors. This gives a data return rate of 99.1% over the full period. The data return for each site was:

SITE	No. OF RECORDS LOST	No. ANALYSED	% RETURN
NE8	41	2683	98.5
NE6	13	1605	99.2
NE4	4	2001	99.8

The rate of data return is considered to be excellent. No data was lost from the tide records at any of the three sites.

4 CURRENT DATA ANALYSIS

Inspection of plots of the individual one second data points of a burst (with the mean current removed) showed that a noticeable feature was an oscillatory current in a direction perpendicular to the mean current. This phenomenom was more pronounced under higher mean current speeds.

An analysis of the expected frequency of vortex shedding around a buoy of 0.4 metres diameter under a current of 0.5 m/s shows that the buoy would undergo a forced oscillation of approximately 4 seconds period. This matches the observed frequency of the oscillations in measured current perpendicular to the mean current, leading to the belief that the observed oscillations are caused by movement of the subsurface buoy due to vortex shedding around the buoy.

To reduce the effect of this induced velocity a filtering technique was developed and applied to the data. The filter is of the cosine taper type which is symmetrical and causes no phase shift. The response factors after filtering at various periods are:

PERIOD (SECONDS)	RESPONSE FACTOR
2	0.02
3	0.03
4	0.01
5	0.51
6	1.13
7	1.00
8 (and longer)	0.99

It can be seen that the filter removes virtually all oscillations of periods less than 4 seconds, and gives a 49% reduction at 5 seconds. Oscillations of periods 6 seconds or more are not affected by the filter. To retain accuracy at the start and end of each 128 data point burst the first and last 14 points are discarded. Thus all analysis has been carried out on 100 filtered data points.

The filtering technique used will not remove any significant wave induced oscillatory currents. The magnitude of the wave induced currents at the bed are a linear function of wave height and an exponentially decreasing function of relative depth (ie. wave length/water depth). Thus a wave of period 4 seconds will cause virtually no induced bottom current in 20 metres of water, while a wave of similar height but of period 10 seconds will cause a measurable oscillatory current.

For example a 0.6 metre wave of period 4 seconds will cause the following maximum oscillatory current (based on first order wave theory):

Site	Depth (m)	Current (m/s)
NE8	19.3	0.007
NE6	16.4	0.015
NE4	10.1	0.072

Thus it can be seen that waves of a period of 4 seconds will cause virtually no oscillatory bottom current even at the shallowest site. Therefore by removing all current oscillations of periods less than 4-5 seconds by the filtering technique, no significant oscillations caused by wave action have been removed.

4.1 Time History Plots

Time History plots of average current speed and direction for the sites are shown in:

NE8:	Figures 3-11
NE6:	Figures 28-32
NE4:	Figures 45-51

Directions are relative to True North and are the directions the current is flowing towards. Speed values are averages over 100 seconds.

Some general observations from the time history plots can be made:

1. The currents are driven by the semi-diurnal tides, thus giving four speed maxima and four speed minima per day. The ebb flow is generally stronger than the associated flood flow. This effect is more pronounced at NE4.

2. The maximum recorded speed was at NE4 of approximately 0.85 m/s. The maximum at NE6 was 0.82 m/s and NE8 was 0.65 m/s. Generally speeds were similar at NE4 and NE6 and reduced at NE8.

3. Generally the directions during a tidal cycle described a full circle ie. flood - then east - ebb - then west - flood. However, on occasions the flow at NE8 passed through west after both flood and ebb currents. This was generally during periods of neap tides. Examples of this flow can be found on 21:12:85 (Figure 4) and 17:01:86 (Figure 8).

4.2 Current Speed - Direction Frequency

Current speed - direction frequency roses are presented in Figure 12, 33 and 52 for the sites NE8, NE6 and NE4, respectively. The associated matrices are shown in Tables 2, 6 and 10.

It can be seen that the ebb and flood flows are not directly opposed. The approximate directions in degrees are:

	Ebb	Flood
NE8	0	185
NE6	5	190
NE4	20	210

This effect combined with the stronger ebb flow gives rise to a net current drift.

4.3 Current Speed Probability of Exceedance

Current speed probability of exceedance plots are shown in Figures 13, 34 and 53. The vertical speed scale is linear and the horizontal scale is a normal probability distribution. The probability refers to that average speed (over 100 seconds) which will be exceeded. Thus it can be seen that the current speed that will be exceeded by 50% of all average speeds is:

NE8	0.27 m/s
NE6	0.37 m/s
NE4	0.38 m/s

The upper portion of the probability line (ie $P < 50\%$) tends towards a straight line. This is as would be expected from the results of the study at NE2. Variations from a straight line in this portion are probably due to the smaller number of data points.

The lower portion of the probability line curves asymtopically to zero as there is always some net current.

4.4 Progressive Vector Plot

Progressive vector plots for the sites NE8, NE6 and NE4 are shown in figures 14, 35 and 54 respectively. These plots are the result of plotting an average speed - direction data point as a distance vector. The vectors are plotted progressively in time, with the start of one vector at the end of the previous vector. The result gives a pictorial representation of the net current flow past a recording site. These plots should not be confused with the path a drogue buoy would follow if released at the site. This is because current conditions alter as distance from the site increases.

A number of observations can be made from these plots:

1. The principal tidal current directions are apparent. The form of the tidal variations is fairly consistent from site to site.

2 The net current drifts were:

NE8	:	0.021 m/s	N of W
NE6	:	0.045 m/s	NNW
NE4	:	0.082 m/s	W of N

3 Although the current speeds at NE6 and NE4 were similar, the net drift at NE4 was nearly twice as large as that at NE6. It should be noted that the scale on Figure 54 is half that of the scale used in Figures 14 and 35.

4.5 Harmonic Analysis of Tidal Currents

The harmonic analysis package developed by the Institute of Ocean Sciences in Vancouver, Canada, Reference 1, was used to analyse the data for harmonic constants. This program is able to process data having gaps. It calculates the amplitudes and Greenwich phases from the data using a least squares fit procedure coupled with nodal modulation. Only those constituents which can be resolved over the length of the data record are included. A standard data package of 69 constituents is considered for inclusion in the analysis. Up to 77 additional shallow water constituents can be requested. Constituents are usually selected on the basis that the record is long enough for a 360 degrees phase separation between constituents having similar phase speeds. This is known as the Rayleigh criterion, and for a full 360 degree phase separation between consitutents it is given the value 1.0.

The analysis is carried out on two orthogonal velocity components derived from the original data. Components were chosen in the east-west direction and the north-south direction. Positive direction were true east and true north.

Maintaining the Rayleigh criterion at 1.0 allowed the determination of 38 constituents. Results of harmonic analysis were:

		Net Current (m/s)	RMS error (m/s)
NE8	North-South	0.004	0.048
	East-West	-0.021	0.036
NE6	North-South	0.037	0.055
	East-West	-0.021	0.030
NE4	North-South	0.084	0.047
	East-West	-0.016	0.041

The value of the RMS error refers to the root mean square value of the difference between the measured current and the predicted current over the recording period using the harmonic constants derived in the analysis. The difference between measured and predicted is also known as the residual. In comparison with tidal current analyses carried out

at other sites the values of the RMS errors obtained are considered very good. Tables of the harmonic constants obtained are presented in Tables 4, 8 and 12.

Plots of measured and predicted tidal current values and residuals are shown in the following Figures:

	North-South	East-West
NE8	15-19	20-24
NE6	36-38	39-41
NE4	55-58	59-62

No filtering has been undertaken to remove any meteorological effects of short duration (ie. of the order of 2-3 days). Our experience is that filtering does not provide any better estimate of the harmonic constants but only reduces the RMS error.

4.6 Maximum Average Currents in a Tide Cycle

At each site the times of successive high and low tides and the associated tidal range were calculated from the 635-11L tide gauge data. The current data was then searched for the maximum average current which occurred in a particular flood or ebb tide. The results of this analysis for the three sites are plotted in Figures 25, 42 and 63. Listings of the maximum average current and tidal range are presented in tables 5, 9 and 13.

The data at NE6 and NE4 is quite similar on both flood and ebb tides. At NE8 the flood currents are slightly less than at NE6 or NE4 for a similar tidal range. However, the ebb currents at NE8 are approximately 60% of the ebb current at NE6 or NE4 for a similar tidal range.

During this analysis the time lag between the change in current speed and the peak or trough of the tide became apparent. Time differences of up to an hour between the change in tide and the change in current were observed. This indicates flood and ebb currents are channelled differently.

This effect is relatively common and is dependent upon the extent of the reflected tide wave at the location. In a progressive wave, peak water levels and currents occur at the same time, whereas in a standing wave the peak currents occur at mean water. Thus the "mix" of incident and reflected tidal wave activity has a dominating influence on phasing. Bed friction also has an effect on the phasing related to the boundary layer. However, this phenomenom will not be discussed further than to say that the phase can vary through the water column.

4.7 One Second Currents

At each site the maximum average flood and ebb current was found. For this burst, and the preceeding and following burst, the individual one second current values that make up the burst have been plotted. It should be noted that these one second values are filtered as noted in Section 4.0 and so only the remaining 100 out of 128 original points are plotted. Figures 26, 27, 43, 44, 64 and 65 present these plots.

The data has been presented with the average current already subtracted. This procedure allows the variation in current around the mean to be observed.

5 ANALYSIS OF TIDES

The same harmonic analysis package used for the analysis of currents (4.5) was used. Again the Rayleigh criterion was set to 1.0. The length of the data sets allowed the determination of 38 constituents at each site. These are presented in Tables 14, 15 and 16.

The results of harmonic analysis at the three sites were:

	MWL (m)	RMS ERROR (m)
NE8	19.266	0.047
NE6	16.405	0.059
NE4	10.131	0.044

The principal tidal planes relative to MSL at the three sites are:

NE8 :	HAT	=	1.18 (m)			
	MHHW	=	0.71	MHWS	=	0.74
	MLHW	=	0.41	MHWN	=	0.38
	MHLW	=	-0.41	MLWN	=	-0.38
	MLLW	=	-0.71	MLWS	=	-0.74
	LAT	=	-0.96	ISLW	=	-1.05
NE6 :	HAT	=	1.16 (m)			
	MHHW	=	0.70	MHWS	=	0.72
	MLHW	=	0.40	MHWN	=	0.38
	MHLW	=	-0.40	MLWN	=	-0.38
	MLLW	=	-0.70	MLWS	=	-0.72
	LAT	=	-0.87	ISLW	=	-1.02
NE4 :	HAT	=	1.21 (m)			
	MHHW	=	0.70	MHWS	=	0.71
	MLHW	=	0.39	MHWN	=	0.38
	MHLW	=	-0.39	MLWN	=	-0.38
	MLLW	=	-0.70	MLWS	=	-0.71
	LAT	=	-0.91	ISLW	=	-1.02

The values of HAT and LAT were determined by examining predicted high and low water levels for the period 1976-1993. This technique is currently used by the Hydrographer, RAN, (Ref 2). The Admiralty Criterion for a diurnal tide is that:

$$\pi S_2 < 2 (K_1 + O_1)$$

This is true for all three sites. However, this is not an absolute criterion, and after inspection of the plots of measured water levels it would be more appropiate to describe the tides as semi-diurnal with significant diurnal inequality. No filtering of the data for meteorological events has been undertaken for the reasons outlined in Section 4.5.

Plots of measured and predicted water levels over the period are shown in the following Figures:

NE8	66-69
NE6	71-73
NE4	75-77

In each case the first one or two days data after deployment has been excluded from the analysis due to settlement of the mooring. Water level probability of exceedance plots are shown in Figures 70, 74 and 78. The probability line is derived from predicted water levels at 15 minute intervals for an entire year (1986). Values are ranked in bands of 0.02m and probabilities of exceedance calculated.

6 CONCLUSIONS

Good quality current and tide data has been collected at three sites along the North East Channel for a period of over one month. The results presented in this report will allow the study of sediment movement in the area.

7 REFERENCES

1 Manual for Tidal Heights Analysis and Prediction. Pacific Marine Science Report 77-10, prepared for the Institute of Ocean Science, Patricia Bay, Victoria, BC, Canada by M G G Foreman.

2 Australian National Tide Tables (1984): Published annually by the Hydrographer, Royal Australian Navy.

APPENDIX A

INSTRUMENT SPECIFICATIONS

620A BACM

BURST-AVERAGING CURRENT METER

9/6/84 Code String: 620A-DS-984-1

The Sea Data Model 620A Burst-Averaging Current Meter (BACM) is a smart electromagnetic-sensor instrument with a 4-year field-proven history. The new 620A features unique internal processing with the benefit of extra flexibility: the instrument offers regular vector-averaged current meter recording, burst recording for internal turbulence use, or a combination of these two applications.

The 620A is capable of recording data in any one of at least four different data formats, and thus offers the user the opportunity to tailor the data format to best satisfy the needs of the experiment. High-density recording methods and a high capacity alkaline battery pack allow for deployments of over a year in length.



The 620A BACM Current Meter.

STANDARD FEATURES

The 620A features a Marsh-McBirney 4-inch sphere two-axis electromagnetic (EM) current sensor, an 8-bit digital optical-wheel compass with a Sea Data gimbal mount, a strain gauge pressure sensor, and a YSI precision thermistor temperature sensor. The reliable Sea Data Model 610 digital recorder is used to record the data. Continuous quarter-second vector-averaged data is provided by the Sea Data SB-10 'Sea Brain'™ data cruncher.

HIGHLIGHTS

- New 'Sea Brain' data cruncher with 32-bit arithmetic
- Fully vector-averaged north and east current measurements
- Switch-selectable burst data or simple mean data, both with averaging intervals from 1 to 256 seconds
- Seiche and internal wave measuring capability
- Marsh-McBirney electromagnetic current sensor
- Reliable Sea Data Model 610 recorder with 15 megabit capacity
- Inexpensive molded fiberglass alkaline battery pack
- A variety of additional sensors available using 6' card electronics
- Suitable for independent deployments of over a year in length
- RS-232C test interface
- Internal self-checking features
  1. Unique 'mooring rotation rate' compass checking
  2. Zero offset subtraction for zero drift
  3. Calibration mode at the start of every burst

THE 620A BACM VS. THE 620 BCM

The improvements of the 620A over the 620 include:

1) Full vector-averaging with switch-selectable data output formats: a) original 620 mode, b) several new 620A burst modes, and c) compact vector-average-only mode (similar to the new 625 solid-state current meter).
2) Faster operating: 1 and 2 second scan rates added for boundary-layer turbulence studies.
3) More convenient measurement intervals (5, 10, 20 min.) added.
4) New Sea Data compass gimbal, new compass electronics with lower-current pulse, LED protection.
5) New battery-voltage regulator for greater CMOS reliability.
6) Automatic zero-offset subtraction before vector-averaging.
7) New higher-precision dual A/D converter card.
8) Software executed diagnostic and test features added.

'Sea Brain' is a trademark of SEA DATA CORPORATION.

Sea Data Corporation • One Bridge St. • Newton, MA 02158 • (617)244-3216 • TLX:951107 SEADATANEW

A Closer Look . . .

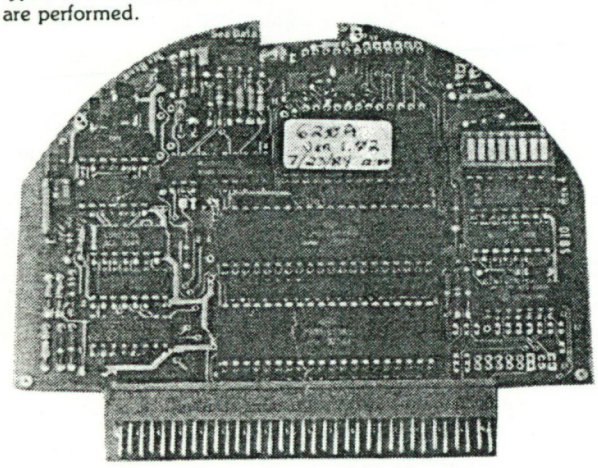
SEA BRAIN DATA CRUNCHER

The SB-10 is a versatile data cruncher board containing an 80C85 CMOS microprocessor that processes data with 8K bytes of program, as directed by the front panel switches. The special circuitry employed by the SB-10 allows the microprocessor to shut down when in sleep mode, and thus dramatically reduces current drain.

An 8-bit DIP switch on the SB-10 allows for the selection of recording formats and data processing modes. As an example, the zero-offset and CAL features may be disabled by changing the DIP switch positions.

Four of the five signal channels in the 620A are digitized with integrating A/D converter cards that perform continuous integration of the input signal. A delta-sigma converter is employed, along with a 32-bit software accumulator in the data cruncher, to insure data integrity over long intervals. The data cruncher divides the integrated data by the time interval determined from the SCAN RATE switch to provide a true average, independent of the interval. (An integrator or averager is the optimum filter for noisy or varying signals, consistent with the Nyquist sampling criteria.)

The data averaging occurs 1024 times per second and vector calculations are performed for each 250 milli-seconds. Thus for a typical 3-minute mean data value, 768 vector averages are performed.



The SB-10 data cruncher circuit card.

THE SEA DATA MODEL 610 CASSETTE RECORDER

The Sea Data Model 610 cassette recorder used in the 620A utilizes a rough industrial 200 step-per-revolution stepping motor with unique 8-phase current-source drive, and writes on four tracks at an 800 bpi density. High density writing is thus accomplished without sacrificing reliability. The recorder electronics employs all C-MOS circuitry to minimize power drain, yielding a typical standby consumption of less than 0.3 mA for the 620A (this includes all of the other electronics too).

The recorder is internationally recognized for its precision and reliability; there are currently more than 2000 units in use in the field.

A standard Sea Data cassette tape reader will write the information on the data tapes onto either IBM-compatible 9-track tapes, or directly into a computer; there are more than 150 of these readers in use in the field today. The companion ARI allows asynchronous reading. An immediate visual representation of the data can be generated by connecting the reader to a Model 17 D/A Display, which will provide the drive for a strip chart recorder.

A VARIETY OF DATA FORMATS

The 620A is equipped with four switch-selectable data formats optimized data storage. Two burst formats are included, one of which contains an additional vector mean for the burst data. One conventional 'vector-averaging' mean data format is included. The 620A also offers one bursting data mode identical to that of the original 620 BCM; this is the only format without vector-averaging of the data. In the future, Sea Data plans to add data formats which emulate those of the other current meters on the market.

PROPERTIES OF EACH RECORD FORMAT

	BACM	BURST-ONLY	COMPACT	BCM
BURST-AVERAGED	X	X	-	X
MEAN DATA	X	-	X	-
TOTAL BITS IN RECORD	296	256	104	264
RECORD CAPACITY				
300' TAPE:	31,117	35,158	69,415	29,426
450' TAPE:	46,675	52,737	104,123	44 [illegible]
DURATION @ 7.5 MINUTES (months)	5.4	6	12	5

The four record formats differ in bit length and the format in which the current velocity data is recorded on the cassette. In addition to the current velocity data, each record format includes the time, pressure, temperature, compass rate-of change, compass reading, and information on the positions of the rotary switches.

LONG TERM DEPLOYMENTS

The 620A has two power sections: one for the recorder and the logic electronics, and the other for the EM sensors. In general, the battery is sufficient to power both of these sections for at least one full experiment, using one full data tape. In some cases, several tapes may be written and frequently several experiments may be powered by a single battery.

BATTERY CAPACITY OF THE SDB-9

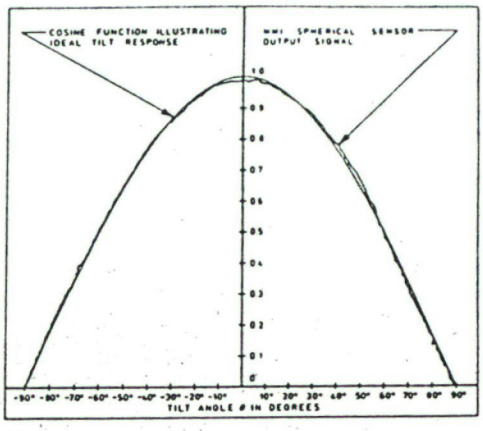
BATTERY SECTION	VOLTAGE (fresh)	TYPICAL CAPACITY SDB-9
Recorder Electronics	18 15	10 Ahr (both together)
EM Sensor	+/- 9	20 Ahr

In burst mode, the 620A can write 360,000 north, east vector-averaged current velocity data sets on a 450' tape. Internal wave measurements are practical: for example, with 24 8-second averaged measurements every 15 minutes, the 620A's data tape will last 156 days and the EM sensor's battery has 20§ of its power to spare. In continuous operation with 8-second averaging, the data tape lasts 33 days but with only a 15§ power safety margin.

Bottom turbulence climates from surface waves are also easy to measure. If 128 points at 1-second intervals are measured each 15 minutes, the tape will last a month and two tapes may be written with one battery. Full-fledged directional surface-wave recording is best done with Sea Data model 621 or 635-9, and 635-12 instruments.

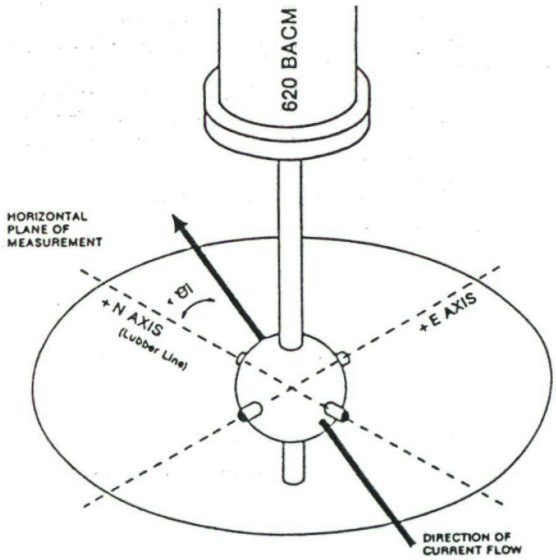
MARSH-MCBIRNEY FLOW SENSOR

The 620A BACM uses the Marsh-McBirney electromagnetic flow sensor to measure instantaneous current velocity, which is then converted to north and east averages by the SB-10 data cruncher.



Vertical tilt response of the Marsh-McBirney sensor.

This sensor is claimed to be 'THE ONLY COMMERCIALLY-AVAILABLE SENSOR THAT CAN ACCURATELY MEASURE NEAR-SURFACE OCEAN CURRENTS' due to nearly ideal cosine tilt-response. Housed in a four-inch rubber sphere on a steel extension from the 620A BACM housing, the sensor is rugged enough to withstand exceptional storm forces and is more linear at intermediate currents than smaller versions.



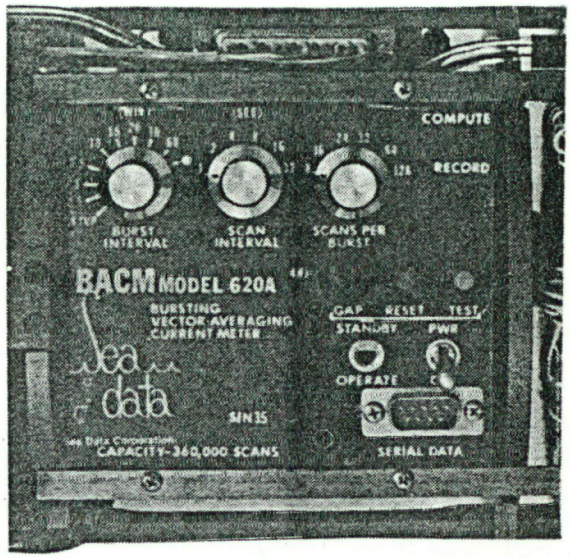
The compass receives the X, Y current velocities and the angle θi between the lubber line (Y axis) and north as input.

RS-232C TEST INTERFACES

A digital test-signal connector provides access to the 620A's sensor electronics with both VDM and RS-232C transmission formats. These signals help eliminate the last minute worries associated with long-duration experiments.

FRONT PANEL PROGRAMMING

A straight-forward front panel allows the user to program the measurement rate for optimum capacity. The 620A's averaging rate is determined by the settings of the BURST INTERVAL (time interval between the beginning of current recording bursts), SCAN INTERVAL (current measurement interval during a burst), and SCANS PER BURST (duration of recording burst) rotary switches. A number of test features can be activated from the front panel. One allows direct monitoring of the sensor data, without data cruncher processing. A series of LEDs that flash during operation reassure the user that the instrument is sampling and recording data.



The front panel of the 620A.

OPTIONAL MODIFICATIONS

SMALL REMOTE EM SENSOR: A small 1.5-inch diameter Marsh-McBirney EM sensor on the end of a 2.5 meter electrical cable (selectable) can be substituted for the 4.0-inch sphere. The sensor has an integrally molded mounting bar.

STRAIN-GAUGE PRESSURE TRANSDUCER: Optional sensor with 0.2§ accuracy.

QUARTZ PRESSURE TRANSDUCER: The 620A can be equipped with a Paroscientific Quartz Pressure Transducer for enhanced wave and tide measurements which is good to about 0.015§ absolute and 0.005§ relative.

TEST CONNECTOR: A plastic underwater test connector may be added to allow external STANDBY or RESET, and external data monitoring.

CONTINUOUS OPERATION: Either a larger battery or a lithium battery may be specified to allow long-term current sensor operation.

CONDUCTIVITY: A Sea Data 7-terminal conductivity cell may be added.

INTEGRATOR (AVERAGING) INPUTS: Additional integrating A/D converter cards may be added.

TILT SENSOR: A tilt sensor option is available. This option requires a longer instrument housing.

THERMISTOR CHAIN: A 6-foot thermistor chain will enable the 620A to be used for thermocline and internal-wave measurement.

REAL TIME DATA ACQUISITION: Real time accoustic or hard-wire data telemetry capabilities are available with the 620A. The standard RS-232C output may be employed for simple applications, or custom data output formats may be ordered.

GENERAL SPECIFICATIONS

SENSORS

2-Axis Water Velocity, Magnetic Direction, Depth (optional), and Temperature

CONTROLS

Toggles:	POWER/OFF, STANDBY/OPERATE, GAP, RESET, TEST
Rotary Switches:	BURST INTERVAL, SCAN INTERVAL, SCANS PER BURST
LED Indicators:	COMPUTE, RECORD, 4Hz

WATER VELOCITY

Sensor:	2-axis Marsh-McBirney 4.0-inch EM sphere with low-voltage electronics
Range:	+/- 300 cm/sec
Resolution:	0.15 cm/sec (12-bits)
Threshold:	0.15 cm/sec (12-bits)
Noise:	less than 0.2 cm/sec (rms, typical, with 4 sec. or slower averaging)
Error:	less than 2 cm/sec + 2% of signal

DIRECTION

Sensor:	#218 Digicourse eight-bit digital optical-wheel compass in Sea Data #418 gimbal mount
Resolution:	1.4°
Tilt Range:	operational +/-35 degrees from vertical

TEMPERATURE

Type:	YSI 0.1°C endcap mounted interchangeable thermistor
Range:	-4.5°C to +34°C
Accuracy:	+/- 0.15°C
Resolution:	0.01°C

DEPTH (OPTIONAL)

Conversion:	12-bits averaged for 2 seconds, once each record
Sensor:	CIC pressure sensor with 1% accuracy or Sensometrics strain gauge with 0.2% accuracy
Range:	1000 psig (660 meters); also 50 and 100 psia available

DATA STORAGE

Medium:	Standard digital certified 300' or 450' cassette tapes
Formats:	Four (see text)

TIMEBASE

Crystal:	2.097152 MHz quartz crystal
Stability:	Stable to +/- 1 ppm over +5°C to +40°C
Accuracy:	Better than 30 seconds per 12 months

BURST PROGRAMMING

Burst Interval = 0.5, 5.0, 7.5, 10, 15, 20, 30, 60 min., continuous
Burst Duration = 8, 16, 24, 32, 64, 128 scans
Scan Rate = 1, 2, 4, 8, 16, 32 sec.
Typical Duty Cycle: from 5 to 30% as determined by above switches

POWER

Standard:	SDB-9 Sea Data 3 section 30 Ahr alkaline battery pack. Example: in continuous operation, battery lasts 40 days. With 24 8-sec scans every 15 min., battery lasts 180 days. Generally, the battery lasts longer than the data tape.
Optional:	SDB-9L sea Data 7-section 75Ahr Lithium battery pack. For multiple experiments, more than 9 months at fast measurement intervals, etc.

ELECTRONICS RACK

Size:	33 inches long by 5.8 inches diameter
Cards:	9 5.8"-cards plus 4 MMI cards; 3 unused card slots

DATA MONITORING

VDM Form:	The data written to the digital recorder may be monitored directly by a VDM plugged into the SERIAL DATA jack
RS-232C:	300, 600, 1200, or 2400 baud ASCII hexidecimal binary data with CR-LF separating each record (switch-selectable)
Logic Levels:	0 and +10 volts (most terminals and computers will accept this); optional +/-8 volt converter available

PRESSURE CASE

Material:	6061-T6 aluminum, rated to 3500 psi
Finish:	Sanford hard-coat anodize overcoated with polyurethane paint
Size:	Case: 7.0-inch diameter by 37.5 inches long Overall: 9.0-inch diameter by 57.5 inches long
Weight:	Operational: 87 lbs - Air, 34 lbs. - Water Shipping, with crate: 153 lbs., less battery: 139 lbs
EM sensor:	1.0-inch diameter type 316 stainless steel rod
Tension:	In-line tension up to 5000 lbs.
Hardware:	Crosby galvanized steel shackles, 0.75-inch pin with glass fiber insulators, optional side-mounted tabs with nylon insulators

NOTES:

Contact SEA DATA for additional information o
the 620A BACM or any other SEA DATA product

Sea Data Corporation • One Bridge St. • Newton, MA 02158 • (617)244-3216 • TLX:951107 SEADATANEW

635-11
SPECIFICATIONS



HIGHLIGHTS:

- Uses the Paroscientific Quartz Sensor
- 0.05 cm Depth Resolution (20 m Range), 0.002° Temperature Resolution
- Has 15-Megabit Data Capacity on Standard 450′ Cassette Tapes
- Fully Reparable (Unpotted) Electronics
- Continuously Powers its Sensor With a 16-Month Battery

THE 635-11 WAVE AND TIDE RECORDER

This specification sheet provides interested parties with all relevant specifications concerning the Sea Data 635-11 Wave and Tide Recorder. The 635-11 combines the unsurpassed accuracy of the Paroscientific Quartz Pressure Sensor with the high data capacity of the Sea Data MOdel 610 Recorder, giving you an instrument with unbeatable performance specifications. Tapes from the 635-11 are easily read with the standard Sea Data Model 12B Tape Reader. Included in this specification sheet is information concerning the physical parameters of the instrument, sensor specifications and electronics specifications. Together with Product Flyer 635-11, this sheet provides complete information on the characteristics of the 635-11.

OTHER VERSIONS OF THE 635-11

In addition to the version of the 635-11 housed in a six-inch pressure housing with a endcap-mounted sensor, the -11 is available in several other forms:

635-11A, 635-11R

These loggers use the same electronics as the 635-11, but the 635-11A features an additional sensor for atmospheric measurements and the 635-11R has one remote sensor for underwater use. Cables are available in SO or double-armor sheath styles in lengths up to 1500 meters long.

1235-11

The 1235-11 uses the same electronics as the 635-11, but houses them in a 12-inch, environmentally secure fiberglass case. Power is either from a 120 VAC source or from a 20 Ahr battery. Sensor cables are available up to 1500 meters long.

1735-11, 1735A

The 1735-11's house the 635-11's electronics in a 17-inch box suitable for mounting in a 19-inch relay rack. Sensor cables are available in lengths up to 1500 meters in SO or double-armored-sheath styles. Power is by an internal 120 VAC supply with a 5 Ahr rechargeable battery keepalive, or by an external 12-volt source.

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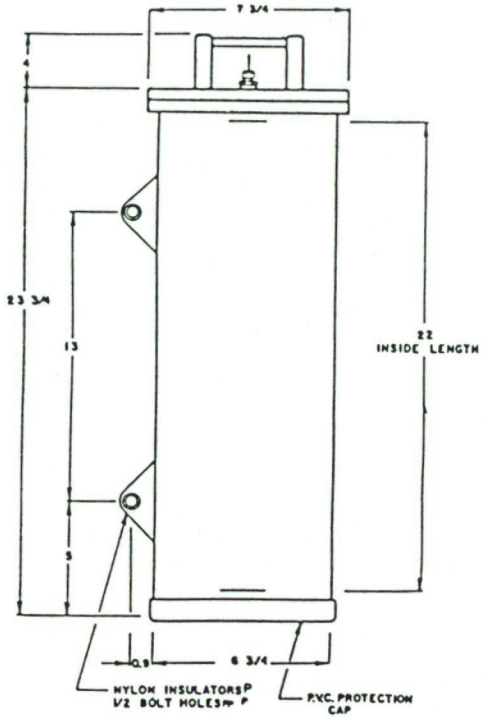
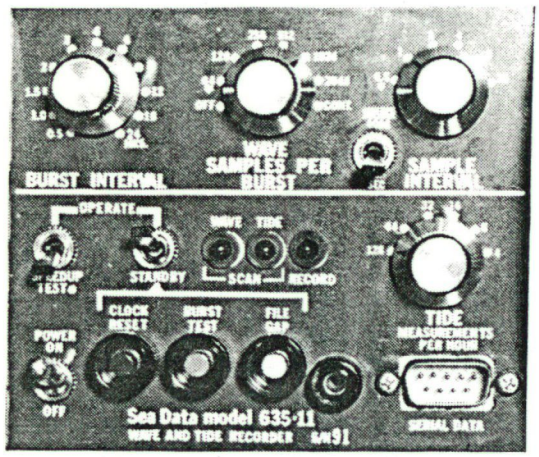




The 635-11's front panel

ORDERING INFORMATION:

You can order the 635-11 in your choice of chassis configurations (635 or 1235). Pressure ranges available for the Paros sensor are 10, 20, 55, 120, 190, 250 and 600 meters. You must specify which of these ranges you want when you order your instrument. Changing ranges is little more than changing sensors. The 635-11 is available with 0.25 sec scanning, and a 1.25x burst multiplier toggle. Spare parts and mooring systems are available for Sea Data.

If you need more information concerning the 635-11 Wave and Tide Recorder, or about other Sea Data Products, please get in touch with us!

SENSOR SPECIFICATIONS:

PRESSURE - water height

Sensor: PAROS SCIENTIFIC "DIGI-QUARTZ"

	100 psia		45 psia	
	feet	meters	feet	meters
Standard Ranges:	190	58	65	20
Maximum Depth	235	70	90	25
Resolution - waves:	0.0035	0.1 cm	0.0015	0.045 cm
tides:	0.004	0.12 cm	0.0017	0.05 cm
Accuracy				
(more than 80 ft)	0.03		0.014	0.4 cm
(less than 80 ft)	0.05 ft		(these aren't typos!)	
vs temp @30 ft	0.004 ft/°C (max)		0.003 ft/°C (max)	

Frequency Response: DC to 1.0 Hz (Nyquist limit for 0.5 s sampling)

Stability

vs time: 0.0002 %FS/month at (almost constant) ocean depths.

vs temp: zero 0.0007 %FS/°C
span 0.005 %FS/°C (at 2/3 FS, 0.004 %/°C)

vs FM Noise: below limit of resolution.

TEMPERATURE

Range: -4.5°C to +34.5°C

Resolution: 0.003°C

Accuracy: 0.07°C (Special versions to 0.01°C)

Stability: 0.005°C (small temp. excursions)
0.02°C (full temperature cycling)

FM noise: 0.002°C

Time constant: 30 minutes (options to 3 s)

ELECTRONICS SPECIFICATIONS:

TIMEBASE: 4.194304 MHz special quartz crystal

Stability: 0.1 ppm/°C, 1 ppm/year. Unmeasurable (0.0001%) pressure data error at ocean depths.

OPERATING CONTROLS

BURST INTERVAL, WAVE SAMPLES PER BURST, SAMPLE INTERVAL (with HOURS/4096) toggle) and TIDE MEASUREMENTS PER HOUR rotary switches, OPERATE/STANDBY and SPEEDUP TEST toggles, CLOCK RESET, BURST TEST and FILE GAP pushbuttons.

TIDE PROGRAMMING

Duration: 28.125 seconds to 15 minutes, with Koehler memory integrators. (128 - 64 - 32 - 16 - 8 - 4 intergrated samples every hour with TIDE MEASUREMENTS PER HOUR switch.)

WAVE PROGRAMMING - from 0.5 hour to 24 hours between bursts as follows:

BURST INTERVAL: 0.5, 1, 1.5, 2, 3, 4, 6, 8, 12, 16 or 24 hours.

SAMPLE INTERVAL: seconds mode: 0.5, 1, 2, 4, 8, 16 seconds/sample.
hours/4096 mode: 8192 - 4096 - 2048 - 1024 - 512 - 256 meas./hour.

WAVE SAMPLES PER BURST: 64 - 128 - 256 - 512 - 1024 - 2048 samples/burst, and "CONT" continuous burst -- 8.5 days at a 1 sec rate.

RECORD FORMAT - standard Sea Data tapes
308 bits long, 2 simultaneous interweaving formats:

Tides: mode, header, time, 8 sets of P and T measurements, parity.

Waves: mode, burst record number, 16 pressure samples, parity.

DATA FORMAT

Time: 20-bit binary, 128 ticks/hour (approx. 14 months before wraparound).

Pressure: tides, 20-bit binary; waves, 16-bit binary.

Temperature: 16-bit binary.

DATA STORAGE

Media: Digitally certified 300 and 450 ft. cassette tapes.

Format: 800-bpi bi-phase code on 4 tracks, 308-bit data records:

Capacity: 30,800 data records, 300' tape. (10 megabits)
48,000 data records, 450' tape. (15 megabits)

POWER

SDB-4 Sea Data 20 AHr Alkaline battery - good for 6 months or 2 tapes

SDB-4L Sea Data 40 AHr Lithium battery - good for 1.5 years.

PHYSICAL SPECIFICATIONS:

SIZE

Case: 7" diam. x 24" long.

Mounts: two 0.5" bolt holes on 13" centers, 1.0" clearance.

WEIGHT 41 lbs. in air, with battery; 12.5 lbs in water.

PRESSURE CASE

Material: 6061-T6 Aluminum

Hardware: 316 Stainless and Delrin insulators

Finish: Hard-coat anodize with electrostatic epoxy overcoat.

Depth: 1100 meter operating depth.

SITE		Current Data	Tide Data
NE8	from	1030 12:12:85	0100 14:12:85
	to	1230 06:02:86	1200 06:02:86
NE6	from	1830 06:02:86	0100 08:02:86
	to	1030 12:03:86	1000 12:03:86
NE4	from	1330 12:03:86	0100 13:03:86
	to	0730 23:04:86	0700 23:04:86

TABLE 1 : DEPLOYMENT PERIODS - AS ANALYSED

TABLE 2

CURRENT SPEED - DIRECTION FREQUENCY MATRIX, NE8

CURRENT SPEED - DIRECTION FREQUENCY MATRIX.

LAWSON & TRELOAR Pty Ltd.

CLIENT : PORT OF BRISBANE AUTHORITY

LOCATION : NORTH EAST CHANNEL NE8

LATITUDE : 26 degs 59' 12" S
LONGITUDE : 153 degs 20' 11" E

DATA START TIME : 1030 12:12:85

DATA END TIME : 1230 06:02:86

RUN DATE : 13:05:86

SPEED (m/s)

DIRECTION (DEGS)	0.0+	0.1+	0.2+	0.3+	0.4+	0.5+	0.6+	0.7+	0.8+	0.9+	1.0+	TOTALS %
337.5 - 22.5	1.08	4.92	10.59	10.29	7.31	3.17	0.45					37.79
22.5 - 67.5	1.34	2.01	1.16	0.45	0.11							5.07
67.5 - 112.5	0.97	0.30										1.27
112.5 - 157.5	1.16	0.71										1.86
157.5 - 202.5	1.12	5.48	10.85	10.47	8.80	0.89						37.61
202.5 - 247.5	1.27	4.92	1.98	0.30	0.04							8.50
247.5 - 292.5	1.68	1.27										2.94
292.5 - 337.5	1.49	3.24	0.22									4.96
TOTALS %	10.10	22.85	24.79	21.51	16.25	4.06	0.45	0.00	0.00	0.00	0.00	100.00

TOTAL NUMBER OF DATA POINTS = 2683

NOTES : - Matrix values are percentages of total number of good data points.
- Values include speeds greater than or equal to their column heading, but less than the following heading.

TABLE 3

MAXIMUM AVE CURRENT - TIDAL RANGE FREQUENCY MATRIX, NE8

TIDAL RANGE - MAX AVERAGE CURRENT FREQUENCY MATRIX

LAWSON & TRELOAR PTY LTD

CLIENT : PORT OF BRISBANE AUTHORITY

LOCATION : NORTH EAST CHANNEL NE8

DATA START TIME : 1030 12:12:85

DATA END TIME : 1230 06:02:86

FLOOD TIDE RANGE (m)

SPEED (m/s)	0.00+	0.20+	0.40+	0.60+	0.80+	1.00+	1.20+	1.40+	1.60+	1.80+	2.00+	TOTALS %
0.0 - 0.1												0.00
0.1 - 0.2		0.93										0.93
0.2 - 0.3		0.93	3.70	3.70	0.93							9.26
0.3 - 0.4				6.48	8.33	3.70	1.85					20.37
0.4 - 0.5				3.70	16.67	14.81	3.70	6.48	7.41	0.93		53.70
0.5 - 0.6							0.93	1.85	6.48	3.70	2.78	15.74
0.6 - 0.7												0.00
0.7 - 0.8												0.00
0.8 - 0.9												0.00
0.9 - 1.0												0.00
1.0 >												0.00
TOTALS %	0.00	1.85	3.70	13.89	25.93	18.52	6.48	8.33	13.89	4.63	2.78	100.00

TOTAL NUMBER OF DATA POINTS = 108

NOTES : - Matrix values are percentages of total number of good data points.
- Values include ranges greater than or equal to their column heading, but less than the following heading.

TIDAL RANGE - MAX AVERAGE CURRENT FREQUENCY MATRIX

LAWSON & TRELOAR PTY LTD

CLIENT : PORT OF BRISBANE AUTHORITY

LOCATION : NORTH EAST CHANNEL NE8

DATA START TIME : 1030 12:12:85

DATA END TIME : 1230 06:02:86

EBB TIDE RANGE (m)

SPEED (m/s)	0.00+	0.20+	0.40+	0.60+	0.80+	1.00+	1.20+	1.40+	1.60+	1.80+	2.00+	TOTALS %
0.0 - 0.1												0.00
0.1 - 0.2			0.93									0.93
0.2 - 0.3			1.87	4.67								6.54
0.3 - 0.4			0.93	5.61	16.82	5.61						28.97
0.4 - 0.5					4.67	14.02	8.41	0.93				28.04
0.5 - 0.6						4.67	8.41	11.21	6.54	1.87		32.71
0.6 - 0.7									1.87	0.93		2.80
0.7 - 0.8												0.00
0.8 - 0.9												0.00
0.9 - 1.0												0.00
1.0 >												0.00
TOTALS %	0.00	0.00	3.74	10.28	21.50	24.30	16.82	12.15	8.41	2.80	0.00	100.00

TOTAL NUMBER OF DATA POINTS = 107

NOTES : - Matrix values are percentages of total number of good data points.
- Values include ranges greater than or equal to their column heading, but less than the following heading.

CONSTANT	FREQUENCY (cyc/hr)	AMPLITUDE (m)	PHASE (deg)
Z0	0.0000000	0.0043	360.00
MM	0.0015122	0.0064	16.32
MSF	0.0028219	0.0091	46.08
ALP1	0.0343966	0.0037	52.36
2Q1	0.0357063	0.0029	81.64
Q1	0.0372185	0.0027	122.70
O1	0.0387307	0.0252	204.21
NO1	0.0402686	0.0008	152.98
P1	0.0415526	0.0167	255.17
K1	0.0417807	0.0601	259.06
J1	0.0432929	0.0048	315.81
001	0.0448308	0.0052	316.76
UPS1	0.0463430	0.0008	291.46
EPS2	0.0761773	0.0058	101.32
MU2	0.0776895	0.0212	63.48
N2	0.0789993	0.0713	349.54
M2	0.0805114	0.4014	3.53
L2	0.0820235	0.0203	15.62
S2	0.0833333	0.1202	34.05
K2	0.0835615	0.0359	24.95
ETA2	0.0850736	0.0019	111.96
MO3	0.1192421	0.0156	274.61
M3	0.1207671	0.0081	156.53
MK3	0.1222921	0.0111	7.51
SK3	0.1251141	0.0017	45.79
MN4	0.1595106	0.0049	350.28
M4	0.1610228	0.0064	339.53
SN4	0.1623326	0.0002	237.61
MS4	0.1638447	0.0103	5.47
S4	0.1666667	0.0030	135.53
2MK5	0.2028036	0.0116	140.71
2SK5	0.2084474	0.0001	254.58
2MN6	0.2400221	0.0082	236.07
M6	0.2415342	0.0072	243.68
2MS6	0.2443561	0.0079	271.73
2SM6	0.2471781	0.0011	319.05
3MK7	0.2833149	0.0038	307.33
M8	0.3220456	0.0005	47.75

TABLE 4a : TIDAL CURRENT HARMONIC CONSTANTS, NE8

NORTH - SOUTH

CONSTANT	FREQUENCY (cyc/hr)	AMPLITUDE (m)	PHASE (deg)
Z0	0.0000000	0.0211	180.00
MM	0.0015122	0.0077	338.81
MSF	0.0028219	0.0018	131.10
ALP1	0.0343966	0.0018	34.71
2Q1	0.0357063	0.0030	340.82
Q1	0.0372185	0.0013	193.62
O1	0.0387307	0.0031	205.62
NO1	0.0402686	0.0010	71.40
P1	0.0415526	0.0021	210.44
K1	0.0417807	0.0076	214.34
J1	0.0432929	0.0024	71.30
001	0.0448308	0.0017	358.47
UPS1	0.0463430	0.0009	162.70
EPS2	0.0761773	0.0032	69.54
MU2	0.0776895	0.0013	59.01
N2	0.0789993	0.0146	285.12
M2	0.0805114	0.0576	298.98
L2	0.0820235	0.0046	16.63
S2	0.0833333	0.0173	314.49
K2	0.0835615	0.0052	305.39
ETA2	0.0850736	0.0027	293.23
MO3	0.1192421	0.0048	132.15
M3	0.1207671	0.0015	322.54
MK3	0.1222921	0.0042	222.02
SK3	0.1251141	0.0015	251.67
MN4	0.1595106	0.0055	218.55
M4	0.1610228	0.0131	273.30
SN4	0.1623326	0.0010	239.24
MS4	0.1638447	0.0062	297.73
S4	0.1666667	0.0025	34.36
2MK5	0.2028036	0.0082	47.68
2SK5	0.2084474	0.0009	103.18
2MN6	0.2400221	0.0053	110.72
M6	0.2415342	0.0090	158.93
2MS6	0.2443561	0.0057	198.50
2SM6	0.2471781	0.0018	244.54
3MK7	0.2833149	0.0042	44.00
M8	0.3220456	0.0020	174.66

TABLE 4b : TIDAL CURRENT HARMONIC CONSTANTS, NE8

EAST - WEST

TABLE 5

LISTING OF MAXIMUM AVE CURRENT - TIDAL RANGE, NE8

DATE	TIME	Vmax m/s	Flood Range m
12:12:85	1830	0.459	1.122
13:12:85	0630	0.526	2.184
13:12:85	2000	0.435	1.067
14:12:85	0700	0.560	2.100
14:12:85	2000	0.458	0.966
15:12:85	0730	0.552	1.873
15:12:85	2130	0.480	0.868
16:12:85	1000	0.509	1.649
16:12:85	2200	0.439	0.755
17:12:85	1000	0.447	1.383
17:12:85	2330	0.375	0.688
18:12:85	1100	0.412	1.073
18:12:85	2330	0.375	0.716
19:12:85	1200	0.393	0.872
20:12:85	0100	0.423	0.820
20:12:85	1300	0.294	0.711
21:12:85	0100	0.368	0.936
21:12:85	1430	0.251	0.638
22:12:85	0230	0.413	1.092
22:12:85	1500	0.286	0.648
23:12:85	0300	0.500	1.285
23:12:85	1600	0.325	0.653
24:12:85	0430	0.469	1.427
24:12:85	1600	0.394	0.717
25:12:85	0430	0.507	1.582
25:12:85	1700	0.379	0.746
26:12:85	0500	0.490	1.635
26:12:85	1900	0.404	0.817
27:12:85	0630	0.507	1.676
27:12:85	1830	0.391	0.817
28:12:85	0530	0.481	1.731
28:12:85	1930	0.426	0.849
29:12:85	0630	0.540	1.746
29:12:85	1930	0.400	0.873
30:12:85	0730	0.493	1.691
30:12:85	2100	0.432	0.851
31:12:85	0900	0.470	1.594
31:12:85	2130	0.327	0.817
01:01:86	0900	0.502	1.491
01:01:86	2230	0.405	0.770
02:01:86	1000	0.484	1.331
02:01:86	2230	0.415	0.866
03:01:86	1100	0.459	1.176
04:01:86	0030	0.412	0.973
04:01:86	1230	0.374	1.006
05:01:86	0030	0.417	1.125
05:01:86	1400	0.292	0.885
06:01:86	0200	0.410	1.336
06:01:86	1400	0.403	0.803
07:01:86	0330	0.472	1.561

DATE	TIME	Vmax m/s	Flood Range m
07:01:86	1500	0.429	0.796
08:01:86	0230	0.488	1.740
08:01:86	1600	0.453	0.894
09:01:86	0600	0.509	1.892
09:01:86	1800	0.458	0.964
10:01:86	0430	0.514	1.978
10:01:86	1800	0.408	0.991
11:01:86	0530	0.513	2.029
11:01:86	1930	0.479	1.034
12:01:86	0630	0.534	1.980
12:01:86	2030	0.443	1.035
13:01:86	0730	0.482	1.861
13:01:86	2100	0.443	0.992
14:01:86	0800	0.484	1.660
14:01:86	2100	0.443	0.962
15:01:86	0800	0.456	1.402
15:01:86	2130	0.440	0.916
16:01:86	0930	0.391	1.051
16:01:86	2300	0.355	0.860
17:01:86	1100	0.355	0.801
18:01:86	0000	0.341	0.858
18:01:86	1130	0.248	0.561
19:01:86	0130	0.328	0.946
19:01:86	1130	0.200	0.393
20:01:86	0200	0.353	1.031
20:01:86	1400	0.191	0.365
21:01:86	0200	0.416	1.156
21:01:86	1530	0.285	0.420
22:01:86	0430	0.376	1.254
22:01:86	1800	0.255	0.560
23:01:86	0400	0.416	1.442
23:01:86	1700	0.348	0.693
24:01:86	0430	0.438	1.587
24:01:86	1730	0.407	0.799
25:01:86	0500	0.466	1.731
25:01:86	1800	0.393	0.884
26:01:86	0630	0.529	1.763
26:01:86	1830	0.427	0.995
27:01:86	0700	0.510	1.777
27:01:86	1930	0.434	1.049
28:01:86	0700	0.501	1.789
28:01:86	2030	0.475	1.111
29:01:86	0930	0.501	1.721
29:01:86	2100	0.454	1.092
30:01:86	1030	0.446	1.602
30:01:86	2300	0.411	1.090
31:01:86	0900	0.413	1.358
31:01:86	2230	0.468	1.129
01:02:86	1000	0.356	1.092
01:02:86	2330	0.415	1.146

DATE	TIME	Vmax m/s	Flood Range m
02:02:86	1200	0.410	0.827
03:02:86	0000	0.411	1.173
03:02:86	1300	0.272	0.620
04:02:86	0200	0.388	1.321
04:02:86	1400	0.284	0.572
05:02:86	0200	0.418	1.453
05:02:86	1600	0.382	0.669
06:02:86	0530	0.433	1.660

DATE	TIME	Vmax m/s	Ebb m	Range
13:12:85	0030	0.562	-1.322	
13:12:85	1400	0.638	-1.878	
14:12:85	0100	0.594	-1.246	
14:12:85	1400	0.587	-1.847	
15:12:85	0230	0.538	-1.060	
15:12:85	1500	0.603	-1.704	
16:12:85	0300	0.484	-0.937	
16:12:85	1530	0.496	-1.507	
17:12:85	0400	0.389	-0.762	
17:12:85	1630	0.525	-1.304	
18:12:85	0400	0.353	-0.659	
18:12:85	1830	0.430	-1.167	
19:12:85	0630	0.322	-0.547	
19:12:85	1830	0.410	-1.018	
20:12:85	0630	0.222	-0.554	
20:12:85	1930	0.391	-0.948	
21:12:85	0830	0.283	-0.635	
21:12:85	2030	0.398	-0.948	
22:12:85	0900	0.334	-0.846	
22:12:85	2130	0.372	-0.963	
23:12:85	1030	0.339	-1.044	
23:12:85	2230	0.344	-0.959	
24:12:85	1100	0.432	-1.171	
24:12:85	2330	0.374	-0.997	
25:12:85	1030	0.410	-1.357	
25:12:85	2330	0.340	-0.980	
26:12:85	1200	0.534	-1.433	
27:12:85	0000	0.418	-1.025	
27:12:85	1230	0.586	-1.518	
28:12:85	0100	0.515	-1.033	
28:12:85	1300	0.588	-1.518	
29:12:85	0130	0.492	-1.034	
29:12:85	1330	0.546	-1.536	
30:12:85	0130	0.389	-1.016	
30:12:85	1330	0.505	-1.550	
31:12:85	0230	0.487	-0.962	
31:12:85	1530	0.549	-1.498	
01:01:86	0330	0.454	-0.897	
01:01:86	1630	0.513	-1.409	
02:01:86	0400	0.348	-0.773	
02:01:86	1630	0.582	-1.362	
03:01:86	0600	0.298	-0.734	
03:01:86	1730	0.487	-1.299	
04:01:86	0500	0.367	-0.759	
04:01:86	1900	0.419	-1.237	
05:01:86	0800	0.329	-0.861	
05:01:86	1900	0.432	-1.242	
06:01:86	0830	0.421	-1.030	
06:01:86	2000	0.436	-1.155	
07:01:86	0930	0.522	-1.250	

DATE	TIME	Vmax m/s	Ebb Range m
07:01:86	2030	0.414	-1.154
08:01:86	1030	0.520	-1.493
08:01:86	2300	0.464	-1.168
09:01:86	1100	0.580	-1.733
09:01:86	2330	0.537	-1.230
10:01:86	1300	0.555	-1.796
11:01:86	0030	0.513	-1.213
11:01:86	1330	0.599	-1.861
12:01:86	0100	0.480	-1.175
12:01:86	1400	0.531	-1.789
13:01:86	0130	0.444	-1.145
13:01:86	1530	0.502	-1.658
14:01:86	0230	0.460	-1.054
14:01:86	1600	0.516	-1.534
15:01:86	0300	0.422	-0.947
15:01:86	1630	0.458	-1.357
16:01:86	0430	0.376	-0.809
16:01:86	1630	0.431	-1.176
17:01:86	0600	0.301	-0.667
17:01:86	1730	0.347	-1.029
18:01:86	0600	0.261	-0.565
18:01:86	1830	0.342	-0.887
19:01:86	0700	0.128	-0.527
19:01:86	1900	0.285	-0.767
20:01:86	0830	0.320	-0.653
20:01:86	2100	0.280	-0.676
21:01:86	0930	0.348	-0.879
21:01:86	2030	0.279	-0.715
22:01:86	1000	0.350	-1.075
22:01:86	2230	0.374	-0.819
23:01:86	1100	0.459	-1.220
23:01:86	2330	0.431	-0.960
24:01:86	1130	0.543	-1.388
24:01:86	2330	0.522	-1.072
25:01:86	1230	0.568	-1.413
26:01:86	0030	0.500	-1.091
26:01:86	1230	0.566	-1.606
27:01:86	0100	0.534	-1.217
27:01:86	1300	0.611	-1.668
28:01:86	0130	0.497	-1.244
28:01:86	1430	0.511	-1.675
29:01:86	0230	0.464	-1.192
29:01:86	1430	0.590	-1.628
30:01:86	0300	0.513	-1.140
30:01:86	1530	0.540	-1.568
31:01:86	0400	0.499	-1.046
31:01:86	1600	0.544	-1.424
01:02:86	0500	0.390	-0.931
01:02:86	1700	0.491	-1.272
02:02:86	0600	0.389	-0.884

DATE	TIME	Vmax m/s	Ebb m	Range
02:02:86	1800	0.385	-1.098	
03:02:86	0700	0.368	-0.852	
03:02:86	2000	0.371	-0.930	
04:02:86	0900	0.384	-1.030	
04:02:86	2030	0.355	-0.867	
05:02:86	0930	0.478	-1.280	
05:02:86	2130	0.392	-0.910	

TABLE 6

CURRENT SPEED - DIRECTION FREQUENCY MATRIX, NE6

CURRENT SPEED - DIRECTION FREQUENCY MATRIX.

LAWSON & TRELOAR Pty Ltd.

CLIENT : PORT OF BRISBANE AUTHORITY

LOCATION : NORTH EAST CHANNEL NE6

LATITUDE : 27 degs 01' 08" S
LONGITUDE : 153 degs 20' 20" E

DATA START TIME : 1830 06:02:86

DATA END TIME : 1030 12:03:86

RUN DATE : 13:05:86

SPEED (m/s)

DIRECTION (DEGS)	0.0+	0.1+	0.2+	0.3+	0.4+	0.5+	0.6+	0.7+	0.8+	0.9+	1.0+	TOTALS %
337.5 - 22.5	0.44	2.55	5.55	7.54	7.35	7.60	7.66	2.99	0.12			41.81
22.5 - 67.5	1.06	2.31	1.06	0.31	0.06							4.80
67.5 - 112.5	1.31	0.31										1.62
112.5 - 157.5	1.37	0.93										2.31
157.5 - 202.5	1.18	4.74	6.54	7.54	8.16	8.35	3.12	0.44				40.06
202.5 - 247.5	0.75	2.12	0.93	0.25	0.06							4.11
247.5 - 292.5	0.62	1.12										1.74
292.5 - 337.5	0.81	2.37	0.37									3.55
TOTALS %	7.54	16.45	14.45	15.64	15.64	15.95	10.78	3.43	0.12	0.00	0.00	100.00

TOTAL NUMBER OF DATA POINTS = 1605

NOTES : - Matrix values are percentages of total number of good data points.
- Values include speeds greater than or equal to their column heading, but less than the following heading.

TABLE 7

MAXIMUM AVE CURRENT - TIDAL RANGE FREQUENCY MATRIX, NE6

TIDAL RANGE - MAX AVERAGE CURRENT FREQUENCY MATRIX

LAWSON & TRELOAR PTY LTD

CLIENT : PORT OF BRISBANE AUTHORITY

LOCATION : NORTH EAST CHANNEL NE6

DATA START TIME : 1830 06:02:86

DATA END TIME : 1030 12:03:86

FLOOD TIDE RANGE (m)

SPEED (m/s)	0.00+	0.20+	0.40+	0.60+	0.80+	1.00+	1.20+	1.40+	1.60+	1.80+	2.00+	TOTALS %
0.0 - 0.1												0.00
0.1 - 0.2		3.13										3.13
0.2 - 0.3		1.56	1.56									3.13
0.3 - 0.4			6.25	1.56	3.13	1.56	1.56					14.06
0.4 - 0.5				3.13	4.69	1.56	3.13	1.56				14.06
0.5 - 0.6					4.69	9.38	14.06	3.13	3.13			34.38
0.6 - 0.7						7.81	1.56	3.13	6.25	3.13		21.88
0.7 - 0.8						1.56			1.56	6.25		9.38
0.8 - 0.9												0.00
0.9 - 1.0												0.00
1.0 >												0.00
TOTALS %	0.00	4.69	7.81	4.69	12.50	21.88	20.31	7.81	10.94	9.38	0.00	100.00

TOTAL NUMBER OF DATA POINTS = 64

NOTES : - Matrix values are percentages of total number of good data points.
- Values include ranges greater than or equal to their column heading, but less than the following heading.

TIDAL RANGE - MAX AVERAGE CURRENT FREQUENCY MATRIX

LAWSON & TRELOAR PTY LTD

CLIENT : PORT OF BRISBANE AUTHORITY

LOCATION : NORTH EAST CHANNEL NE6

DATA START TIME : 1830 06:02:86

DATA END TIME : 1030 12:03:86

EBB TIDE RANGE (m)

SPEED (m/s)	0.00+	0.20+	0.40+	0.60+	0.80+	1.00+	1.20+	1.40+	1.60+	1.80+	2.00+	TOTALS %
0.0 - 0.1												0.00
0.1 - 0.2												0.00
0.2 - 0.3												0.00
0.3 - 0.4			4.69	6.25								10.94
0.4 - 0.5				7.81	6.25							14.06
0.5 - 0.6					7.81	6.25	1.56					15.63
0.6 - 0.7						4.69	15.63	6.25	1.56			28.13
0.7 - 0.8						3.13	7.81	10.94	7.81			29.69
0.8 - 0.9									1.56			1.56
0.9 - 1.0												0.00
1.0 >												0.00
TOTALS %	0.00	0.00	4.69	14.06	14.06	14.06	25.00	17.19	10.94	0.00	0.00	100.00

TOTAL NUMBER OF DATA POINTS = 64

NOTES : - Matrix values are percentages of total number of good data points.
- Values include ranges greater than or equal to their column heading, but less than the following heading.

CONSTANT	FREQUENCY (cyc/hr)	AMPLITUDE (m)	PHASE (deg)
Z0	0.0000000	0.0372	360.00
MM	0.0015122	0.0164	34.62
MSF	0.0028219	0.0106	2.87
ALP1	0.0343966	0.0047	309.61
2Q1	0.0357063	0.0045	108.72
Q1	0.0372185	0.0084	167.59
O1	0.0387307	0.0437	227.21
NO1	0.0402686	0.0036	110.47
P1	0.0415526	0.0223	259.98
K1	0.0417807	0.0801	263.88
J1	0.0432929	0.0035	91.25
OO1	0.0448308	0.0046	359.51
UPS1	0.0463430	0.0037	92.20
EPS2	0.0761773	0.0069	184.01
MU2	0.0776895	0.0198	119.24
N2	0.0789993	0.0564	0.38
M2	0.0805114	0.5300	7.59
L2	0.0820235	0.0243	344.36
S2	0.0833333	0.1566	32.69
K2	0.0835615	0.0468	23.59
ETA2	0.0850736	0.0083	163.60
MO3	0.1192421	0.0216	298.76
M3	0.1207671	0.0027	176.17
MK3	0.1222921	0.0189	12.51
SK3	0.1251141	0.0052	31.20
MN4	0.1595106	0.0015	338.42
M4	0.1610228	0.0312	82.95
SN4	0.1623326	0.0016	131.07
MS4	0.1638447	0.0169	143.25
S4	0.1666667	0.0036	246.46
2MK5	0.2028036	0.0185	182.27
2SK5	0.2084474	0.0038	258.26
2MN6	0.2400221	0.0108	219.40
M6	0.2415342	0.0234	263.37
2MS6	0.2443561	0.0267	294.91
2SM6	0.2471781	0.0060	308.98
3MK7	0.2833149	0.0077	315.41
M8	0.3220456	0.0085	8.34

TABLE 8a : TIDAL CURRENT HARMONIC CONSTANTS, NE6

NORTH - SOUTH

CONSTANT	FREQUENCY (cyc/hr)	AMPLITUDE (m)	PHASE (deg)
Z0	0.0000000	0.0211	180.00
MM	0.0015122	0.0049	232.36
MSF	0.0028219	0.0110	233.21
ALP1	0.0343966	0.0029	81.33
2Q1	0.0357063	0.0021	335.69
Q1	0.0372185	0.0024	160.24
O1	0.0387307	0.0077	259.26
NO1	0.0402686	0.0030	53.64
P1	0.0415526	0.0032	218.49
K1	0.0417807	0.0116	222.39
J1	0.0432929	0.0045	28.65
001	0.0448308	0.0004	14.36
UPS1	0.0463430	0.0006	308.18
EPS2	0.0761773	0.0013	18.88
MU2	0.0776895	0.0076	8.47
N2	0.0789993	0.0086	2.45
M2	0.0805114	0.0802	316.65
L2	0.0820235	0.0014	74.20
S2	0.0833333	0.0270	1.44
K2	0.0835615	0.0081	352.34
ETA2	0.0850736	0.0018	267.67
MO3	0.1192421	0.0035	208.77
M3	0.1207671	0.0032	37.17
MK3	0.1222921	0.0039	135.96
SK3	0.1251141	0.0022	300.86
MN4	0.1595106	0.0034	314.00
M4	0.1610228	0.0106	251.76
SN4	0.1623326	0.0020	24.68
MS4	0.1638447	0.0107	273.50
S4	0.1666667	0.0014	29.40
2MK5	0.2028036	0.0022	57.16
2SK5	0.2084474	0.0009	129.84
2MN6	0.2400221	0.0016	208.77
M6	0.2415342	0.0069	177.32
2MS6	0.2443561	0.0101	204.66
2SM6	0.2471781	0.0040	279.06
3MK7	0.2833149	0.0016	200.01
M8	0.3220456	0.0021	158.21

TABLE 8b : TIDAL CURRENT HARMONIC CONSTANTS, NE6

EAST - WEST

TABLE 9

LISTING OF MAXIMUM AVE CURRENT - TIDAL RANGE, NE6

DATE	TIME	Vmax m/s	Flood Range m
07:02:86	0500	0.700	1.856
07:02:86	1730	0.543	0.966
08:02:86	0430	0.658	1.935
08:02:86	1800	0.606	1.059
09:02:86	0500	0.712	1.954
09:02:86	1900	0.655	1.099
10:02:86	0700	0.740	1.879
10:02:86	1930	0.615	1.147
11:02:86	0700	0.726	1.729
11:02:86	1930	0.607	1.154
12:02:86	0800	0.683	1.551
12:02:86	2100	0.607	1.188
13:02:86	0730	0.580	1.303
13:02:86	2130	0.542	1.095
14:02:86	1000	0.543	1.075
14:02:86	2100	0.582	1.008
15:02:86	1000	0.470	0.750
15:02:86	2130	0.559	0.973
16:02:86	1130	0.304	0.441
16:02:86	2200	0.429	0.900
17:02:86	1230	0.191	0.263
18:02:86	0100	0.388	0.889
18:02:86	1330	0.194	0.239
19:02:86	0100	0.386	0.930
19:02:86	1500	0.272	0.361
20:02:86	0400	0.466	1.113
20:02:86	1600	0.355	0.562
21:02:86	0430	0.558	1.321
21:02:86	1630	0.473	0.739
22:02:86	0500	0.617	1.521
22:02:86	1730	0.562	0.894
23:02:86	0400	0.667	1.655
23:02:86	1730	0.575	1.033
24:02:86	0530	0.689	1.770
24:02:86	1800	0.721	1.135
25:02:86	0600	0.720	1.856
25:02:86	1930	0.584	1.272
26:02:86	0630	0.667	1.810
26:02:86	1930	0.636	1.344
27:02:86	0700	0.612	1.706
27:02:86	2030	0.563	1.383
28:02:86	0900	0.584	1.480
28:02:86	2100	0.575	1.388
01:03:86	0900	0.543	1.208
01:03:86	2130	0.536	1.349
02:03:86	1000	0.465	0.884
02:03:86	2300	0.484	1.245
03:03:86	1200	0.326	0.573
03:03:86	2300	0.381	1.199
04:03:86	1230	0.278	0.426

DATE	TIME	Vmax m/s	Flood Range m
05:03:86	0100	0.370	1.207
05:03:86	1400	0.320	0.509
06:03:86	0200	0.404	1.313
06:03:86	1600	0.353	0.631
07:03:86	0330	0.447	1.474
07:03:86	1630	0.452	0.830
08:03:86	0500	0.507	1.598
08:03:86	1730	0.521	1.021
09:03:86	0600	0.552	1.648
09:03:86	1730	0.545	1.146
10:03:86	0500	0.611	1.691
10:03:86	1730	0.533	1.296
11:03:86	0700	0.597	1.649
11:03:86	1830	0.596	1.344

DATE	TIME	Vmax m/s	Ebb Range m
07:02:86	1130	0.742	-1.574
07:02:86	2330	0.729	-1.157
08:02:86	1230	0.797	-1.744
09:02:86	0030	0.730	-1.269
09:02:86	1300	0.829	-1.739
10:02:86	0100	0.756	-1.300
10:02:86	1230	0.731	-1.658
11:02:86	0130	0.734	-1.308
11:02:86	1330	0.741	-1.589
12:02:86	0300	0.772	-1.217
12:02:86	1500	0.798	-1.473
13:02:86	0300	0.702	-1.078
13:02:86	1600	0.659	-1.303
14:02:86	0400	0.591	-0.968
14:02:86	1600	0.658	-1.147
15:02:86	0400	0.498	-0.761
15:02:86	1600	0.565	-0.933
16:02:86	0430	0.428	-0.639
16:02:86	1730	0.381	-0.760
17:02:86	0700	0.322	-0.566
17:02:86	1830	0.366	-0.604
18:02:86	0730	0.328	-0.662
18:02:86	1930	0.352	-0.477
19:02:86	0930	0.436	-0.814
19:02:86	2030	0.396	-0.590
20:02:86	0930	0.529	-0.999
20:02:86	2200	0.456	-0.752
21:02:86	1100	0.645	-1.204
21:02:86	2200	0.534	-0.950
22:02:86	1030	0.649	-1.396
22:02:86	2300	0.598	-1.038
23:02:86	1200	0.771	-1.492
24:02:86	0030	0.646	-1.196
24:02:86	1300	0.677	-1.625
25:02:86	0100	0.699	-1.325
25:02:86	1330	0.715	-1.710
26:02:86	0200	0.652	-1.406
26:02:86	1330	0.727	-1.687
27:02:86	0130	0.732	-1.387
27:02:86	1430	0.710	-1.656
28:02:86	0230	0.667	-1.330
28:02:86	1530	0.723	-1.505
01:03:86	0330	0.623	-1.237
01:03:86	1530	0.687	-1.341
02:03:86	0400	0.560	-1.092
02:03:86	1730	0.565	-1.053
03:03:86	0630	0.498	-0.947
03:03:86	1730	0.455	-0.822
04:03:86	0800	0.493	-0.943
04:03:86	1900	0.418	-0.652

DATE	TIME	Vmax m/s	Ebb m	Range
05:03:86	0830	0.504	-1.065	
05:03:86	2100	0.397	-0.630	
06:03:86	1030	0.549	-1.239	
06:03:86	2130	0.488	-0.756	
07:03:86	1130	0.652	-1.437	
07:03:86	2330	0.579	-0.957	
08:03:86	1130	0.666	-1.529	
09:03:86	0030	0.609	-1.177	
09:03:86	1130	0.683	-1.544	
10:03:86	0000	0.658	-1.336	
10:03:86	1200	0.746	-1.545	
11:03:86	0000	0.640	-1.338	
11:03:86	1300	0.734	-1.571	
12:03:86	0130	0.670	-1.320	

TABLE 10

CURRENT SPEED - DIRECTION FREQUENCY MATRIX, NE4

CURRENT SPEED - DIRECTION FREQUENCY MATRIX.

LAWSON & TRELOAR Pty Ltd.

CLIENT : PORT OF BRISBANE AUTHORITY

LOCATION : NORTH EAST CHANNEL NE4

LATITUDE : 27 degs 02' 29" S
LONGITUDE : 153 degs 20' 22" E

DATA START TIME : 1330 12:03:86

DATA END TIME : 0730 23:04:86

RUN DATE : 13:05:86

DIRECTION (DEGS)	SPEED (m/s) 0.0+	0.1+	0.2+	0.3+	0.4+	0.5+	0.6+	0.7+	0.8+	0.9+	1.0+	TOTALS %
337.5 - 22.5	0.25	2.20	4.30	4.95	5.15	5.15	5.95	3.30	0.25			31.48
22.5 - 67.5	1.55	2.30	3.25	2.25	2.65	1.85	1.65	1.20	0.30			16.99
67.5 - 112.5	1.25	0.25										1.50
112.5 - 157.5	0.55	0.15										0.70
157.5 - 202.5	1.20	3.60	3.30	1.60	0.50							10.19
202.5 - 247.5	0.50	2.40	4.65	7.45	11.84	5.35	0.10					32.28
247.5 - 292.5	0.80	1.60	0.35	0.10								2.85
292.5 - 337.5	0.50	2.65	0.50	0.30	0.05							4.00
TOTALS %	6.60	15.14	16.34	16.64	20.19	12.34	7.70	4.50	0.55	0.00	0.00	100.00

TOTAL NUMBER OF DATA POINTS = 2001

NOTES : - Matrix values are percentages of total number of good data points.
- Values include speeds greater than or equal to their column heading, but less than the following heading.

TABLE 11

MAXIMUM AVE CURRENT - TIDAL RANGE FREQUENCY MATRIX, NE4

TIDAL RANGE - MAX AVERAGE CURRENT FREQUENCY MATRIX

LAWSON & TRELOAR PTY LTD

CLIENT : PORT OF BRISBANE AUTHORITY

LOCATION : NORTH EAST CHANNEL NE4

DATA START TIME : 1330 12:03:86

DATA END TIME : 0730 23:04:86

FLOOD TIDE RANGE (m)

SPEED (Tp secs)	0.00+	0.20+	0.40+	0.60+	0.80+	1.00+	1.20+	1.40+	1.60+	1.80+	2.00+	TOTALS %
0.0 - 0.1												0.00
0.1 - 0.2												0.00
0.2 - 0.3		3.85	1.28									5.13
0.3 - 0.4		2.56	1.28	1.28	5.13							10.26
0.4 - 0.5		1.28	3.85	6.41	7.69	10.26	5.13	1.28	1.28			37.18
0.5 - 0.6					3.85	6.41	15.38	14.10	6.41			46.15
0.6 - 0.7									1.28			1.28
0.7 - 0.8												0.00
0.8 - 0.9												0.00
0.9 - 1.0												0.00
1.0 >												0.00
TOTALS %	0.00	7.69	6.41	7.69	16.67	16.67	20.51	15.38	8.97	0.00	0.00	100.00

TOTAL NUMBER OF DATA POINTS = 78

NOTES : - Matrix values are percentages of total number of good data points.
- Values include speeds greater than or equal to their column heading, but less than the following heading.

TIDAL RANGE - MAX AVERAGE CURRENT FREQUENCY MATRIX

LAWSON & TRELOAR PTY LTD

CLIENT : PORT OF BRISBANE AUTHORITY

LOCATION : NORTH EAST CHANNEL NE4

DATA START TIME : 1330 12:03:86

DATA END TIME : 0730 23:04:86

EBB TIDE RANGE (m)

SPEED (Tp secs)	0.00+	0.20+	0.40+	0.60+	0.80+	1.00+	1.20+	1.40+	1.60+	1.80+	2.00+	TOTALS %
0.0 - 0.1												0.00
0.1 - 0.2												0.00
0.2 - 0.3												0.00
0.3 - 0.4		2.56	3.85									6.41
0.4 - 0.5			3.85	6.41	5.13							15.38
0.5 - 0.6				2.56	8.97			1.28				12.82
0.6 - 0.7					3.85	12.82	6.41					23.08
0.7 - 0.8						6.41	15.38	8.97	2.56			33.33
0.8 - 0.9							2.56	2.56	3.85			8.97
0.9 - 1.0												0.00
1.0 >												0.00
TOTALS %	0.00	2.56	7.69	8.97	17.95	19.23	24.36	12.82	6.41	0.00	0.00	100.00

TOTAL NUMBER OF DATA POINTS = 78

NOTES : - Matrix values are percentages of total number of good data points.
- Values include speeds greater than or equal to their column heading, but less than the following heading.

CONSTANT	FREQUENCY (cyc/hr)	AMPLITUDE (m)	PHASE (deg)
ZO	0.0000000	0.0844	360.00
MM	0.0015122	0.0141	347.75
MSF	0.0028219	0.0313	14.39
ALP1	0.0343966	0.0030	11.16
2Q1	0.0357063	0.0101	102.75
Q1	0.0372185	0.0070	159.51
O1	0.0387307	0.0349	202.75
NO1	0.0402686	0.0031	248.50
P1	0.0415526	0.0217	248.77
K1	0.0417807	0.0782	252.67
J1	0.0432929	0.0082	263.13
OO1	0.0448308	0.0099	31.93
UPS1	0.0463430	0.0025	18.25
EPS2	0.0761773	0.0123	153.04
MU2	0.0776895	0.0351	159.65
N2	0.0789993	0.0813	6.34
M2	0.0805114	0.5017	6.23
L2	0.0820235	0.0229	324.73
S2	0.0833333	0.1289	32.21
K2	0.0835615	0.0385	23.11
ETA2	0.0850736	0.0126	214.19
MO3	0.1192421	0.0218	293.43
M3	0.1207671	0.0085	132.48
MK3	0.1222921	0.0081	322.81
SK3	0.1251141	0.0077	359.97
MN4	0.1595106	0.0088	329.18
M4	0.1610228	0.0233	38.15
SN4	0.1623326	0.0021	322.49
MS4	0.1638447	0.0156	44.50
S4	0.1666667	0.0024	4.39
2MK5	0.2028036	0.0075	102.05
2SK5	0.2084474	0.0002	180.26
2MN6	0.2400221	0.0078	221.68
M6	0.2415342	0.0297	230.22
2MS6	0.2443561	0.0325	244.46
2SM6	0.2471781	0.0076	268.54
3MK7	0.2833149	0.0036	86.00
M8	0.3220456	0.0024	351.46

TABLE 12a : TIDAL CURRENT HARMONIC CONSTANTS, NE4

NORTH - SOUTH

CONSTANT	FREQUENCY (cyc/hr)	AMPLITUDE (m)	PHASE (deg)
Z0	0.0000000	0.0158	180.00
MM	0.0015122	0.0040	155.82
MSF	0.0028219	0.0041	266.56
ALP1	0.0343966	0.0023	321.63
2Q1	0.0357063	0.0055	137.11
Q1	0.0372185	0.0048	172.73
O1	0.0387307	0.0148	231.37
NO1	0.0402686	0.0022	305.81
P1	0.0415526	0.0105	234.07
K1	0.0417807	0.0377	237.97
J1	0.0432929	0.0048	251.88
001	0.0448308	0.0034	12.70
UPS1	0.0463430	0.0002	322.96
EPS2	0.0761773	0.0036	10.14
MU2	0.0776895	0.0145	120.48
N2	0.0789993	0.0478	330.31
M2	0.0805114	0.2343	345.23
L2	0.0820235	0.0214	290.58
S2	0.0833333	0.0654	12.49
K2	0.0835615	0.0196	3.39
ETA2	0.0850736	0.0061	130.82
MO3	0.1192421	0.0061	274.41
M3	0.1207671	0.0037	100.39
MK3	0.1222921	0.0038	340.02
SK3	0.1251141	0.0050	349.69
MN4	0.1595106	0.0010	155.50
M4	0.1610228	0.0062	251.54
SN4	0.1623326	0.0019	181.24
MS4	0.1638447	0.0047	231.26
S4	0.1666667	0.0025	302.67
2MK5	0.2028036	0.0030	64.50
2SK5	0.2084474	0.0013	10.60
2MN6	0.2400221	0.0070	215.92
M6	0.2415342	0.0088	228.10
2MS6	0.2443561	0.0097	242.77
2SM6	0.2471781	0.0024	299.73
3MK7	0.2833149	0.0030	102.27
M8	0.3220456	0.0047	158.03

TABLE 12b : TIDAL CURRENT HARMONIC CONSTANTS, NE4

EAST - WEST

DATE	TIME	Vmax m/s	Flood Range m
12:03:86	1900	0.567	1.453
13:03:86	0800	0.560	1.306
13:03:86	2030	0.539	1.371
14:03:86	0800	0.492	1.112
14:03:86	2030	0.525	1.284
15:03:86	0830	0.482	0.886
15:03:86	2130	0.491	1.186
16:03:86	0900	0.399	0.635
16:03:86	2030	0.417	1.088
17:03:86	0930	0.294	0.418
17:03:86	2130	0.404	0.976
18:03:86	1130	0.235	0.232
19:03:86	0000	0.385	0.880
20:03:86	0030	0.439	0.878
20:03:86	1500	0.304	0.353
21:03:86	0230	0.484	0.964
21:03:86	1530	0.376	0.547
22:03:86	0300	0.482	1.170
22:03:86	1530	0.437	0.763
23:03:86	0400	0.495	1.359
23:03:86	1700	0.417	0.967
24:03:86	0430	0.511	1.549
24:03:86	1630	0.456	1.210
25:03:86	0400	0.467	1.686
25:03:86	1800	0.479	1.401
26:03:86	0530	0.537	1.771
26:03:86	1830	0.541	1.601
27:03:86	0630	0.574	1.702
27:03:86	1930	0.548	1.728
28:03:86	0700	0.594	1.522
28:03:86	1930	0.609	1.745
29:03:86	0800	0.495	1.273
29:03:86	2000	0.583	1.709
30:03:86	0900	0.502	0.967
30:03:86	2000	0.557	1.569
31:03:86	0930	0.436	0.665
31:03:86	2130	0.520	1.365
01:04:86	1100	0.402	0.449
01:04:86	2230	0.479	1.201
02:04:86	1300	0.388	0.399
02:04:86	2330	0.447	1.147
03:04:86	1500	0.407	0.570
04:04:86	0200	0.467	1.188
04:04:86	1530	0.482	0.778
05:04:86	0230	0.529	1.304
05:04:86	1700	0.511	0.986
06:04:86	0430	0.533	1.356
06:04:86	1630	0.559	1.169
07:04:86	0500	0.541	1.420
07:04:86	1600	0.576	1.309

DATE	TIME	Vmax m/s	Flood Range m
08:04:86	0500	0.555	1.383
08:04:86	1800	0.560	1.418
09:04:86	0600	0.537	1.303
09:04:86	1800	0.585	1.499
10:04:86	0600	0.529	1.197
10:04:86	1730	0.555	1.462
11:04:86	0630	0.505	1.018
11:04:86	1930	0.553	1.462
12:04:86	0730	0.501	0.877
12:04:86	1930	0.508	1.389
13:04:86	0830	0.418	0.699
13:04:86	1930	0.514	1.311
14:04:86	0900	0.428	0.537
14:04:86	1930	0.526	1.193
15:04:86	1000	0.400	0.360
15:04:86	2130	0.416	1.019
16:04:86	1000	0.288	0.266
16:04:86	2200	0.376	0.864
17:04:86	2330	0.349	0.803
18:04:86	1400	0.298	0.391
19:04:86	0100	0.376	0.889
19:04:86	1430	0.465	0.643
20:04:86	0130	0.468	1.072
20:04:86	1500	0.489	0.948
21:04:86	0330	0.529	1.269
21:04:86	1600	0.508	1.179
22:04:86	0430	0.521	1.402
22:04:86	1600	0.557	1.454

DATE	TIME	Vmax m/s	Ebb Range m
13:03:86	0130	0.773	-1.281
13:03:86	1430	0.771	-1.354
14:03:86	0200	0.704	-1.196
14:03:86	1500	0.713	-1.211
15:03:86	0300	0.711	-1.113
15:03:86	1500	0.646	-1.057
16:03:86	0330	0.581	-0.954
16:03:86	1500	0.573	-0.857
17:03:86	0430	0.451	-0.760
17:03:86	1530	0.454	-0.660
18:03:86	0600	0.423	-0.686
18:03:86	1730	0.326	-0.454
19:03:86	0630	0.400	-0.837
20:03:86	0800	0.492	-0.806
20:03:86	2030	0.345	-0.408
21:03:86	0930	0.582	-0.999
21:03:86	2100	0.481	-0.616
22:03:86	1030	0.650	-1.196
22:03:86	2200	0.612	-0.829
23:03:86	1030	0.710	-1.395
23:03:86	2300	0.760	-1.077
24:03:86	1130	0.757	-1.571
24:03:86	2300	0.721	-1.313
25:03:86	1230	0.768	-1.687
26:03:86	0000	0.759	-1.457
26:03:86	1200	0.862	-1.790
27:03:86	0130	0.782	-1.550
27:03:86	1200	0.853	-1.771
28:03:86	0100	0.783	-1.595
28:03:86	1430	0.811	-1.649
29:03:86	0200	0.553	-1.515
29:03:86	1330	0.742	-1.427
30:03:86	0300	0.766	-1.376
30:03:86	1500	0.699	-1.129
31:03:86	0330	0.712	-1.257
31:03:86	1630	0.607	-0.813
01:04:86	0530	0.621	-1.114
01:04:86	1800	0.464	-0.580
02:04:86	0600	0.625	-1.130
02:04:86	1900	0.376	-0.462
03:04:86	0800	0.602	-1.207
03:04:86	2100	0.455	-0.585
04:04:86	0900	0.702	-1.285
04:04:86	2130	0.567	-0.774
05:04:86	0930	0.788	-1.400
05:04:86	2230	0.651	-1.002
06:04:86	1100	0.818	-1.357
06:04:86	2230	0.755	-1.168
07:04:86	1100	0.811	-1.450
08:04:86	0030	0.723	-1.277

DATE	TIME	Vmax m/s	Ebb m	Range
08:04:86	1130	0.813	-1.453	
09:04:86	0000	0.811	-1.329	
09:04:86	1130	0.748	-1.371	
10:04:86	0030	0.752	-1.302	
10:04:86	1230	0.727	-1.345	
11:04:86	0200	0.690	-1.322	
11:04:86	1400	0.655	-1.224	
12:04:86	0130	0.687	-1.249	
12:04:86	1330	0.620	-1.081	
13:04:86	0200	0.678	-1.150	
13:04:86	1400	0.612	-0.891	
14:04:86	0330	0.640	-1.005	
14:04:86	1430	0.505	-0.725	
15:04:86	0330	0.539	-0.894	
15:04:86	1600	0.415	-0.541	
16:04:86	0400	0.501	-0.814	
16:04:86	1700	0.337	-0.397	
17:04:86	0630	0.448	-0.839	
18:04:86	0630	0.493	-0.862	
18:04:86	2000	0.393	-0.394	
19:04:86	0800	0.573	-0.998	
19:04:86	2030	0.499	-0.602	
20:04:86	0930	0.664	-1.194	
20:04:86	2100	0.558	-0.846	
21:04:86	0930	0.738	-1.422	
21:04:86	2200	0.733	-1.130	
22:04:86	1000	0.772	-1.601	
22:04:86	2230	0.695	-1.344	

CONSTANT	FREQUENCY (cyc/hr)	AMPLITUDE (m)	PHASE (deg)
Z0	0.0000000	19.2664	0.00
MM	0.0015122	0.0425	264.95
MSF	0.0028219	0.0107	334.14
ALP1	0.0343966	0.0049	334.13
2Q1	0.0357063	0.0037	328.44
Q1	0.0372185	0.0212	66.03
O1	0.0387307	0.1078	119.47
NO1	0.0402686	0.0061	240.35
P1	0.0415526	0.0553	154.20
K1	0.0417807	0.1990	158.10
J1	0.0432929	0.0202	213.49
OO1	0.0448308	0.0058	223.31
UPS1	0.0463430	0.0007	67.59
EPS2	0.0761773	0.0019	213.81
MU2	0.0776895	0.0243	289.96
N2	0.0789993	0.1050	227.36
M2	0.0805114	0.5603	247.57
L2	0.0820235	0.0304	269.24
S2	0.0833333	0.1786	269.48
K2	0.0835615	0.0534	260.38
ETA2	0.0850736	0.0021	220.08
MO3	0.1192421	0.0048	169.75
M3	0.1207671	0.0044	327.99
MK3	0.1222921	0.0030	11.12
SK3	0.1251141	0.0041	281.25
MN4	0.1595106	0.0013	114.00
M4	0.1610228	0.0104	142.19
SN4	0.1623326	0.0023	218.22
MS4	0.1638447	0.0048	190.38
S4	0.1666667	0.0035	328.32
2MK5	0.2028036	0.0020	351.24
2SK5	0.2084474	0.0006	347.29
2MN6	0.2400221	0.0027	92.14
M6	0.2415342	0.0038	112.28
2MS6	0.2443561	0.0011	125.83
2SM6	0.2471781	0.0004	92.69
3MK7	0.2833149	0.0010	333.34
M8	0.3220456	0.0020	61.58

TABLE 14 : TIDAL HARMONIC CONSTANTS, NE8

TABLE 13

LISTING OF MAXIMUM AVE CURRENT - TIDAL RANGE, NE4

DATE	TIME	Vmax m/s	Flood Range m
12:03:86	1900	0.567	1.453
13:03:86	0800	0.560	1.306
13:03:86	2030	0.539	1.371
14:03:86	0800	0.492	1.112
14:03:86	2030	0.525	1.284
15:03:86	0830	0.482	0.886
15:03:86	2130	0.491	1.186
16:03:86	0900	0.399	0.635
16:03:86	2030	0.417	1.088
17:03:86	0930	0.294	0.418
17:03:86	2130	0.404	0.976
18:03:86	1130	0.235	0.232
19:03:86	0000	0.385	0.880
20:03:86	0030	0.439	0.878
20:03:86	1500	0.304	0.353
21:03:86	0230	0.484	0.964
21:03:86	1530	0.376	0.547
22:03:86	0300	0.482	1.170
22:03:86	1530	0.437	0.763
23:03:86	0400	0.495	1.359
23:03:86	1700	0.417	0.967
24:03:86	0430	0.511	1.549
24:03:86	1630	0.456	1.210
25:03:86	0400	0.467	1.686
25:03:86	1800	0.479	1.401
26:03:86	0530	0.537	1.771
26:03:86	1830	0.541	1.601
27:03:86	0630	0.574	1.702
27:03:86	1930	0.548	1.728
28:03:86	0700	0.594	1.522
28:03:86	1930	0.609	1.745
29:03:86	0800	0.495	1.273
29:03:86	2000	0.583	1.709
30:03:86	0900	0.502	0.967
30:03:86	2000	0.557	1.569
31:03:86	0930	0.436	0.665
31:03:86	2130	0.520	1.365
01:04:86	1100	0.402	0.449
01:04:86	2230	0.479	1.201
02:04:86	1300	0.388	0.399
02:04:86	2330	0.447	1.147
03:04:86	1500	0.407	0.570
04:04:86	0200	0.467	1.188
04:04:86	1530	0.482	0.778
05:04:86	0230	0.529	1.304
05:04:86	1700	0.511	0.986
06:04:86	0430	0.533	1.356
06:04:86	1630	0.559	1.169
07:04:86	0500	0.541	1.420
07:04:86	1600	0.576	1.309

DATE	TIME	Vmax m/s	Flood Range m
08:04:86	0500	0.555	1.383
08:04:86	1800	0.560	1.418
09:04:86	0600	0.537	1.303
09:04:86	1800	0.585	1.499
10:04:86	0600	0.529	1.197
10:04:86	1730	0.555	1.462
11:04:86	0630	0.505	1.018
11:04:86	1930	0.553	1.462
12:04:86	0730	0.501	0.877
12:04:86	1930	0.508	1.389
13:04:86	0830	0.418	0.699
13:04:86	1930	0.514	1.311
14:04:86	0900	0.428	0.537
14:04:86	1930	0.526	1.193
15:04:86	1000	0.400	0.360
15:04:86	2130	0.416	1.019
16:04:86	1000	0.288	0.266
16:04:86	2200	0.376	0.864
17:04:86	2330	0.349	0.803
18:04:86	1400	0.298	0.391
19:04:86	0100	0.376	0.889
19:04:86	1430	0.465	0.643
20:04:86	0130	0.468	1.072
20:04:86	1500	0.489	0.948
21:04:86	0330	0.529	1.269
21:04:86	1600	0.508	1.179
22:04:86	0430	0.521	1.402
22:04:86	1600	0.557	1.454

DATE	TIME	Vmax m/s	Ebb Range m
13:03:86	0130	0.773	-1.281
13:03:86	1430	0.771	-1.354
14:03:86	0200	0.704	-1.196
14:03:86	1500	0.713	-1.211
15:03:86	0300	0.711	-1.113
15:03:86	1500	0.646	-1.057
16:03:86	0330	0.581	-0.954
16:03:86	1500	0.573	-0.857
17:03:86	0430	0.451	-0.760
17:03:86	1530	0.454	-0.660
18:03:86	0600	0.423	-0.686
18:03:86	1730	0.326	-0.454
19:03:86	0630	0.400	-0.837
20:03:86	0800	0.492	-0.806
20:03:86	2030	0.345	-0.408
21:03:86	0930	0.582	-0.999
21:03:86	2100	0.481	-0.616
22:03:86	1030	0.650	-1.196
22:03:86	2200	0.612	-0.829
23:03:86	1030	0.710	-1.395
23:03:86	2300	0.760	-1.077
24:03:86	1130	0.757	-1.571
24:03:86	2300	0.721	-1.313
25:03:86	1230	0.768	-1.687
26:03:86	0000	0.759	-1.457
26:03:86	1200	0.862	-1.790
27:03:86	0130	0.782	-1.550
27:03:86	1200	0.853	-1.771
28:03:86	0100	0.783	-1.595
28:03:86	1430	0.811	-1.649
29:03:86	0200	0.553	-1.515
29:03:86	1330	0.742	-1.427
30:03:86	0300	0.766	-1.376
30:03:86	1500	0.699	-1.129
31:03:86	0330	0.712	-1.257
31:03:86	1630	0.607	-0.813
01:04:86	0530	0.621	-1.114
01:04:86	1800	0.464	-0.580
02:04:86	0600	0.625	-1.130
02:04:86	1900	0.376	-0.462
03:04:86	0800	0.602	-1.207
03:04:86	2100	0.455	-0.585
04:04:86	0900	0.702	-1.285
04:04:86	2130	0.567	-0.774
05:04:86	0930	0.788	-1.400
05:04:86	2230	0.651	-1.002
06:04:86	1100	0.818	-1.357
06:04:86	2230	0.755	-1.168
07:04:86	1100	0.811	-1.450
08:04:86	0030	0.723	-1.277

DATE	TIME	Vmax m/s	Ebb Range m
08:04:86	1130	0.813	-1.453
09:04:86	0000	0.811	-1.329
09:04:86	1130	0.748	-1.371
10:04:86	0030	0.752	-1.302
10:04:86	1230	0.727	-1.345
11:04:86	0200	0.690	-1.322
11:04:86	1400	0.655	-1.224
12:04:86	0130	0.687	-1.249
12:04:86	1330	0.620	-1.081
13:04:86	0200	0.678	-1.150
13:04:86	1400	0.612	-0.891
14:04:86	0330	0.640	-1.005
14:04:86	1430	0.505	-0.725
15:04:86	0330	0.539	-0.894
15:04:86	1600	0.415	-0.541
16:04:86	0400	0.501	-0.814
16:04:86	1700	0.337	-0.397
17:04:86	0630	0.448	-0.839
18:04:86	0630	0.493	-0.862
18:04:86	2000	0.393	-0.394
19:04:86	0800	0.573	-0.998
19:04:86	2030	0.499	-0.602
20:04:86	0930	0.664	-1.194
20:04:86	2100	0.558	-0.846
21:04:86	0930	0.738	-1.422
21:04:86	2200	0.733	-1.130
22:04:86	1000	0.772	-1.601
22:04:86	2230	0.695	-1.344

CONSTANT	FREQUENCY (cyc/hr)	AMPLITUDE (m)	PHASE (deg)
Z0	0.0000000	19.2664	0.00
MM	0.0015122	0.0425	264.95
MSF	0.0028219	0.0107	334.14
ALP1	0.0343966	0.0049	334.13
2Q1	0.0357063	0.0037	328.44
Q1	0.0372185	0.0212	66.03
01	0.0387307	0.1078	119.47
N01	0.0402686	0.0061	240.35
P1	0.0415526	0.0553	154.20
K1	0.0417807	0.1990	158.10
J1	0.0432929	0.0202	213.49
001	0.0448308	0.0058	223.31
UPS1	0.0463430	0.0007	67.59
EPS2	0.0761773	0.0019	213.81
MU2	0.0776895	0.0243	289.96
N2	0.0789993	0.1050	227.36
M2	0.0805114	0.5603	247.57
L2	0.0820235	0.0304	269.24
S2	0.0833333	0.1786	269.48
K2	0.0835615	0.0534	260.38
ETA2	0.0850736	0.0021	220.08
M03	0.1192421	0.0048	169.75
M3	0.1207671	0.0044	327.99
MK3	0.1222921	0.0030	11.12
SK3	0.1251141	0.0041	281.25
MN4	0.1595106	0.0013	114.00
M4	0.1610228	0.0104	142.19
SN4	0.1623326	0.0023	218.22
MS4	0.1638447	0.0048	190.38
S4	0.1666667	0.0035	328.32
2MK5	0.2028036	0.0020	351.24
2SK5	0.2084474	0.0006	347.29
2MN6	0.2400221	0.0027	92.14
M6	0.2415342	0.0038	112.28
2MS6	0.2443561	0.0011	125.83
2SM6	0.2471781	0.0004	92.69
3MK7	0.2833149	0.0010	333.34
M8	0.3220456	0.0020	61.58

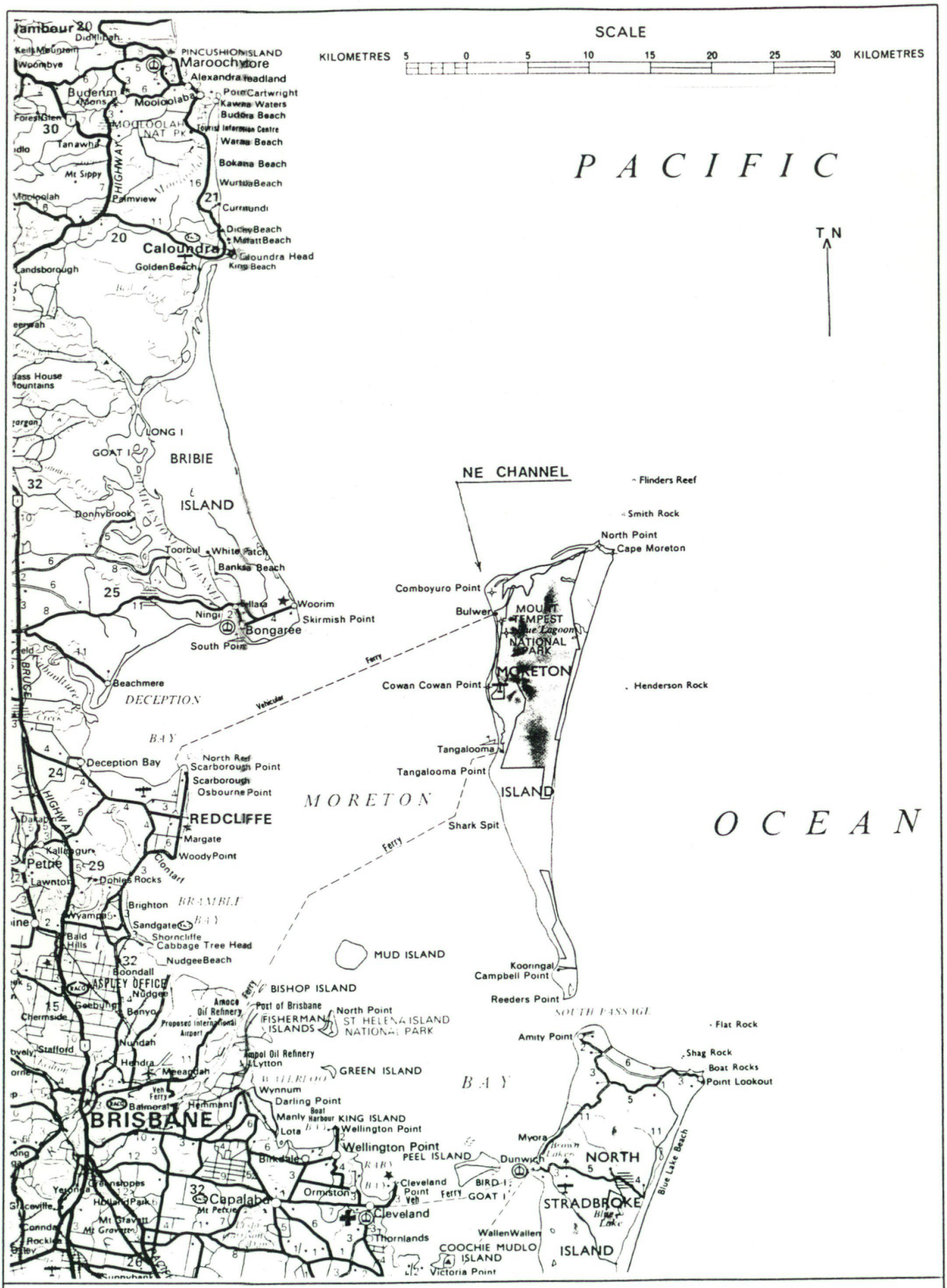
TABLE 14 : TIDAL HARMONIC CONSTANTS, NE8

CONSTANT	FREQUENCY (cyc/hr)	AMPLITUDE (m)	PHASE (deg)
ZO	0.0000000	16.4052	0.00
MM	0.0015122	0.0562	34.32
MSF	0.0028219	0.0266	139.06
ALP1	0.0343966	0.0048	110.52
2Q1	0.0357063	0.0030	36.97
Q1	0.0372185	0.0237	97.22
O1	0.0387307	0.1071	121.49
NO1	0.0402686	0.0046	320.70
P1	0.0415526	0.0537	155.57
K1	0.0417807	0.1935	159.47
J1	0.0432929	0.0038	212.32
OO1	0.0448308	0.0111	217.43
UPS1	0.0463430	0.0026	10.56
EPS2	0.0761773	0.0051	62.63
MU2	0.0776895	0.0097	36.61
N2	0.0789993	0.0851	239.33
M2	0.0805114	0.5508	245.53
L2	0.0820235	0.0205	241.79
S2	0.0833333	0.1713	266.12
K2	0.0835615	0.0512	257.02
ETA2	0.0850736	0.0015	218.98
MO3	0.1192421	0.0033	152.82
M3	0.1207671	0.0041	320.83
MK3	0.1222921	0.0049	13.16
SK3	0.1251141	0.0012	337.98
MN4	0.1595106	0.0019	195.73
M4	0.1610228	0.0096	147.03
SN4	0.1623326	0.0015	154.63
MS4	0.1638447	0.0081	190.74
S4	0.1666667	0.0008	253.17
2MK5	0.2028036	0.0006	132.29
2SK5	0.2084474	0.0019	20.07
2MN6	0.2400221	0.0001	222.05
M6	0.2415342	0.0023	144.17
2MS6	0.2443561	0.0016	131.34
2SM6	0.2471781	0.0011	157.71
3MK7	0.2833149	0.0009	137.39
M8	0.3220456	0.0005	325.50

TABLE 15 : TIDAL HARMONIC CONSTANTS, NE6

CONSTANT	FREQUENCY (cyc/hr)	AMPLITUDE (m)	PHASE (deg)
ZO	0.0000000	10.1308	0.00
MM	0.0015122	0.0281	67.81
MSF	0.0028219	0.0157	152.10
ALP1	0.0343966	0.0033	161.36
2Q1	0.0357063	0.00[illegible]	[illegible].14
Q1	0.03721[illegible]	0.0243	92.30
01	0.0387307	0.1055	117.43
NO1	0.0402686	0.0094	168.68
P1	0.0415526	0.0551	147.37
K1	0.0417807	0.1984	151.27
J1	0.0432929	0.0141	146.63
001	0.0448308	0.0090	249.77
UPS1	0.0463430	0.0006	177.92
EPS2	0.0761773	0.0014	226.30
MU2	0.0776895	0.0159	142.66
N2	0.0789993	0.1063	236.85
M2	0.0805114	0.5462	239.25
L2	0.0820235	0.0099	225.18
S2	0.0833333	0.1657	262.02
K2	0.0835615	0.0495	252.92
ETA2	0.0850736	0.0038	150.52
MO3	0.1192421	0.0008	229.13
M3	0.1207671	0.0057	309.76
MK3	0.1222921	0.0027	4.32
SK3	0.1251141	0.0025	354.80
MN4	0.1595106	0.0022	180.77
M4	0.1610228	0.0125	148.02
SN4	0.1623326	0.0015	168.86
MS4	0.1638447	0.0083	179.99
S4	0.1666667	0.0013	223.98
2MK5	0.2028036	0.0011	5.73
2SK5	0.2084474	0.0017	60.92
2MN6	0.2400221	0.0017	150.81
M6	0.2415342	0.0048	143.64
2MS6	0.2443561	0.0017	163.27
2SM6	0.2471781	0.0008	88.82
3MK7	0.2833149	0.0005	184.48
M8	0.3220456	0.0016	29.27

TABLE 16 : TIDAL HARMONIC CONSTANTS, NE4



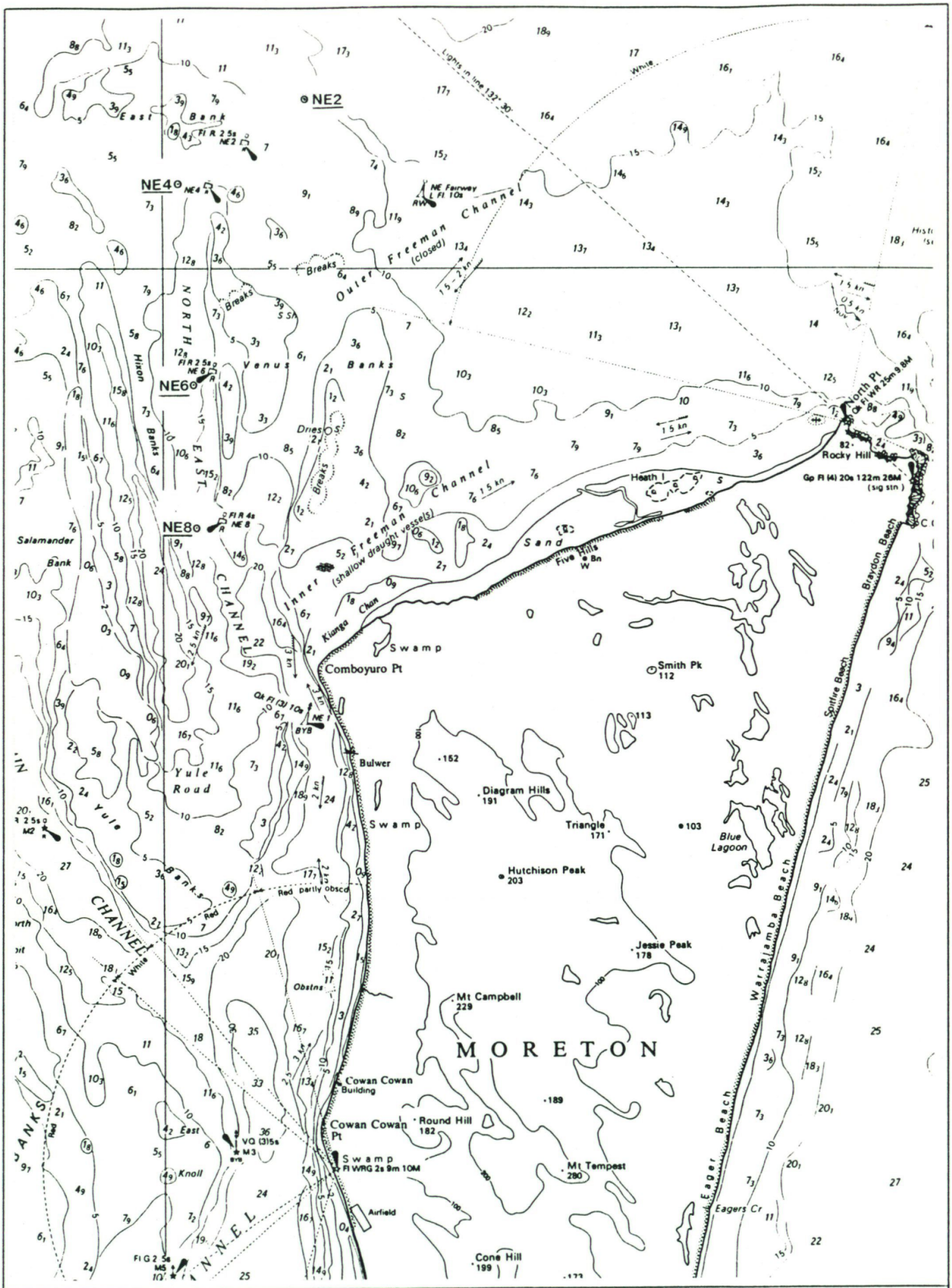
PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY

NORTH EAST CHANNEL LOCATION

LAWSON AND TRELOAR PTY LTD.

DATE 13:05:86

FIG. 1



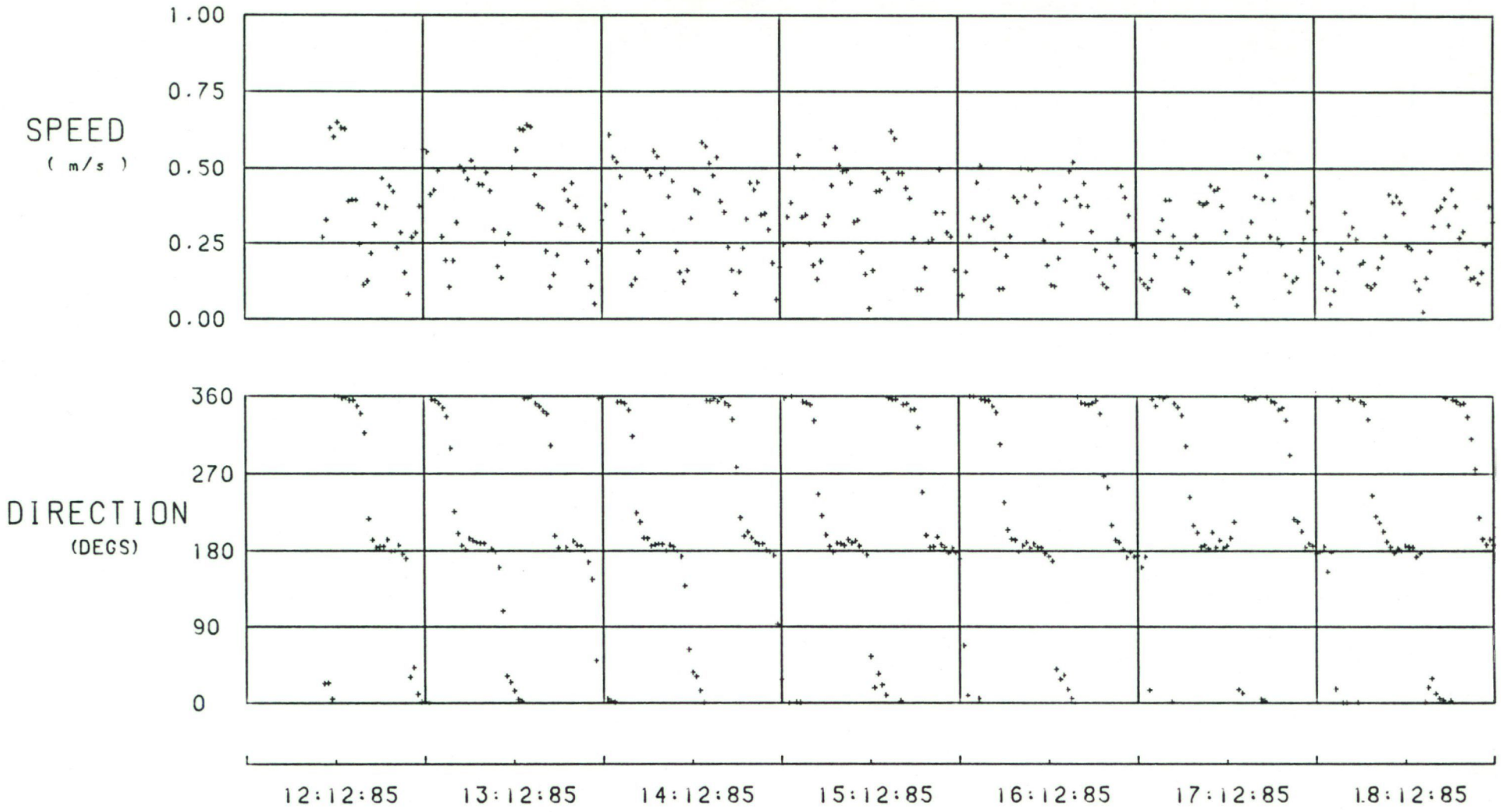
PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY

NORTH EAST CHANNEL LOCALITY AND RECORDING SITES

LAWSON AND TRELOAR PTY LTD.

DATE 23:05:86

FIG. 2



LATITUDE	: 26 degs 59' 12" S
LONGITUDE	: 153 degs 20' 11" E
DATA START TIME	: 1030 12:12:85
DATA END TIME	: 1230 06:02:86

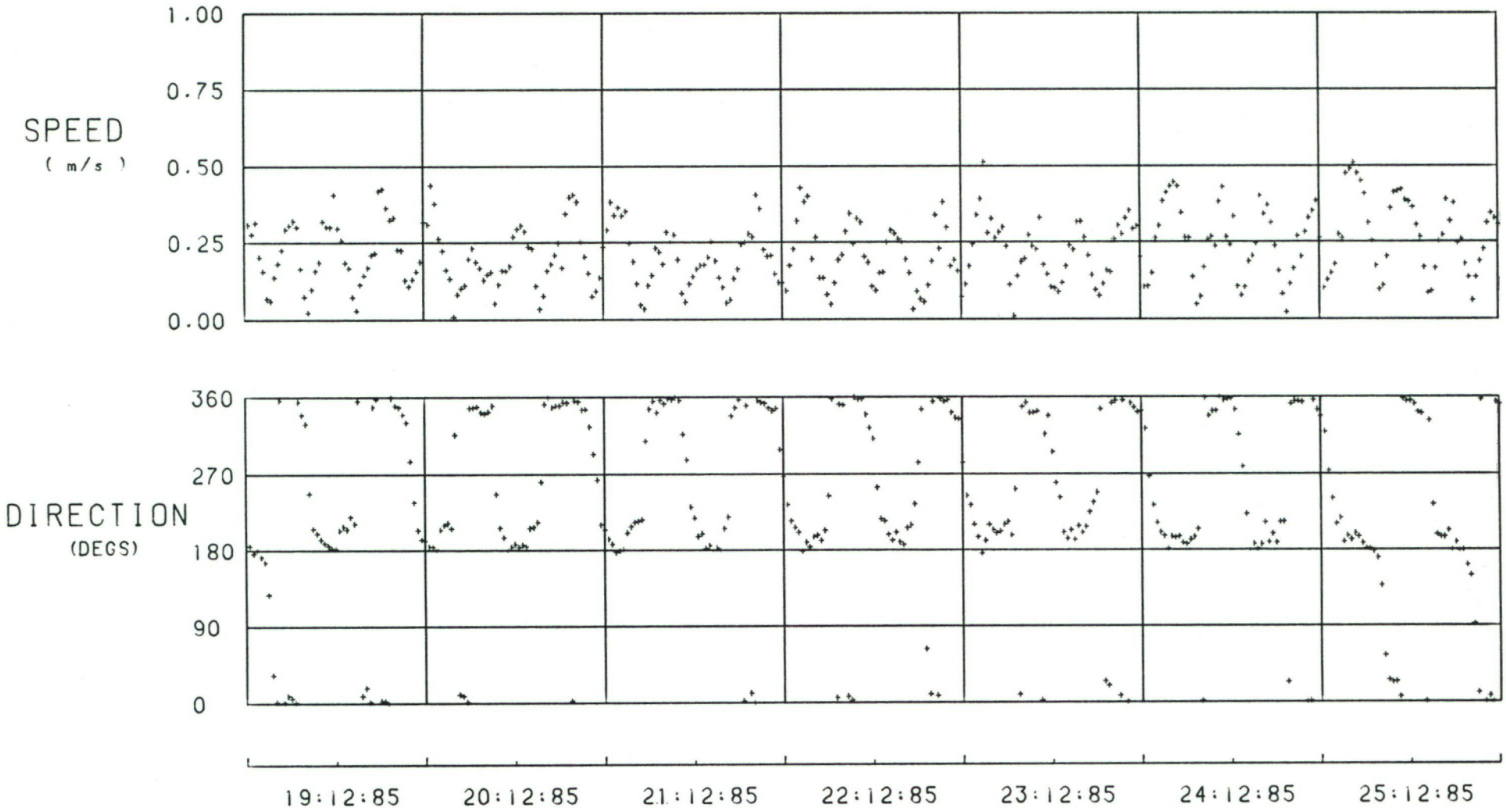
PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY

NORTH EAST CHANNEL NE8
CURRENT SPEED-DIRECTION
TIME HISTORY PLOT

LAWSON AND TRELOAR PTY LTD.

DATE 08:05:86

FIG. 3



LATITUDE	: 26 degs 59' 12" S
LONGITUDE	: 153 degs 20' 11" E
DATA START TIME	: 1030 12:12:85
DATA END TIME	: 1230 06:02:86

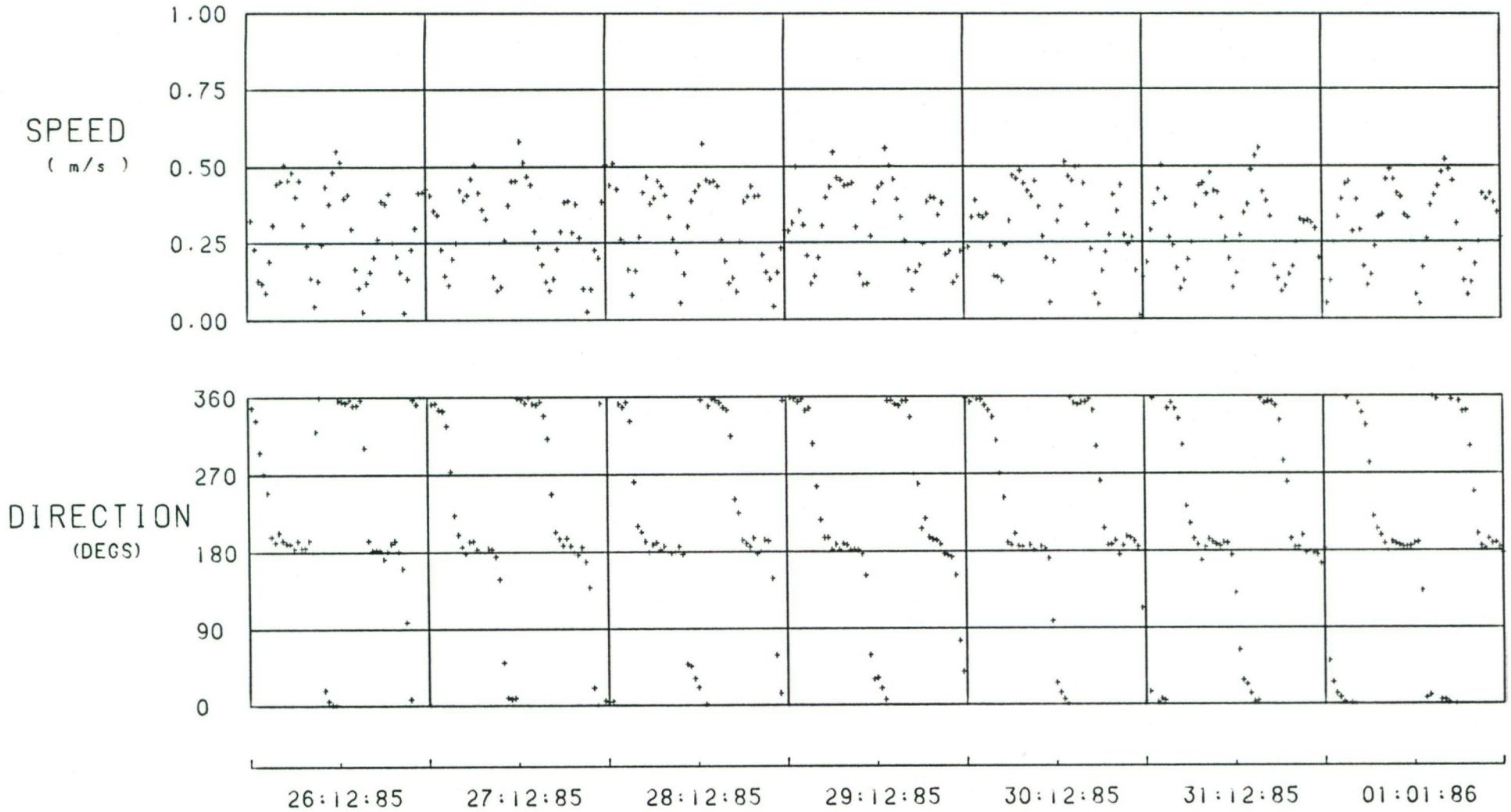
PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY

NORTH EAST CHANNEL NE8
CURRENT SPEED-DIRECTION
TIME HISTORY PLOT

LAWSON AND TRELOAR PTY LTD.

DATE 08:05:86

FIG. 4



LATITUDE : 26 degs 59' 12" S
LONGITUDE : 153 degs 20' 11" E
DATA START TIME : 1030 12:12:85
DATA END TIME : 1230 06:02:86

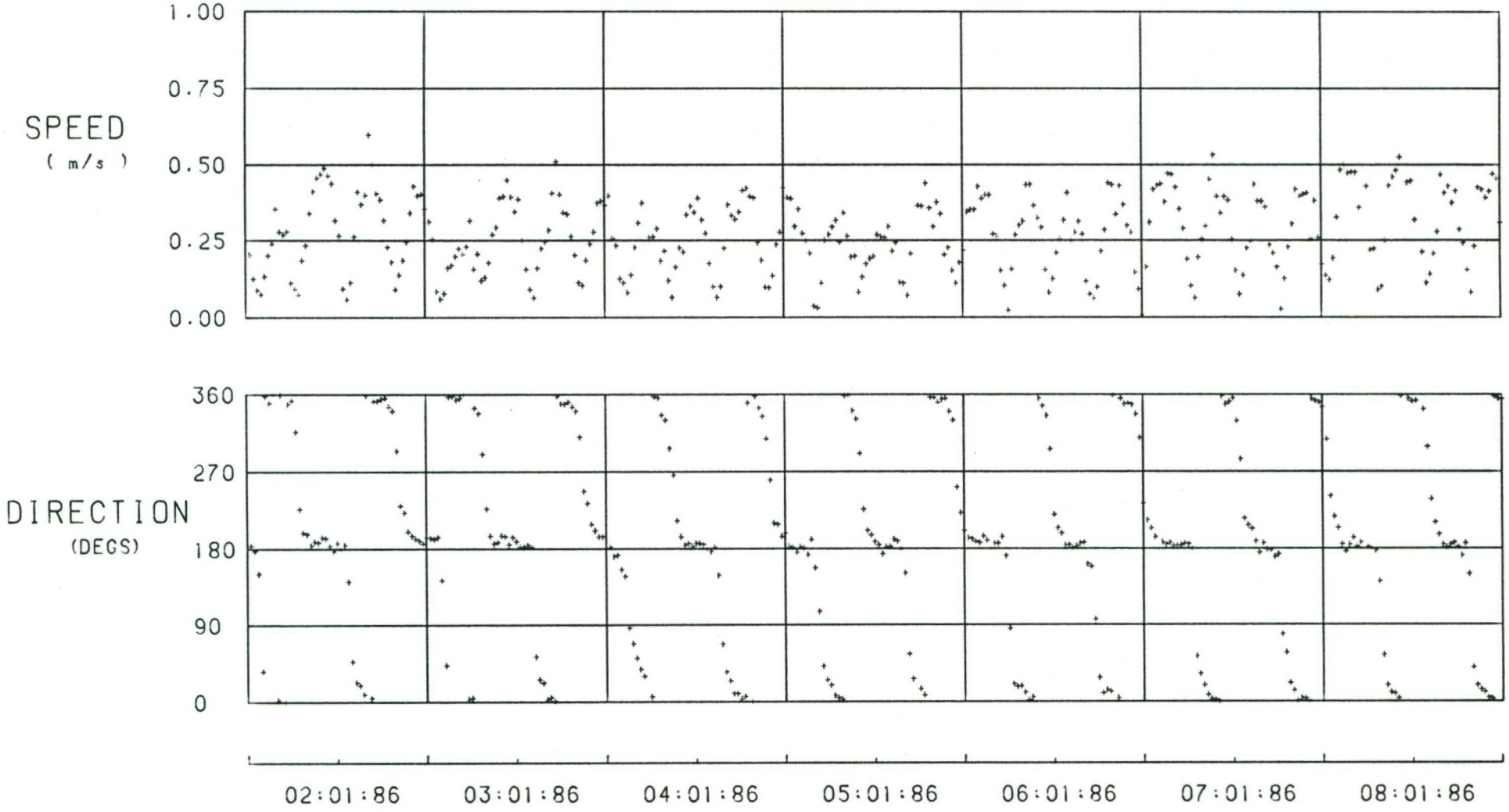
PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY

NORTH EAST CHANNEL NE8
CURRENT SPEED-DIRECTION
TIME HISTORY PLOT

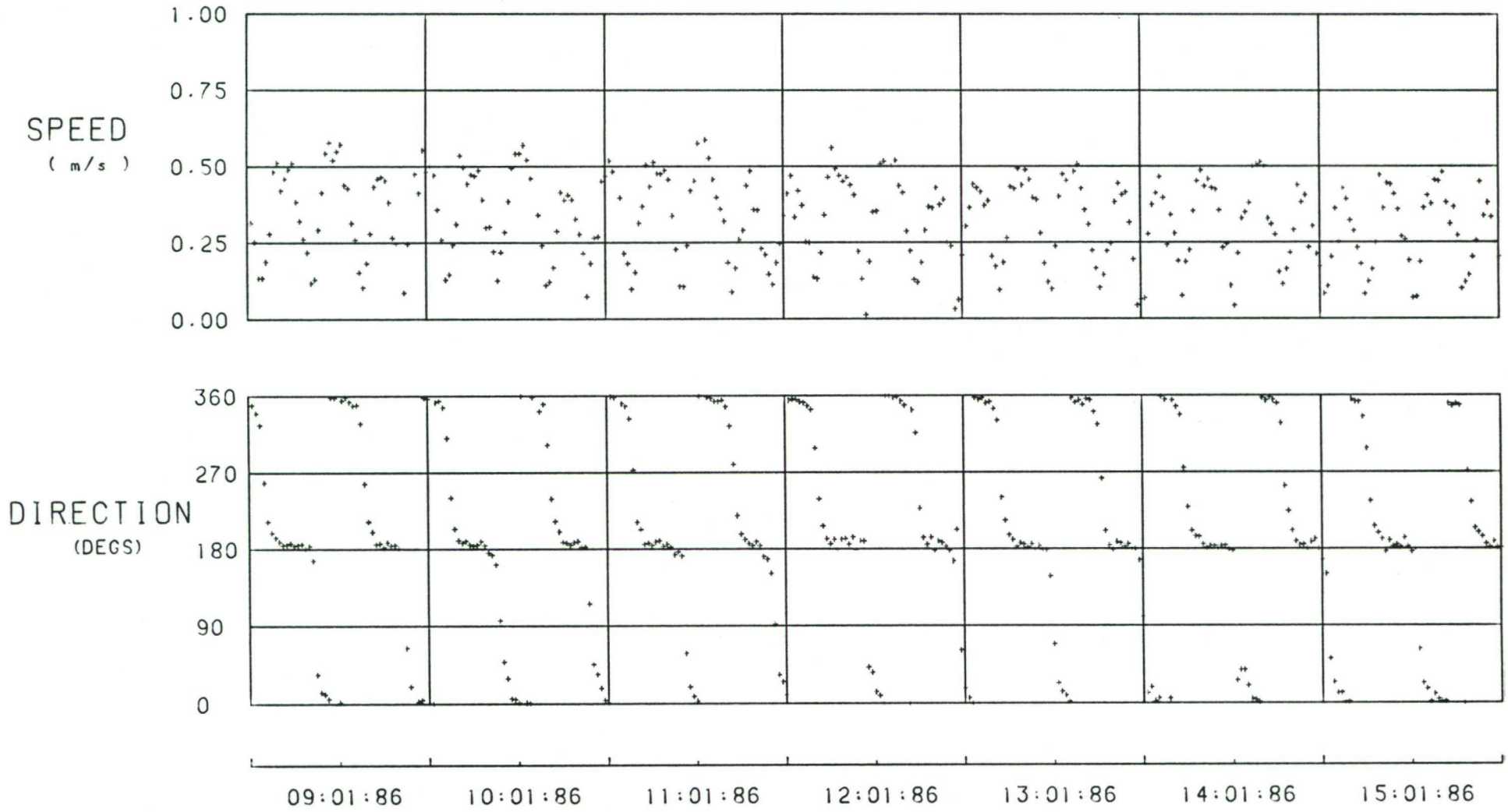
LAWSON AND TRELOAR PTY LTD.

DATE 08:05:86

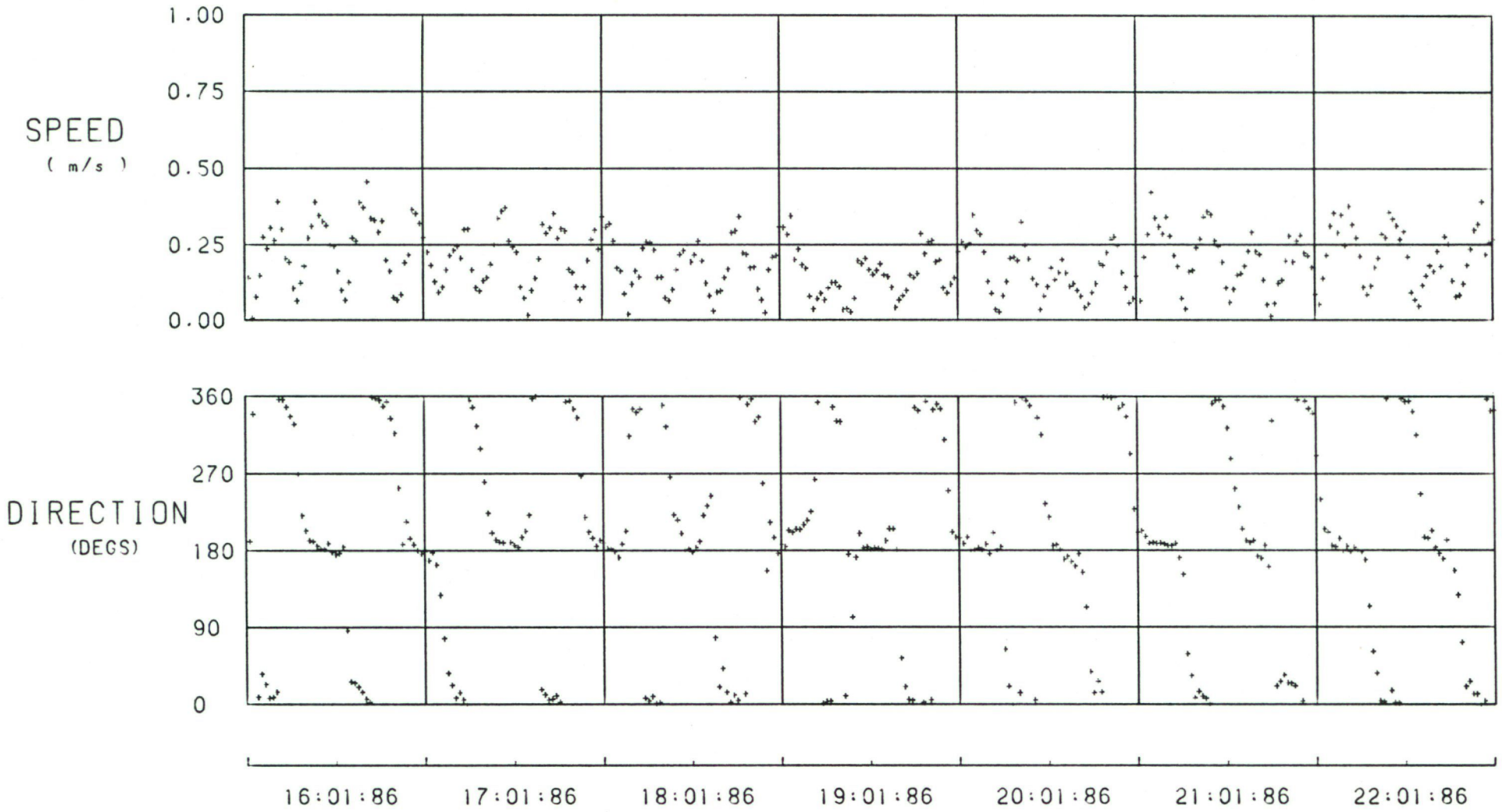
FIG. 5



LATITUDE : 26 degs 59' 12" S	PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY
LONGITUDE : 153 degs 20' 11" E	NORTH EAST CHANNEL NE8 CURRENT SPEED-DIRECTION TIME HISTORY PLOT
DATA START TIME : 1030 12:12:85	LAWSON AND TRELOAR PTY LTD.
DATA END TIME : 1230 06:02:86	DATE 08:05:86 / FIG. 6



LATITUDE : 26 degs 59' 12" S LONGITUDE : 153 degs 20' 11" E DATA START TIME : 1030 12:12:85 DATA END TIME : 1230 06:02:86	PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY		
	NORTH EAST CHANNEL NE8 CURRENT SPEED-DIRECTION TIME HISTORY PLOT	LAWSON AND TRELOAR PTY LTD.	
		DATE 08:05:86	FIG. 7



LATITUDE : 26 degs 59' 12" S
LONGITUDE : 153 degs 20' 11" E
DATA START TIME : 1030 12:12:85
DATA END TIME : 1230 06:02:86

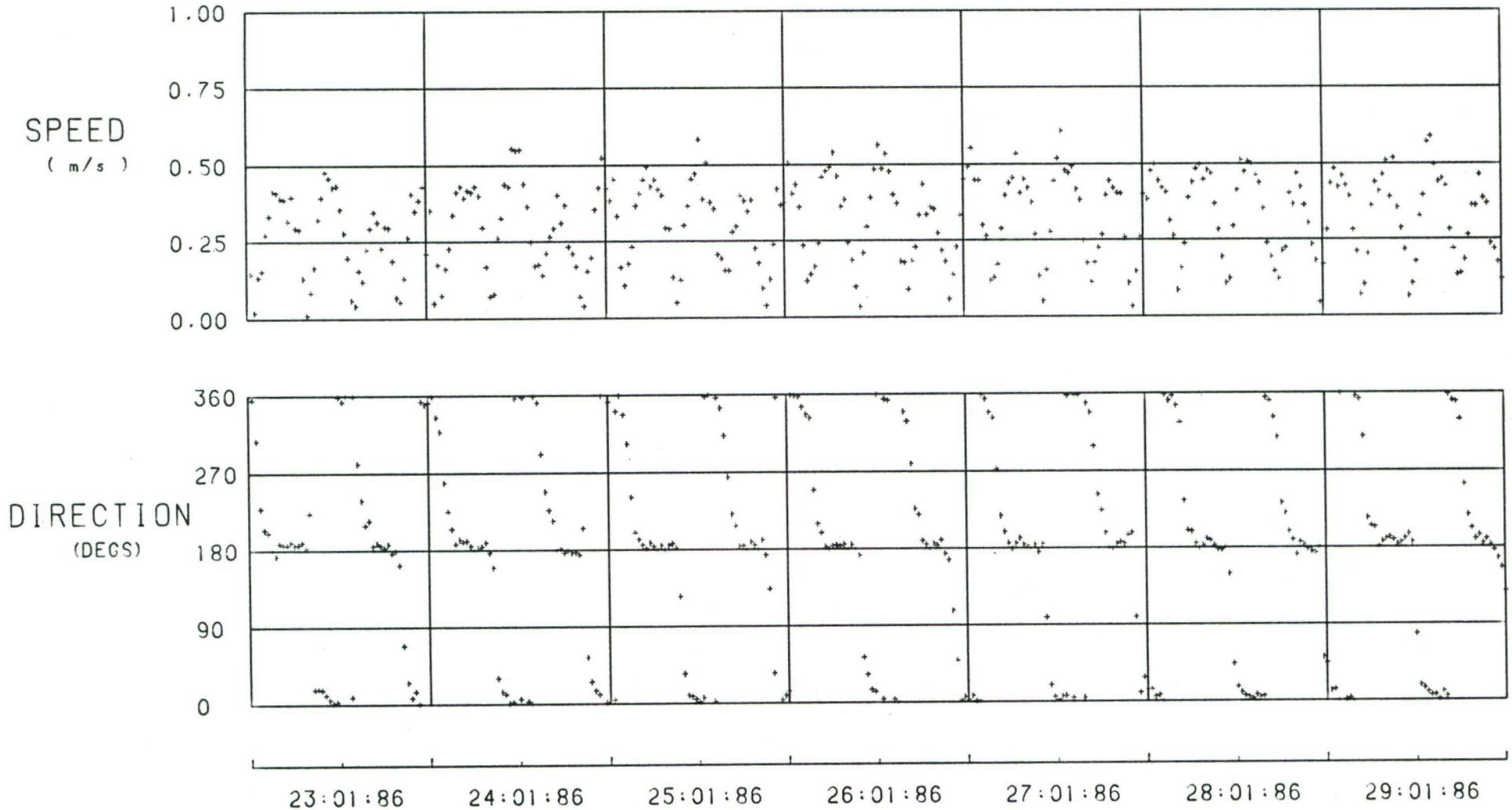
PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY

NORTH EAST CHANNEL NE8
CURRENT SPEED-DIRECTION
TIME HISTORY PLOT

LAWSON AND TRELOAR PTY LTD.

DATE 08:05:86

FIG. 8



LATITUDE	: 26 degs 59' 12" S
LONGITUDE	: 153 degs 20' 11" E
DATA START TIME	: 1030 12:12:85
DATA END TIME	: 1230 06:02:86

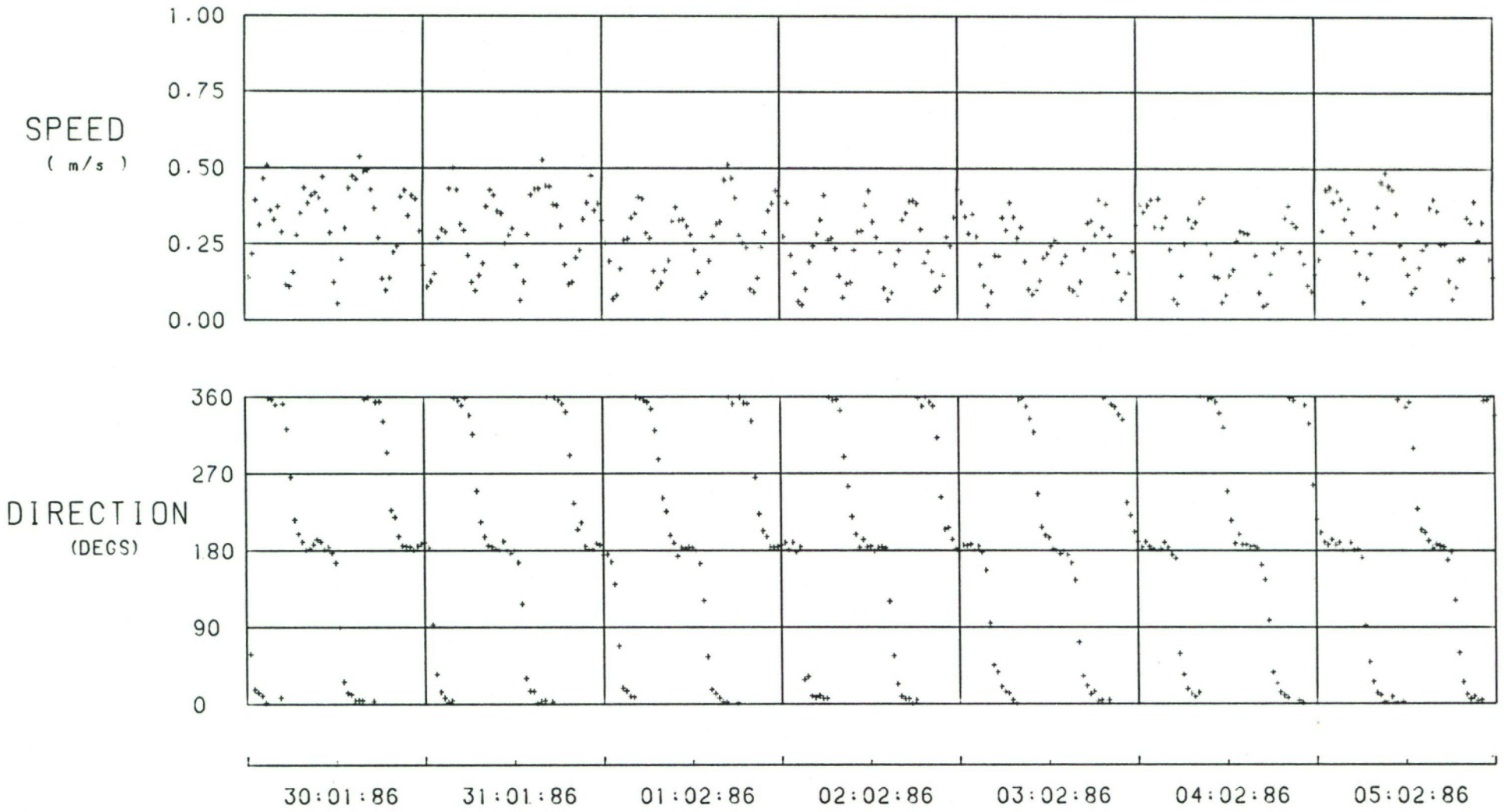
PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY

NORTH EAST CHANNEL NE8
CURRENT SPEED-DIRECTION
TIME HISTORY PLOT

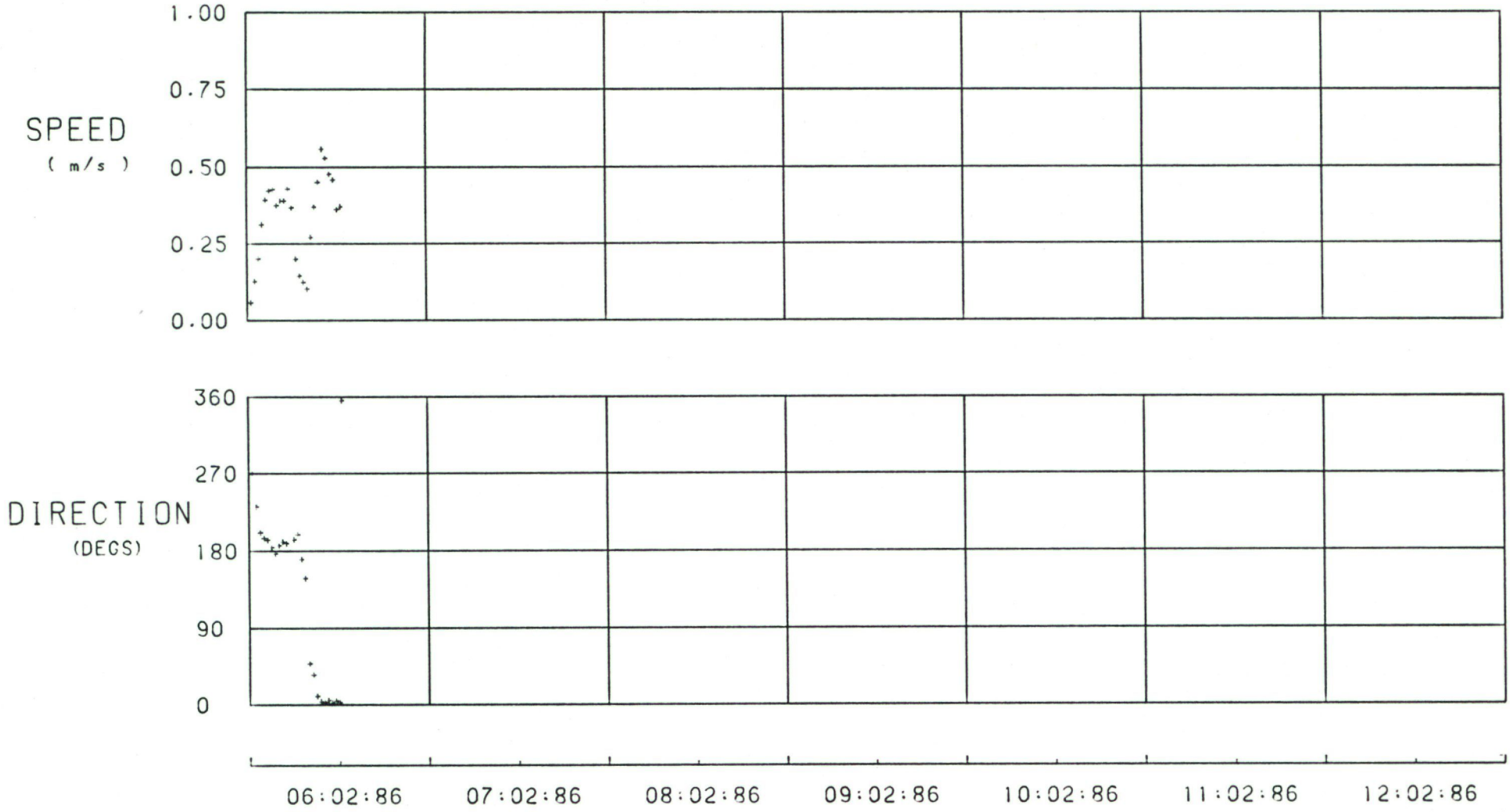
LAWSON AND TRELOAR PTY LTD.

DATE 08:05:86

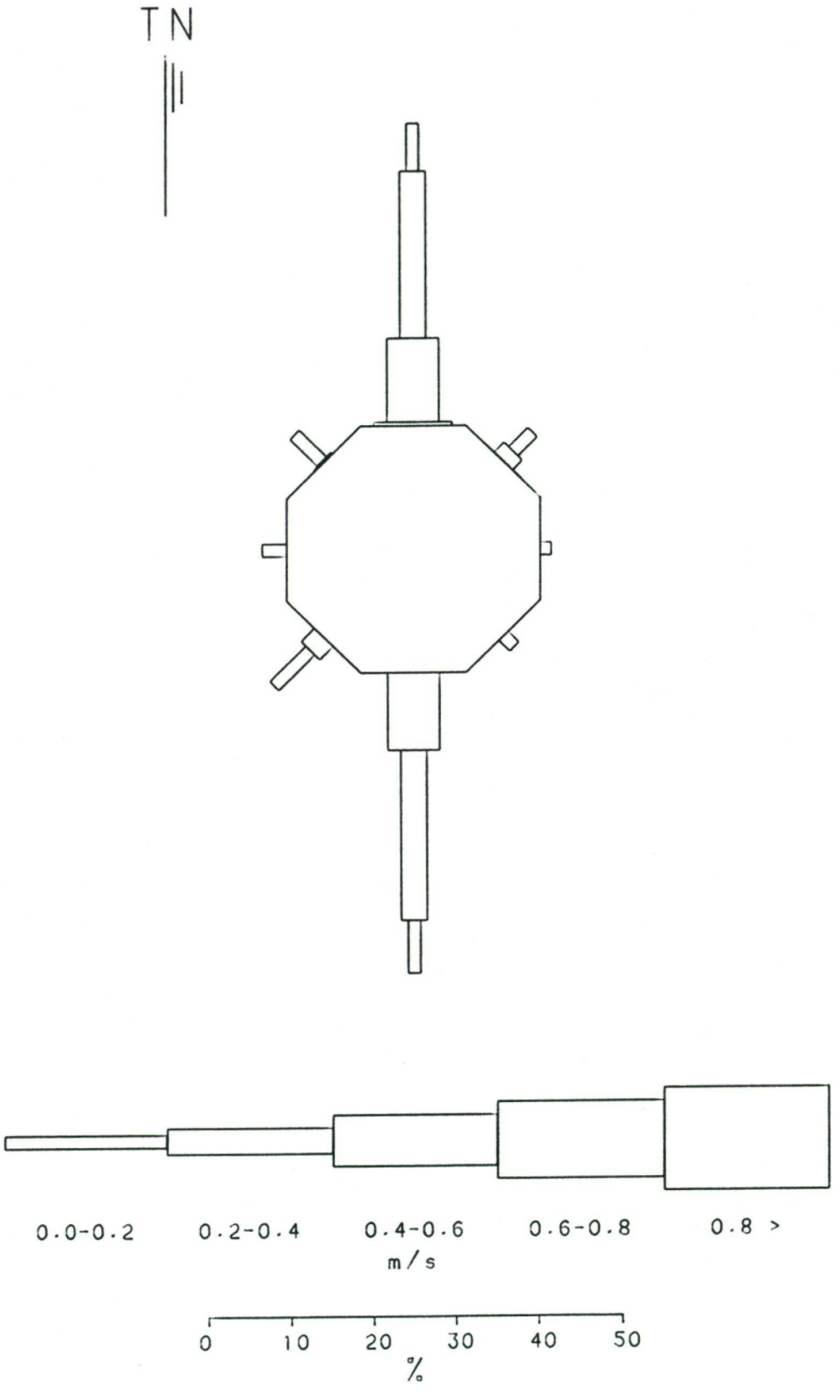
FIG. 9



LATITUDE : 26 degs 59' 12" S	PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY
LONGITUDE : 153 degs 20' 11" E	NORTH EAST CHANNEL NE8 CURRENT SPEED-DIRECTION TIME HISTORY PLOT
DATA START TIME : 1030 12:12:85	LAWSON AND TRELOAR PTY LTD.
DATA END TIME : 1230 06:02:86	DATE 08:05:86 — FIG. 10



LATITUDE : 26 degs 59' 12" S	PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY
LONGITUDE : 153 degs 20' 11" E	NORTH EAST CHANNEL NE8 CURRENT SPEED-DIRECTION TIME HISTORY PLOT
DATA START TIME : 1030 12:12:85	LAWSON AND TRELOAR PTY LTD.
DATA END TIME : 1230 06:02:86	DATE 08:05:86 — FIG. 11



LATITUDE : 26 degs 59' 12" S
LONGITUDE : 153 degs 20' 11" E

DATA START TIME : 1030 12:12:85
DATA END TIME : 1230 06:02:86

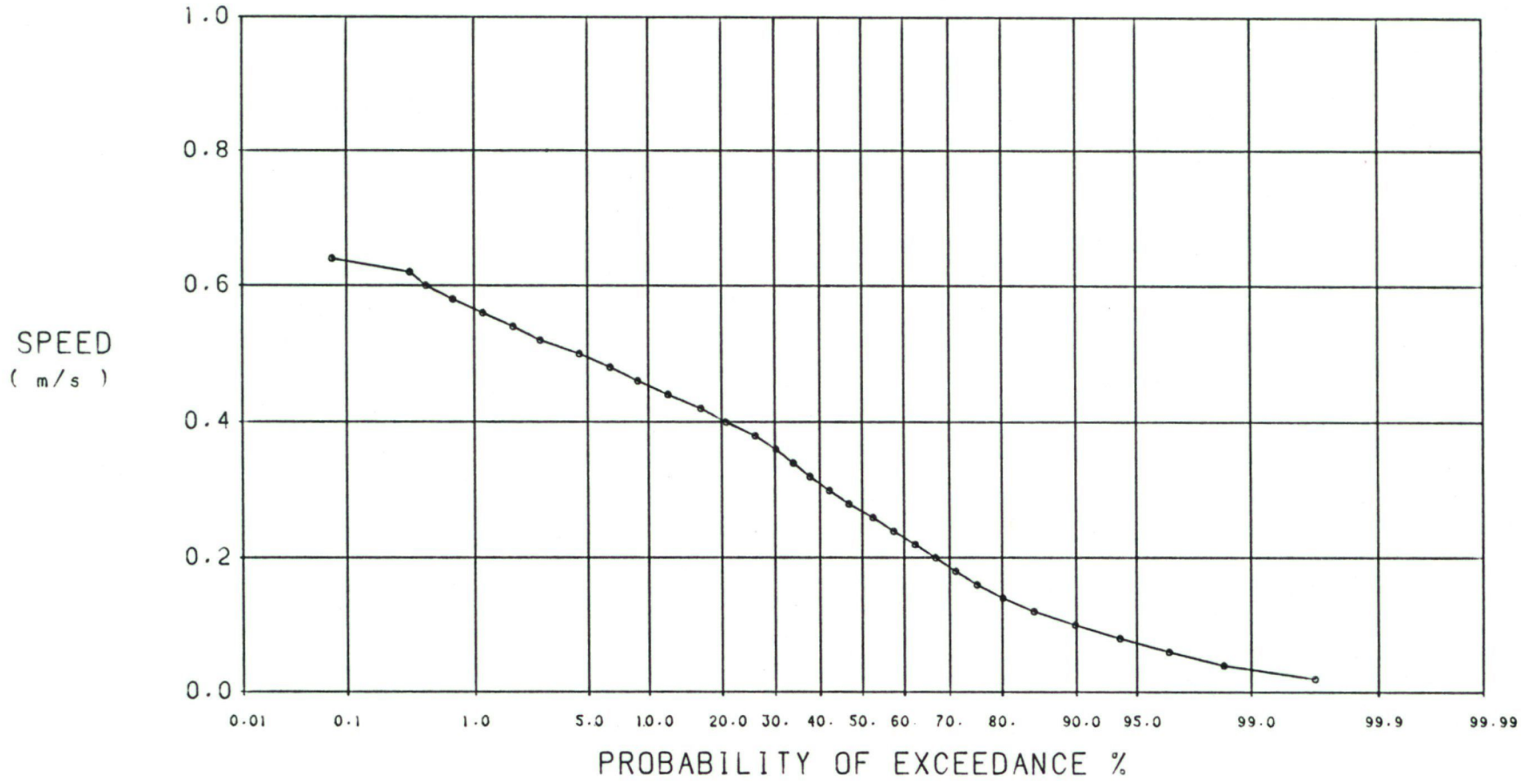
PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY

NORTH EAST CHANNEL NE8 CURRENT SPEED-DIRECTION FREQUENCY ROSE

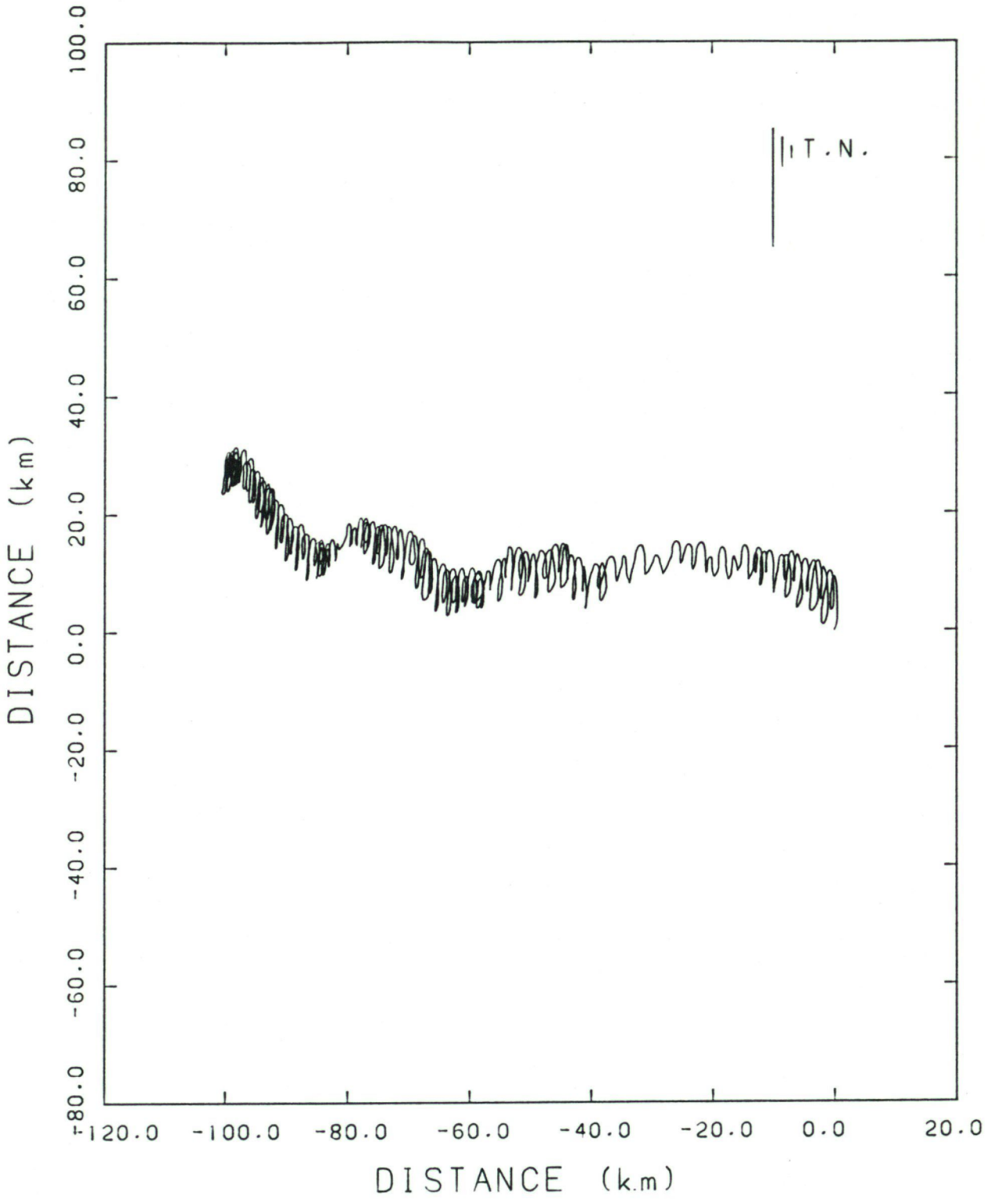
LAWSON AND TRELOAR PTY LTD.

DATE 08:05:86

FIG. 12



LOCATION : NORTH EAST CHANNEL NE8 START TIME : 1030 12:12:85 TOTAL RECORDS: 2683 END TIME : 1230 06:02:86 INSTRUMENT : SEA DATA 620A S/N 58	PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY NORTH EAST CHANNEL NE8 CURRENT SPEED EXCEEDANCE PLOT	LAWSON AND TRELOAR PTY LTD. DATE 08:05:86 FIG. 13



FROM ORIGIN

LATITUDE : 26 degs 59' 12" S
LONGITUDE : 153 degs 20' 11" E
DATA START TIME : 1030 12:12:85
DATA END TIME : 1230 06:02:86

PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY

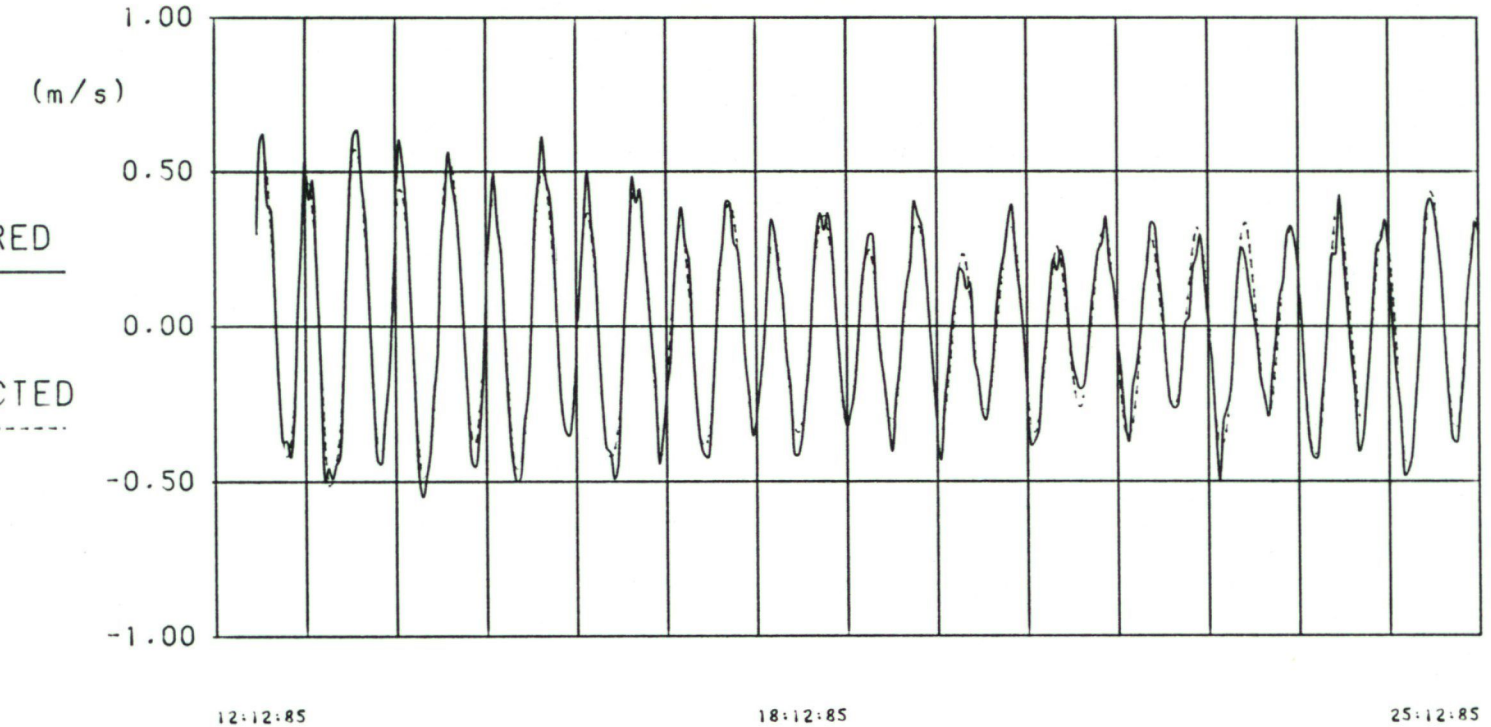
NORTH EAST CHANNEL NE8
PROGRESSIVE VECTOR
PLOT

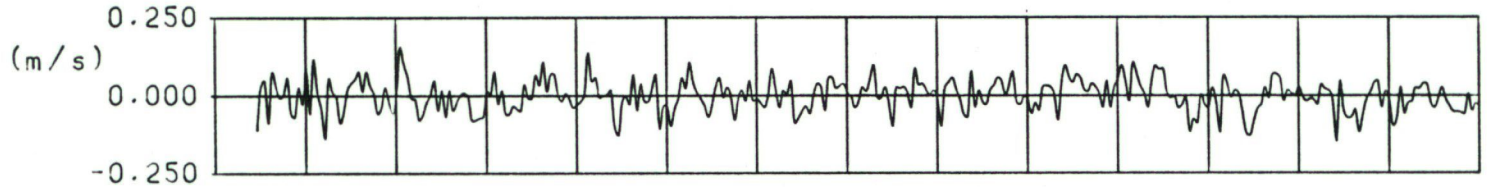
LAWSON AND TRELOAR PTY LTD.

DATE 08:05:86

FIG. 14

SPEED





RESIDUALS

NOTE : MEAN CURRENT REMOVED.

PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY

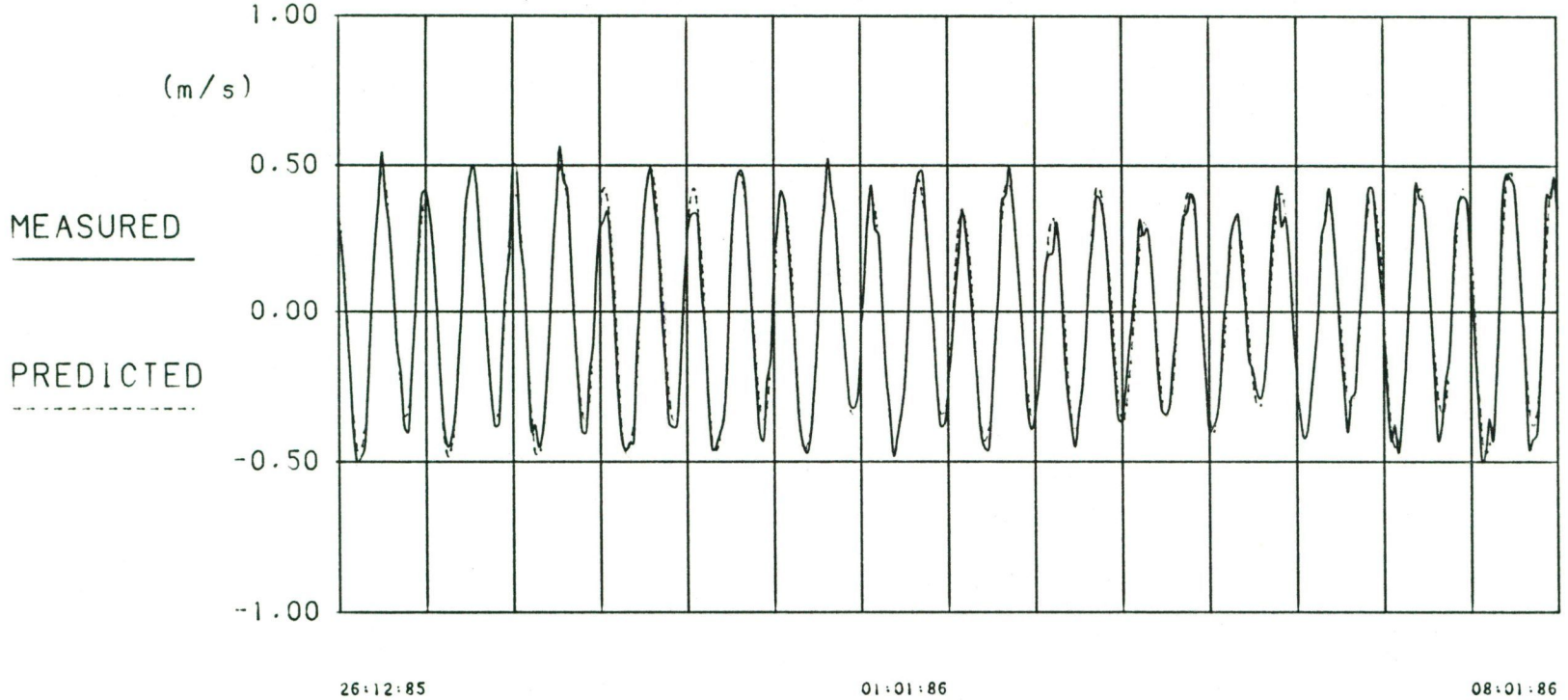
NORTH EAST CHANNEL NE8
NORTH-SOUTH TIDAL CURRENTS
MEASURED - PREDICTED

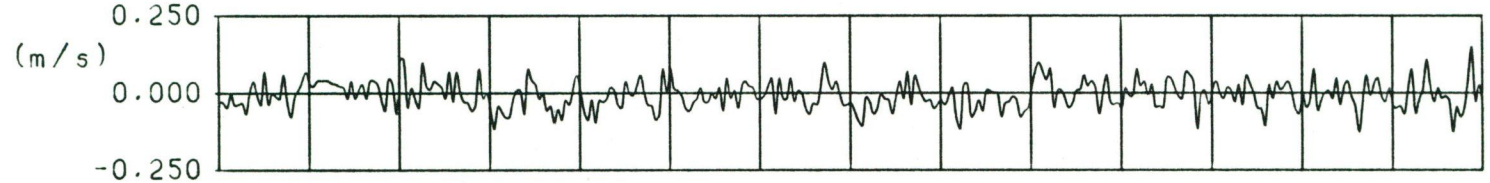
LAWSON AND TRELOAR PTY LTD.

DATE 08:05:86

FIG. 15

SPEED



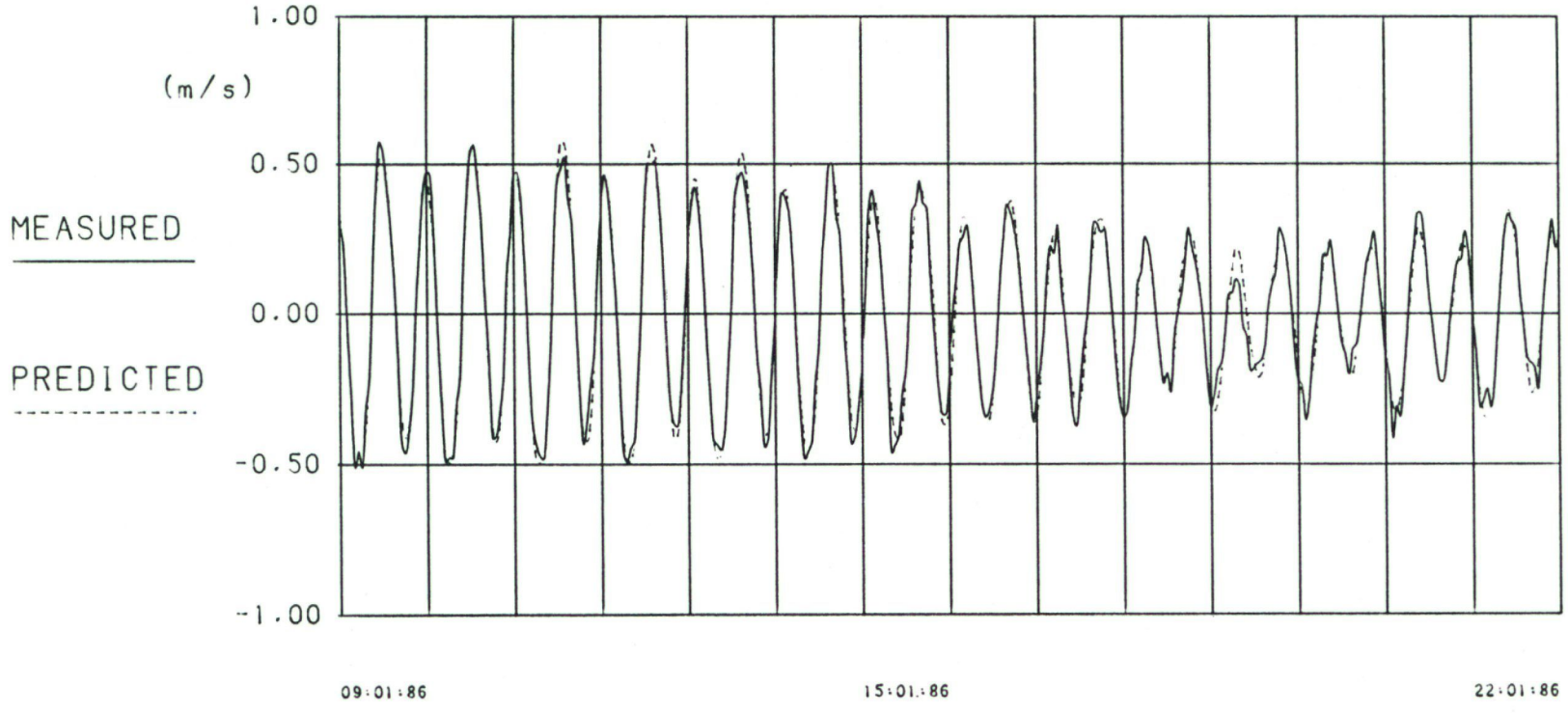


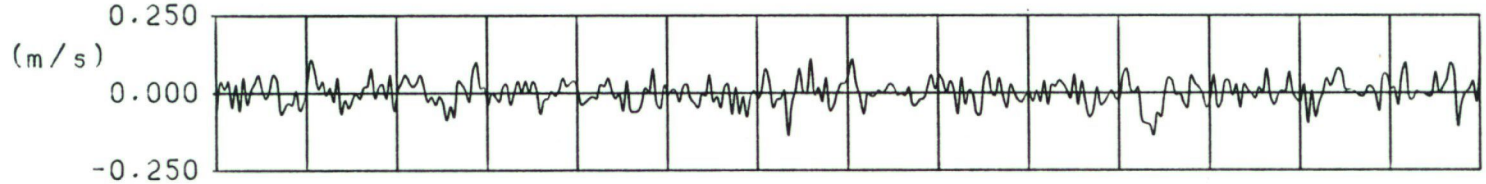
RESIDUALS

NOTE : MEAN CURRENT REMOVED.

PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY	
NORTH EAST CHANNEL NE8 NORTH-SOUTH TIDAL CURRENTS MEASURED - PREDICTED	LAWSON AND TRELOAR PTY LTD.
	DATE 08:05:86 — FIG. 16

SPEED

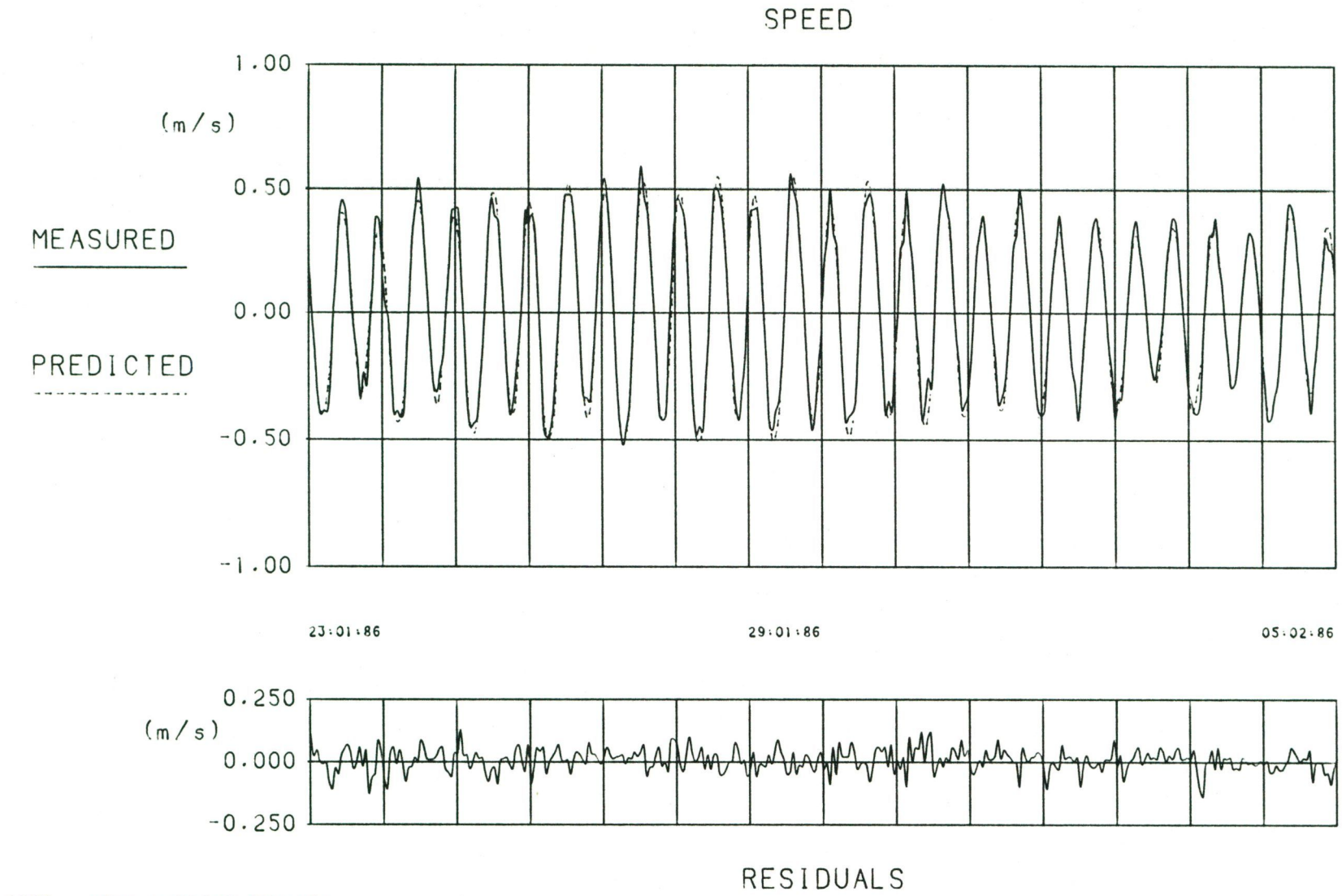




RESIDUALS

NOTE : MEAN CURRENT REMOVED.

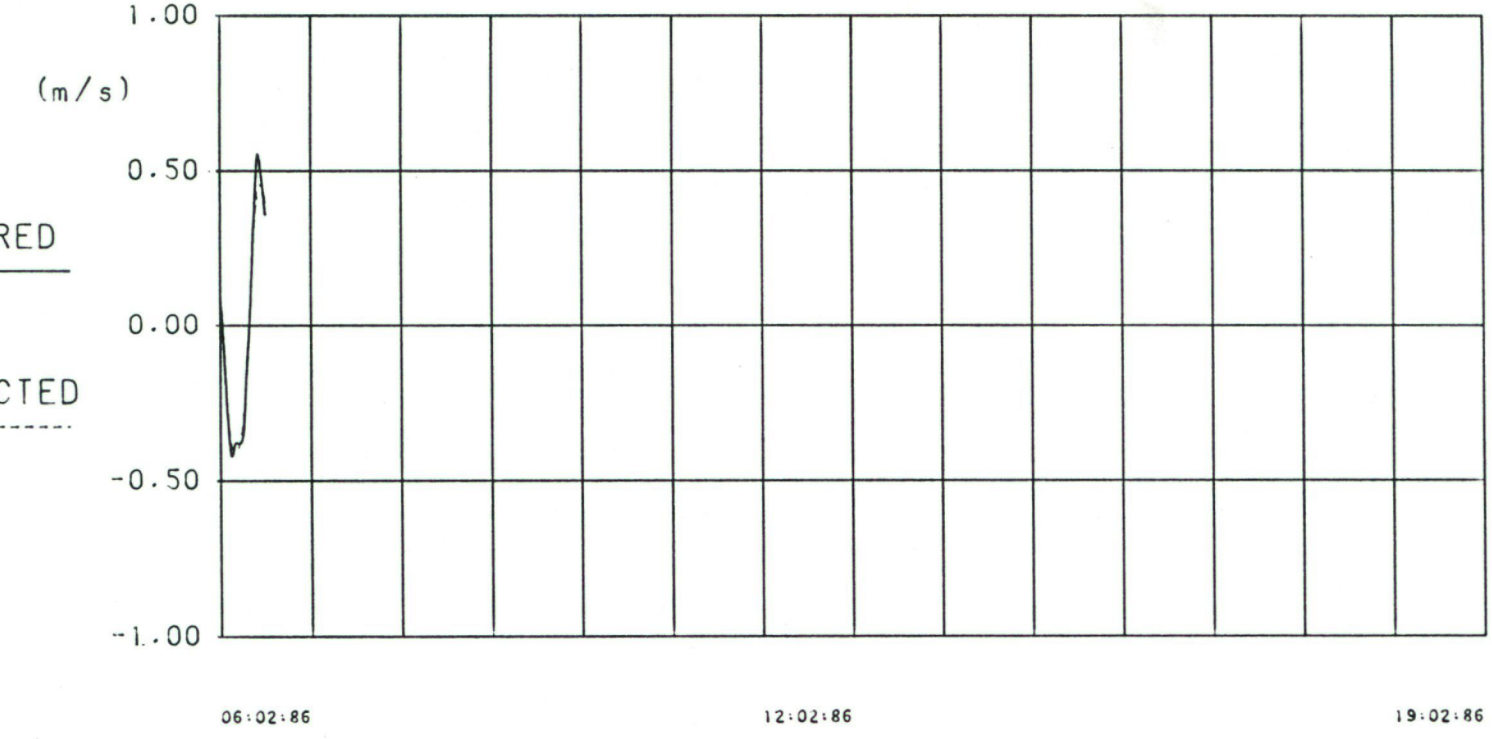
PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY	
NORTH EAST CHANNEL NE8 NORTH-SOUTH TIDAL CURRENTS MEASURED - PREDICTED	LAWSON AND TRELOAR PTY LTD.
	DATE 08:05:86 — FIG. 17

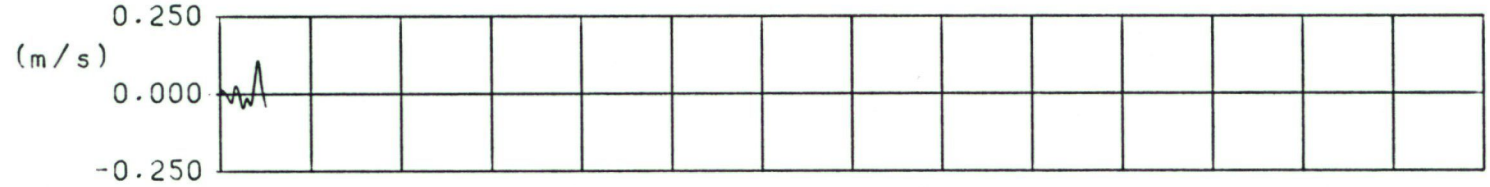


NOTE : MEAN CURRENT REMOVED.

PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY	
NORTH EAST CHANNEL NE8 NORTH-SOUTH TIDAL CURRENTS MEASURED - PREDICTED	LAWSON AND TRELOAR PTY LTD.
	DATE 08:05:86 — FIG. 18

SPEED





RESIDUALS

NOTE : MEAN CURRENT REMOVED.

PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY

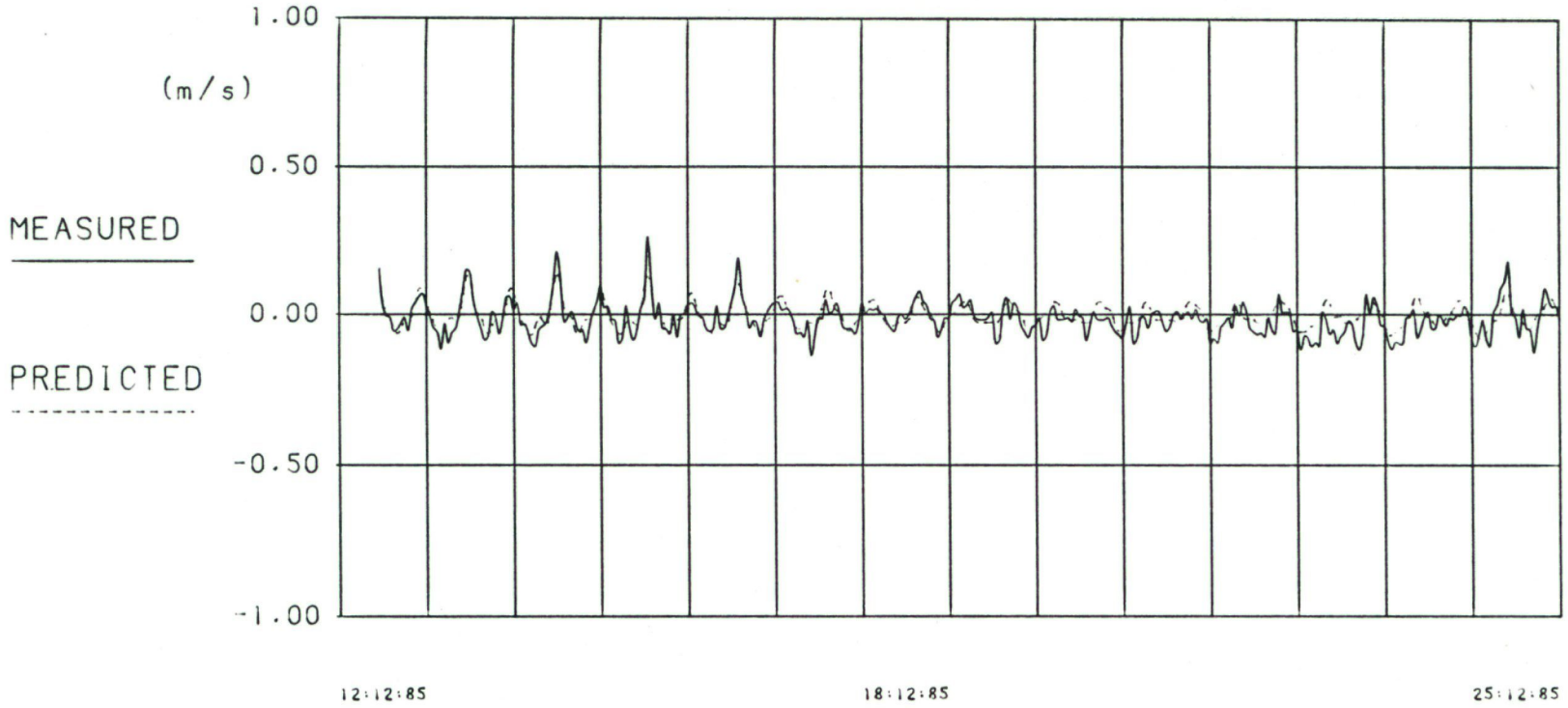
NORTH EAST CHANNEL NE8
NORTH-SOUTH TIDAL CURRENTS
MEASURED - PREDICTED

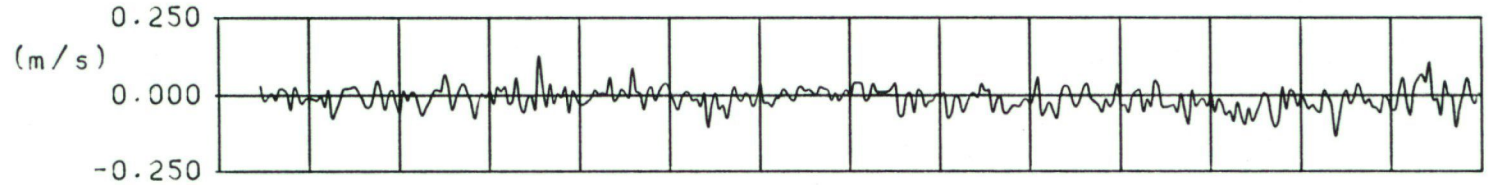
LAWSON AND TRELOAR PTY LTD.

DATE 08:05:86

FIG. 19

SPEED





RESIDUALS

NOTE : MEAN CURRENT REMOVED.

PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY

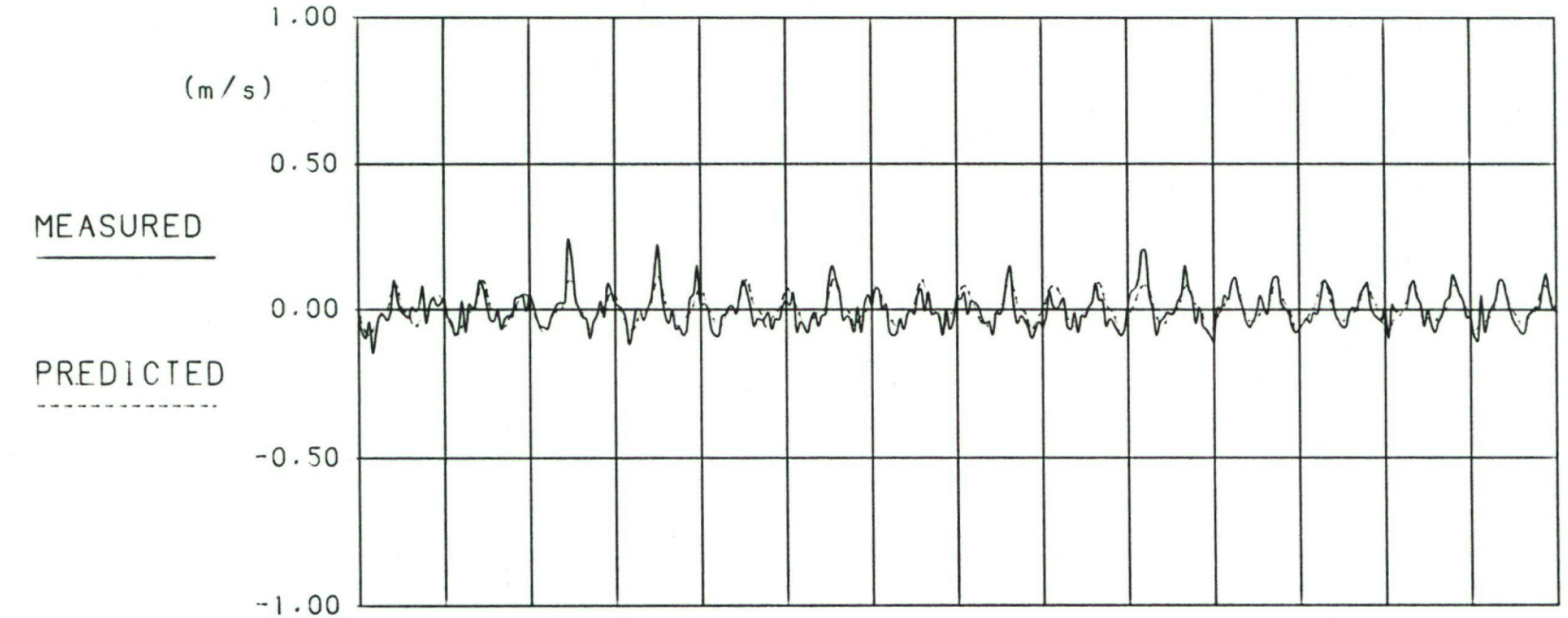
NORTH EAST CHANNEL NE8
EAST-WEST TIDAL CURRENTS
MEASURED - PREDICTED

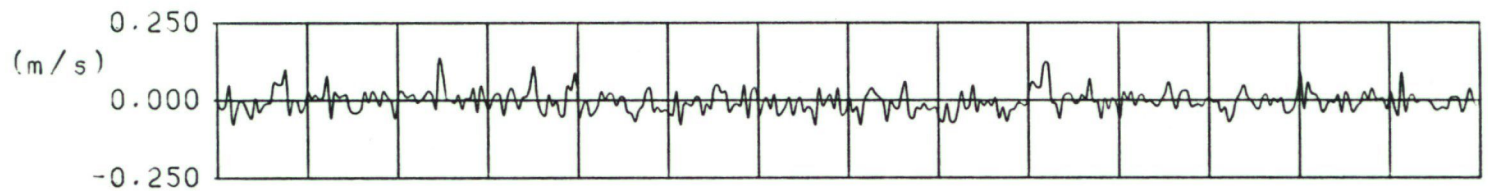
LAWSON AND TRELOAR PTY LTD.

DATE 08:05:86

FIG. 20

SPEED



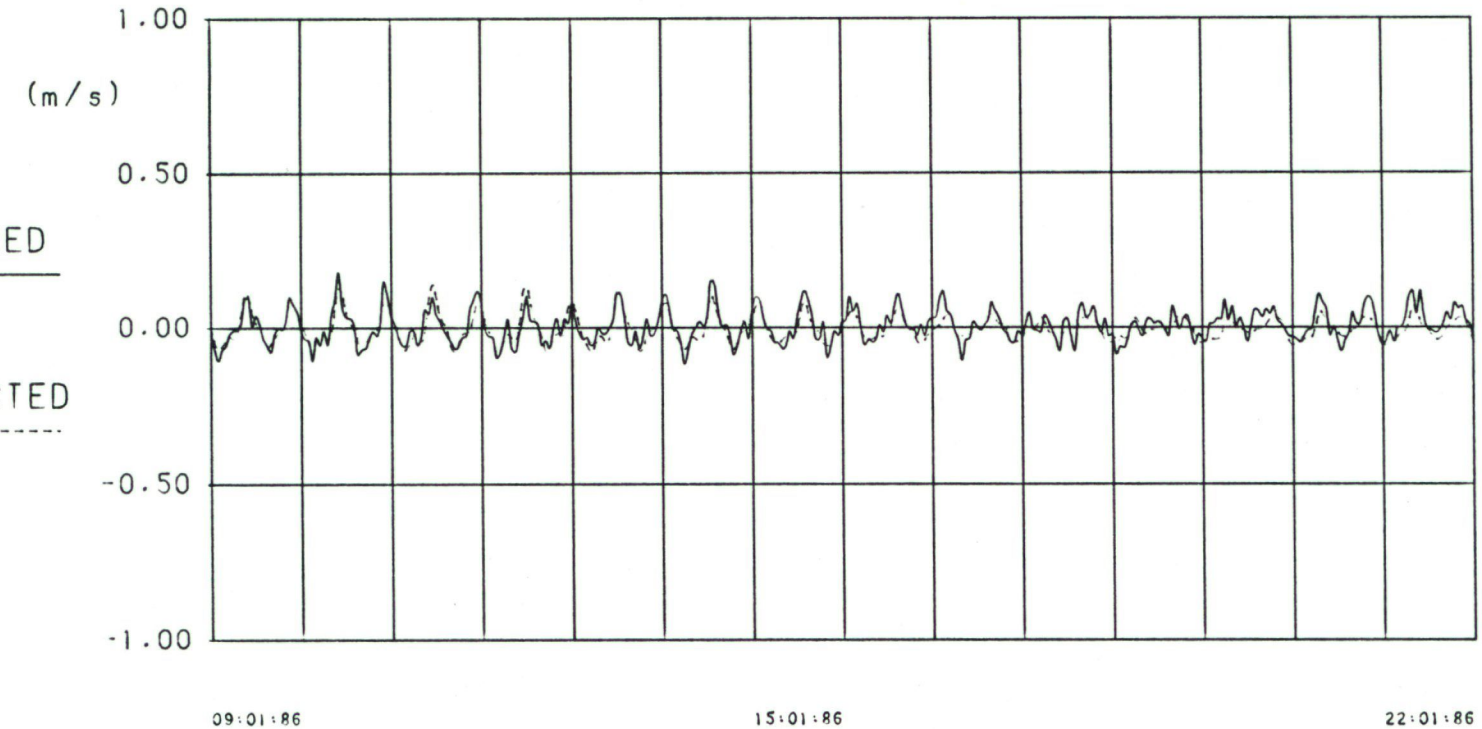


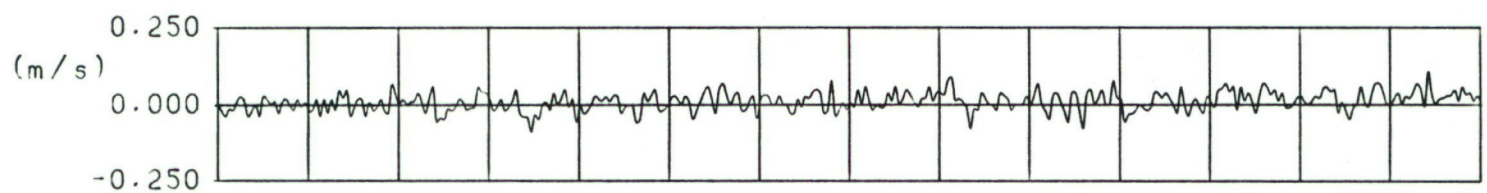
RESIDUALS

NOTE : MEAN CURRENT REMOVED.

	PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY	
NORTH EAST CHANNEL NE8 EAST-WEST TIDAL CURRENTS MEASURED - PREDICTED	LAWSON AND TRELOAR PTY LTD.	
	DATE 08:05:86	FIG. 21

SPEED





RESIDUALS

NOTE : MEAN CURRENT REMOVED.

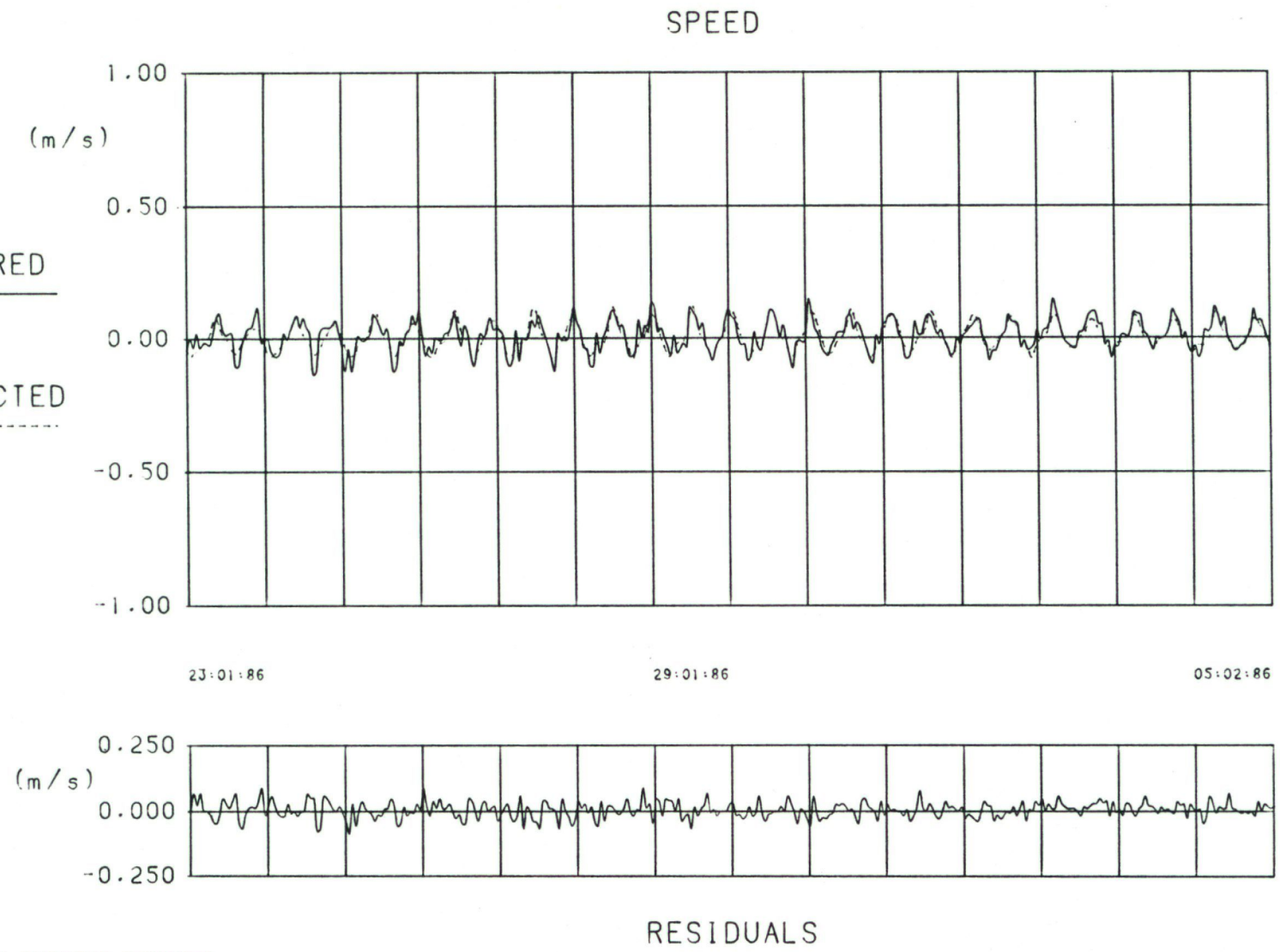
PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY

NORTH EAST CHANNEL NE8
EAST-WEST TIDAL CURRENTS
MEASURED - PREDICTED

LAWSON AND TRELOAR PTY LTD.

DATE 08:05:86

FIG. 22



NOTE : MEAN CURRENT REMOVED.

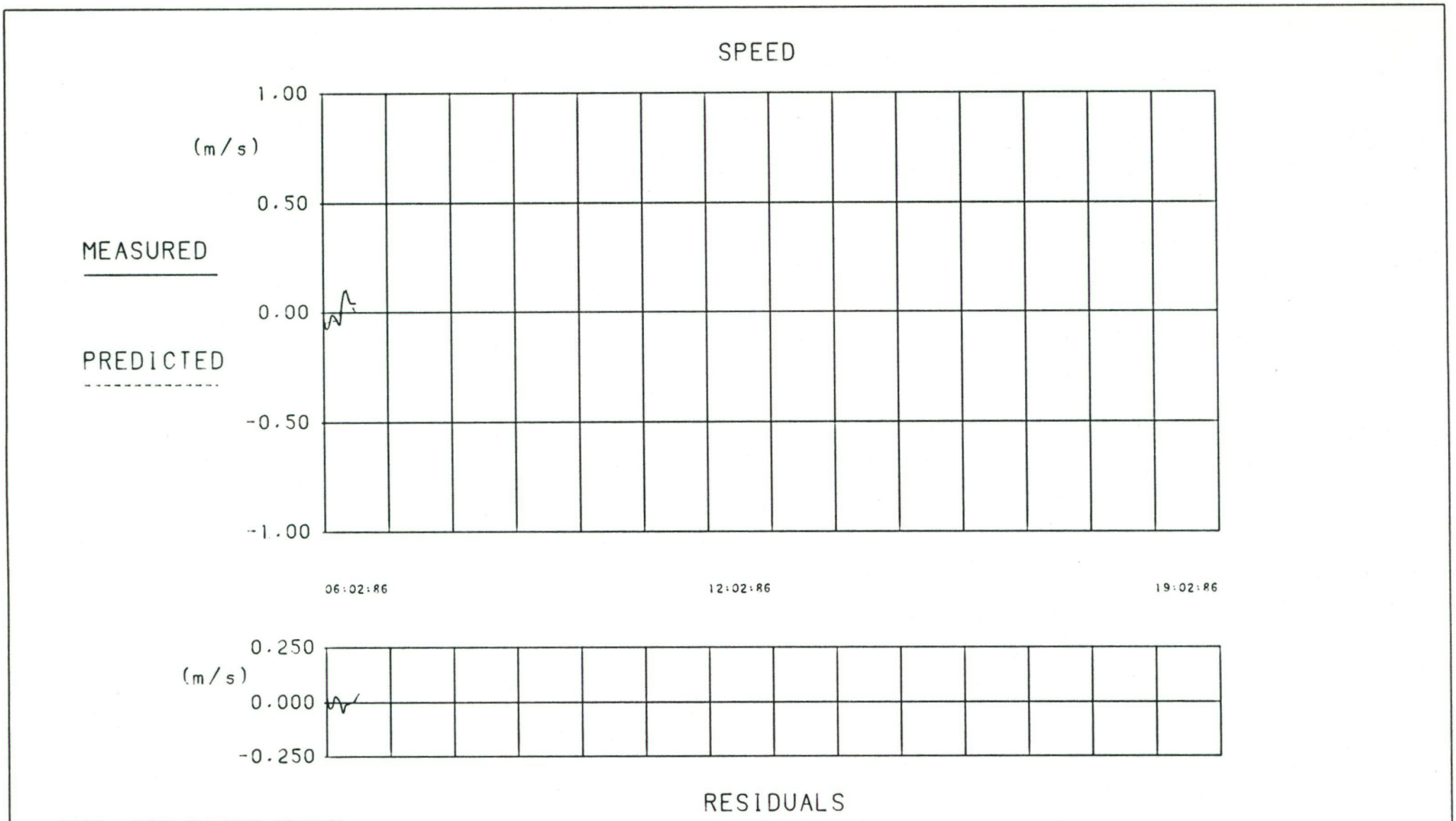
PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY

NORTH EAST CHANNEL NE8
EAST-WEST TIDAL CURRENTS
MEASURED - PREDICTED

LAWSON AND TRELOAR PTY LTD.

DATE 08:05:86

FIG. 23



NOTE : MEAN CURRENT REMOVED.

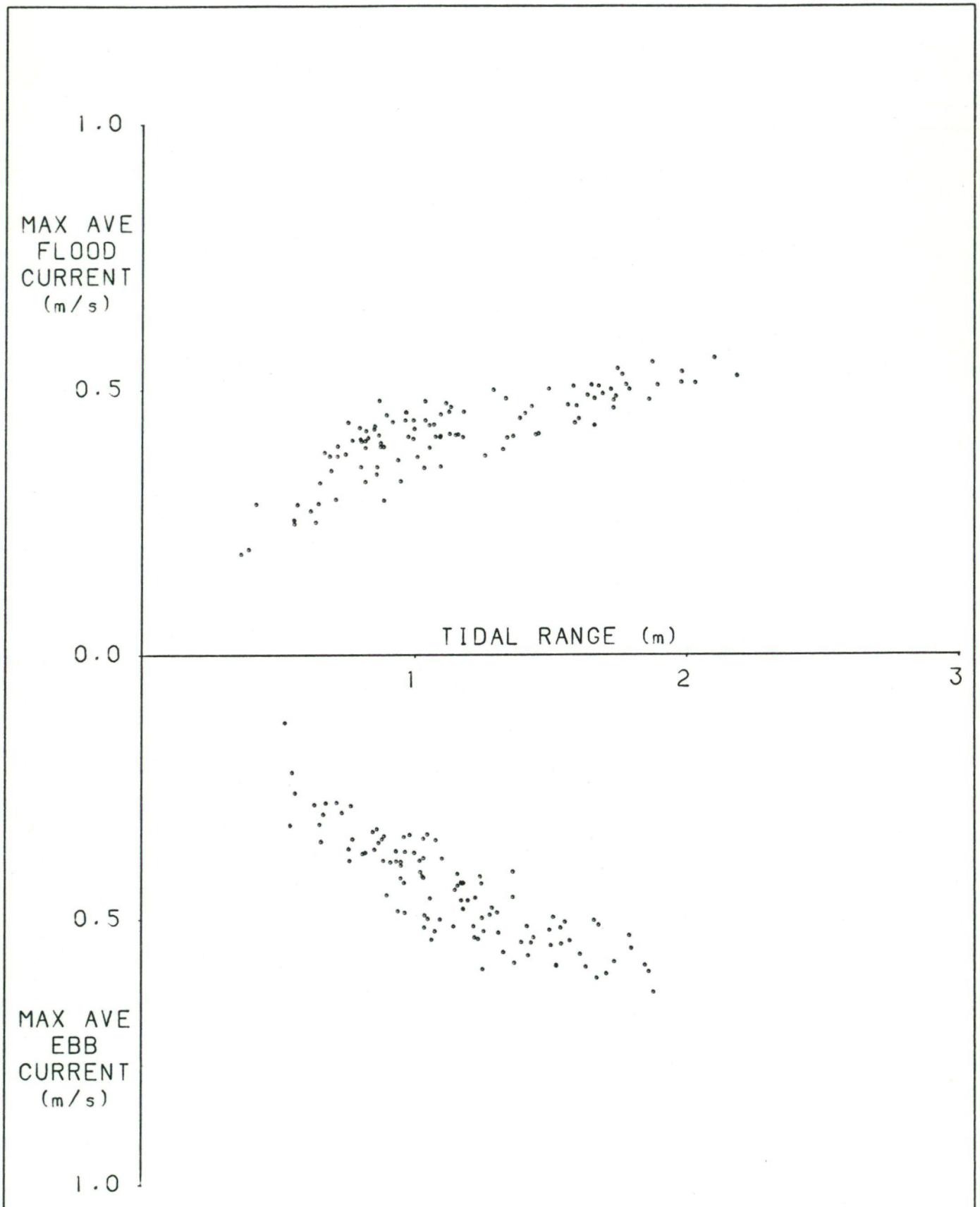
PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY

NORTH EAST CHANNEL NE8
EAST-WEST TIDAL CURRENTS
MEASURED - PREDICTED

LAWSON AND TRELOAR PTY LTD.

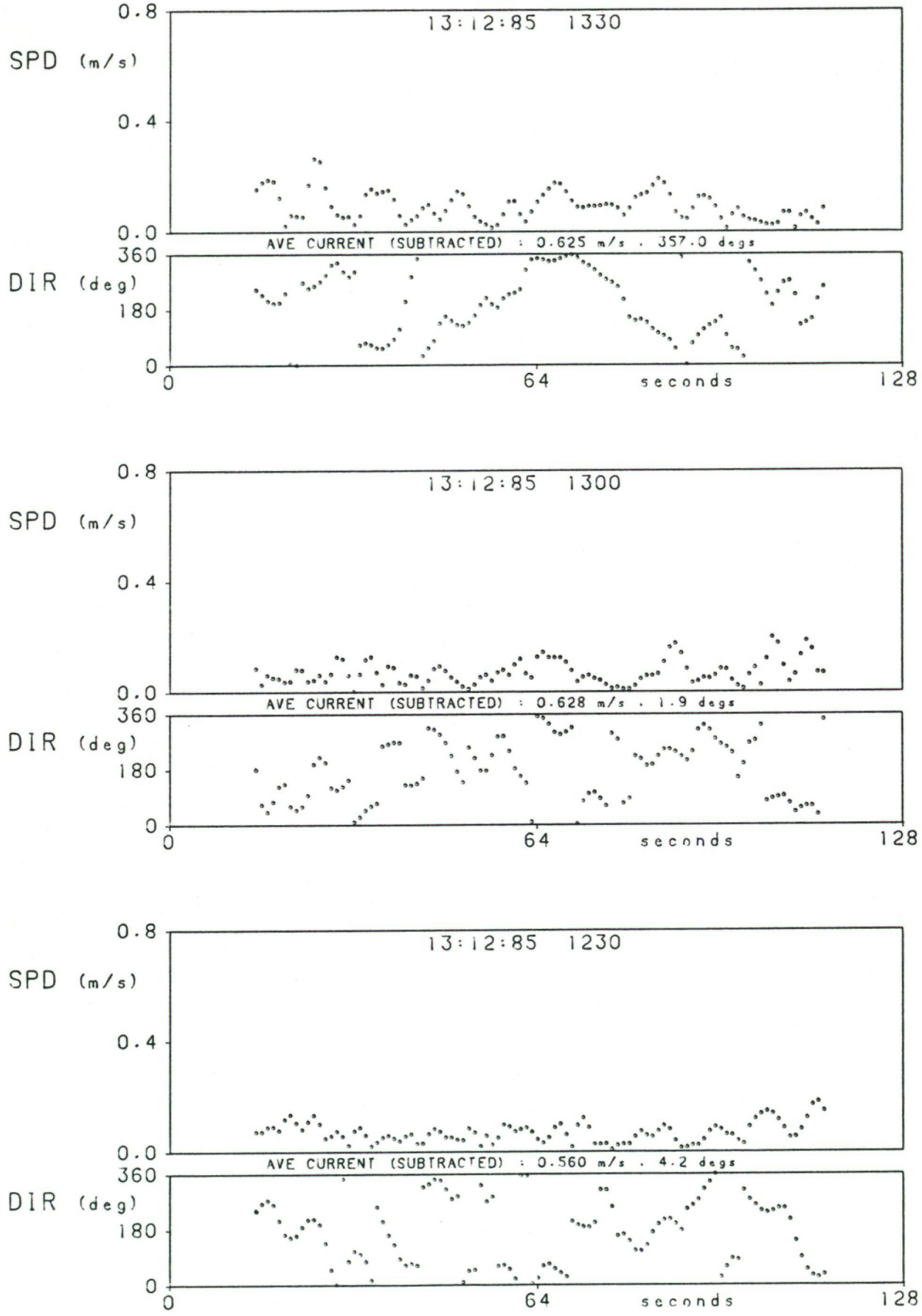
DATE 08:05:86

FIG. 24



PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY

NORTH EAST CHANNEL NE8 MAX AVE CURRENT SPEED TIDAL RANGE	LAWSON AND TRELOAR PTY LTD.	
	DATE 08:05:86	FIG. 25



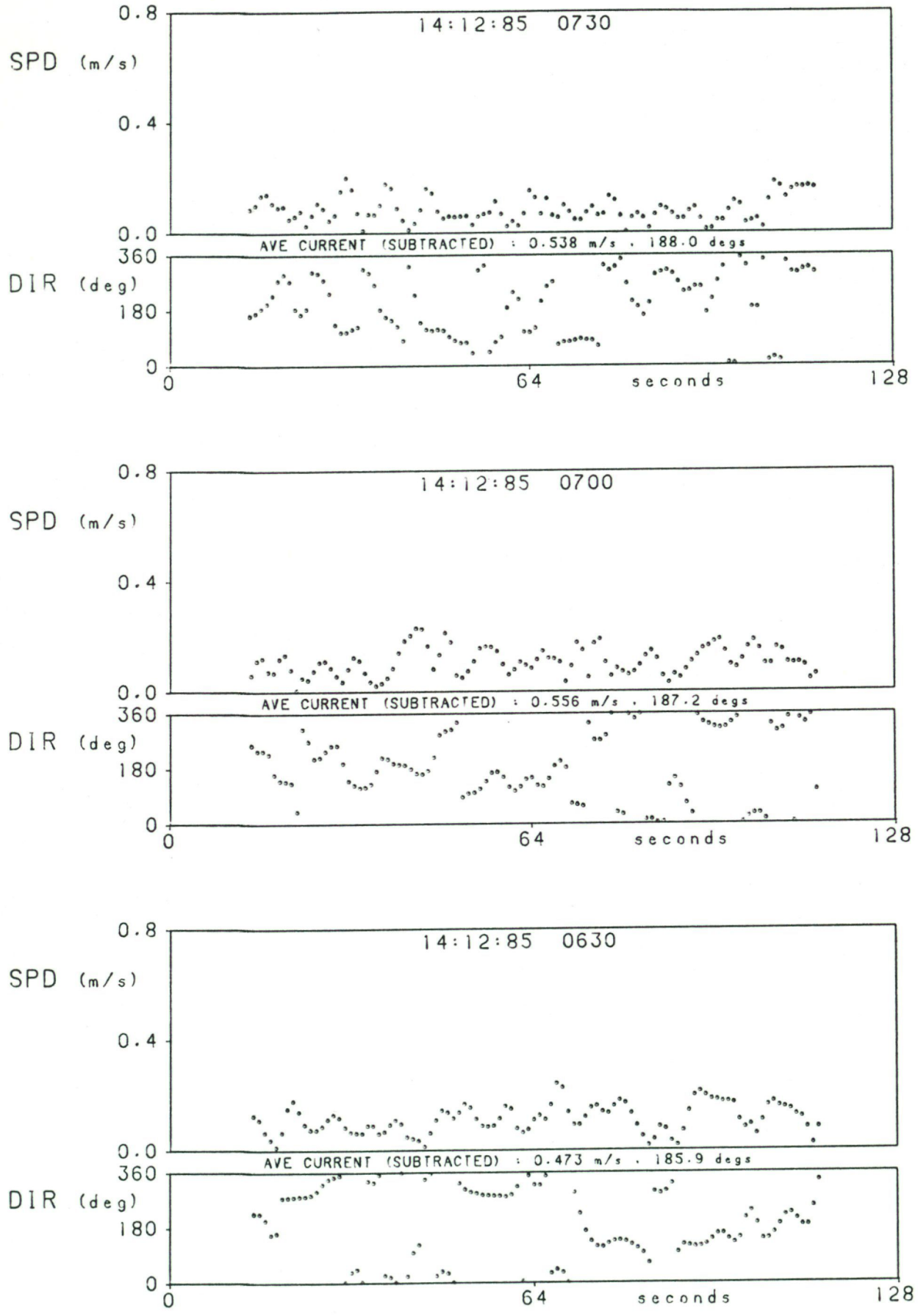
PORT OF BRISBANE AUTHORITY

NORTH EAST CHANNEL NE8
FILTERED 1 SEC CURRENTS
SPD - DIRN TIME HISTORY

LAWSON AND TRELOAR PTY LTD.

DATE 12:05:86

FIG. 26



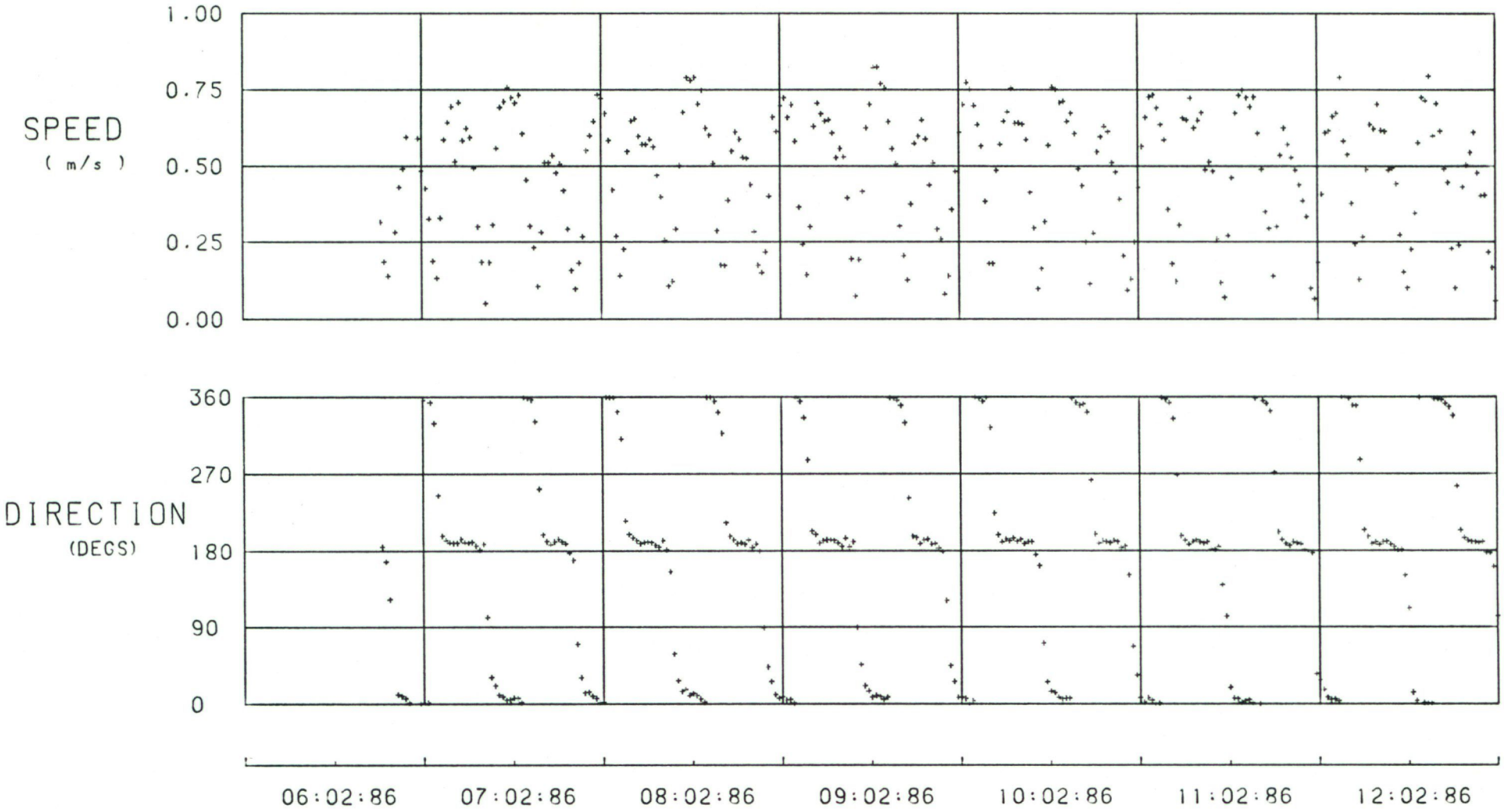
PORT OF BRISBANE AUTHORITY

NORTH EAST CHANNEL NE8
FILTERED 1 SEC CURRENTS
SPD - DIRN TIME HISTORY

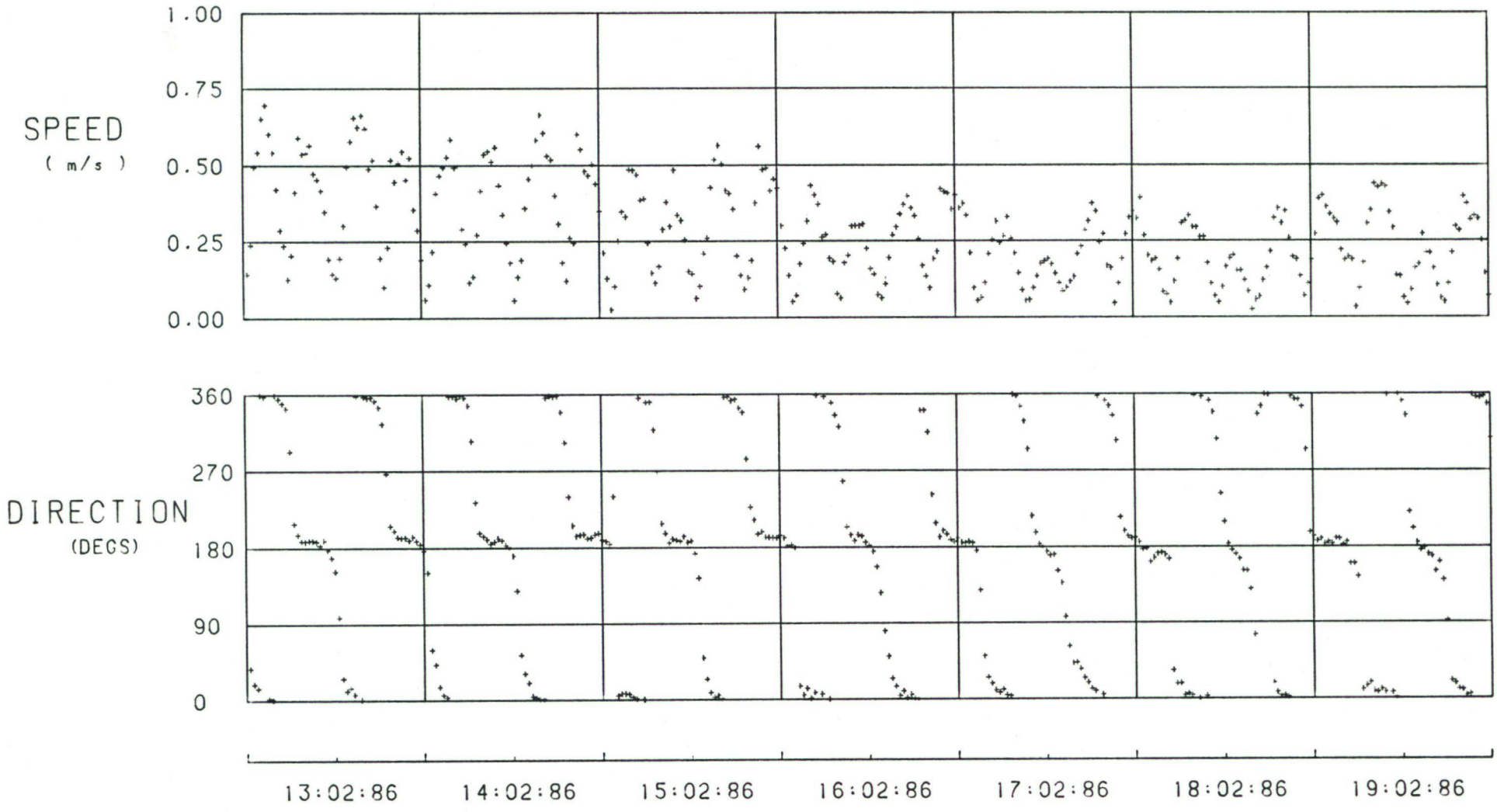
LAWSON AND TRELOAR PTY LTD.

DATE 12:05:86

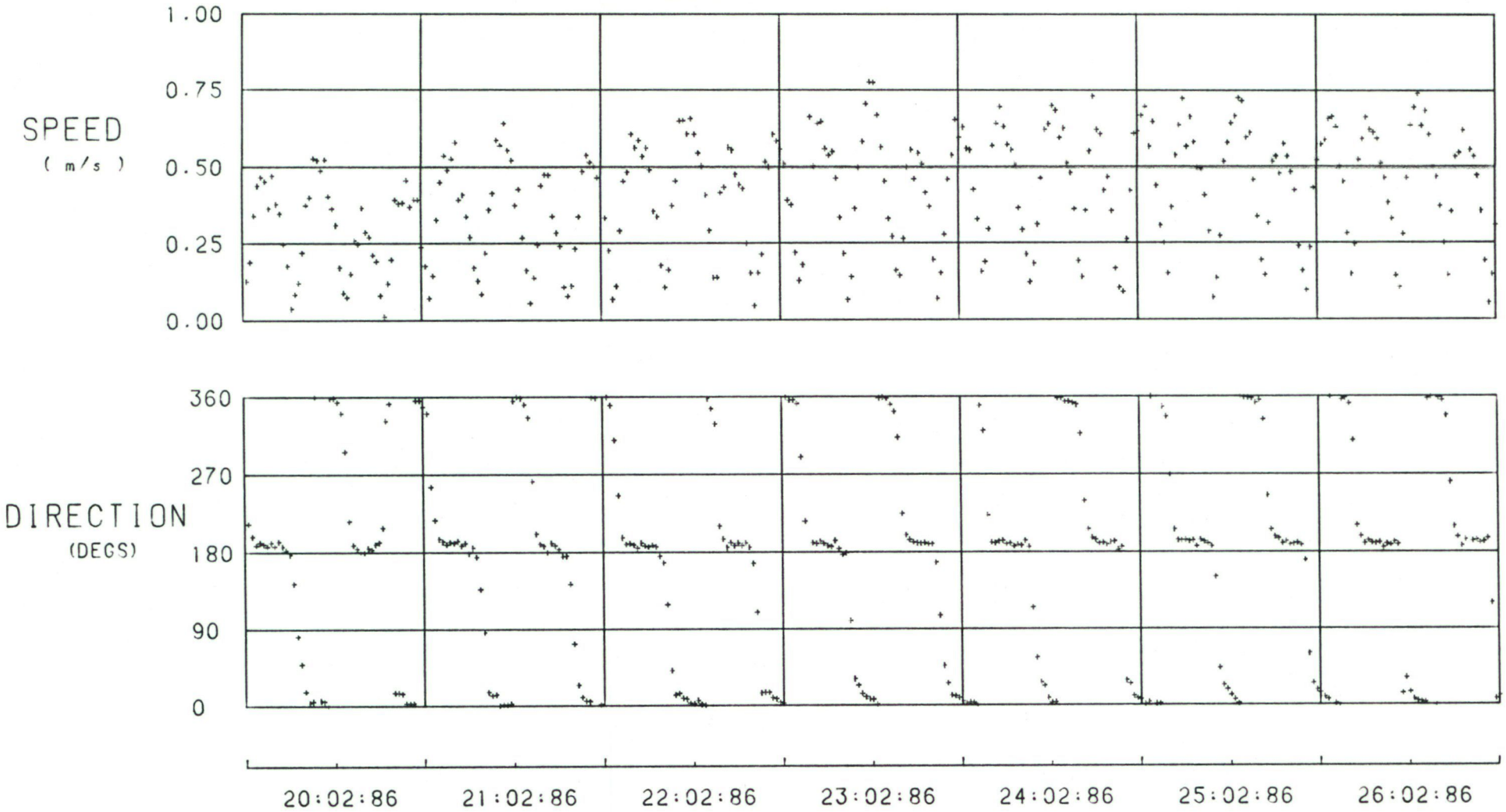
FIG. 27



LATITUDE : 27 degs 01' 08" S LONGITUDE : 153 degs 20' 20" E DATA START TIME : 1830 06:02:86 DATA END TIME : 1030 12:03:86	PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY NORTH EAST CHANNEL NE6 CURRENT SPEED-DIRECTION TIME HISTORY PLOT	LAWSON AND TRELOAR PTY LTD. DATE 08:05:86 FIG. 28



LATITUDE : 27 degs 01' 08" S	PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY
LONGITUDE : 153 degs 20' 20" E	NORTH EAST CHANNEL NE6 CURRENT SPEED-DIRECTION TIME HISTORY PLOT
DATA START TIME : 1830 06:02:86	LAWSON AND TRELOAR PTY LTD.
DATA END TIME : 1030 12:03:86	DATE 08:05:86 / FIG. 29



LATITUDE : 27 degs 01' 08" S
LONGITUDE : 153 degs 20' 20" E
DATA START TIME : 1830 06:02:86
DATA END TIME : 1030 12:03:86

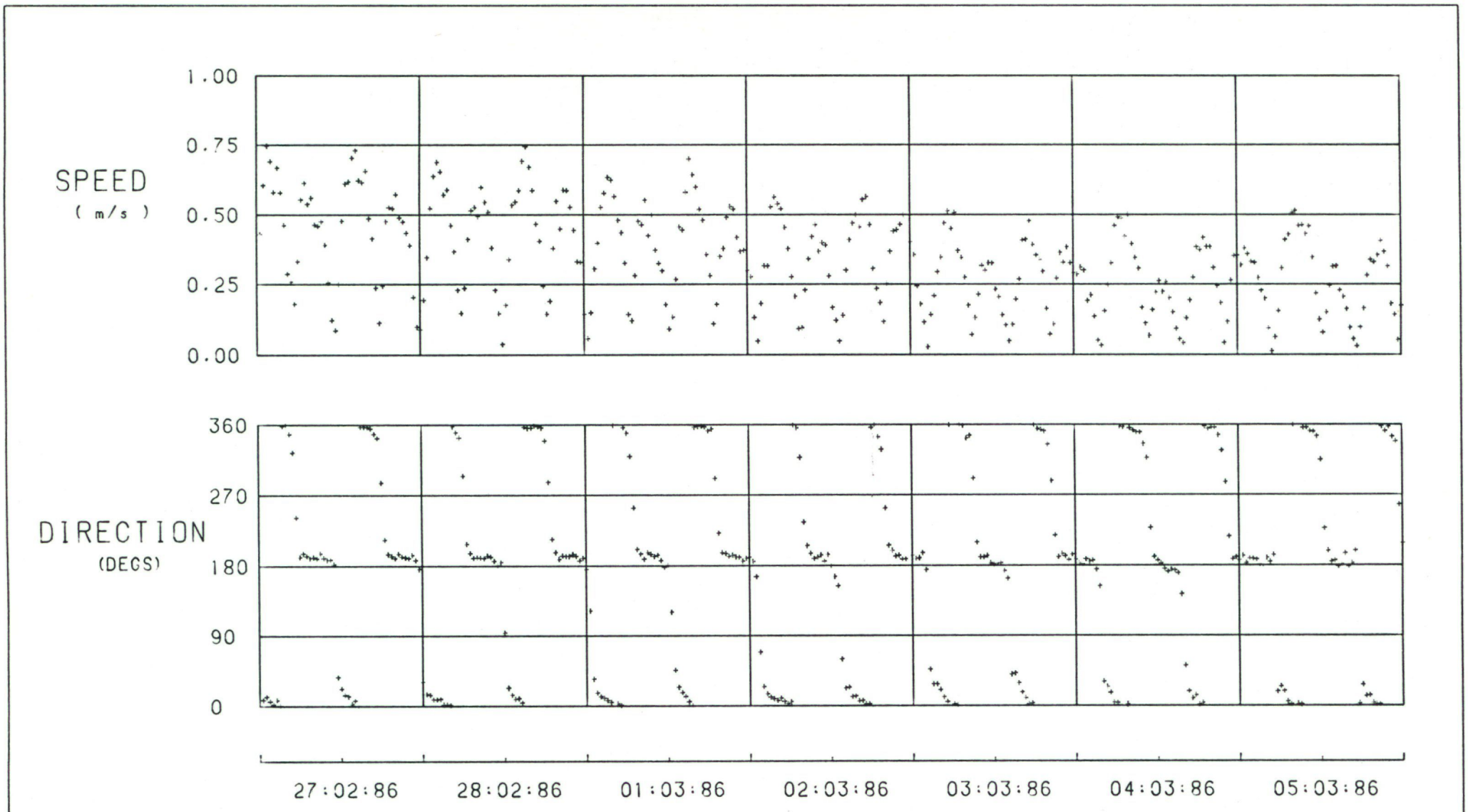
PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY

NORTH EAST CHANNEL NE6
CURRENT SPEED-DIRECTION
TIME HISTORY PLOT

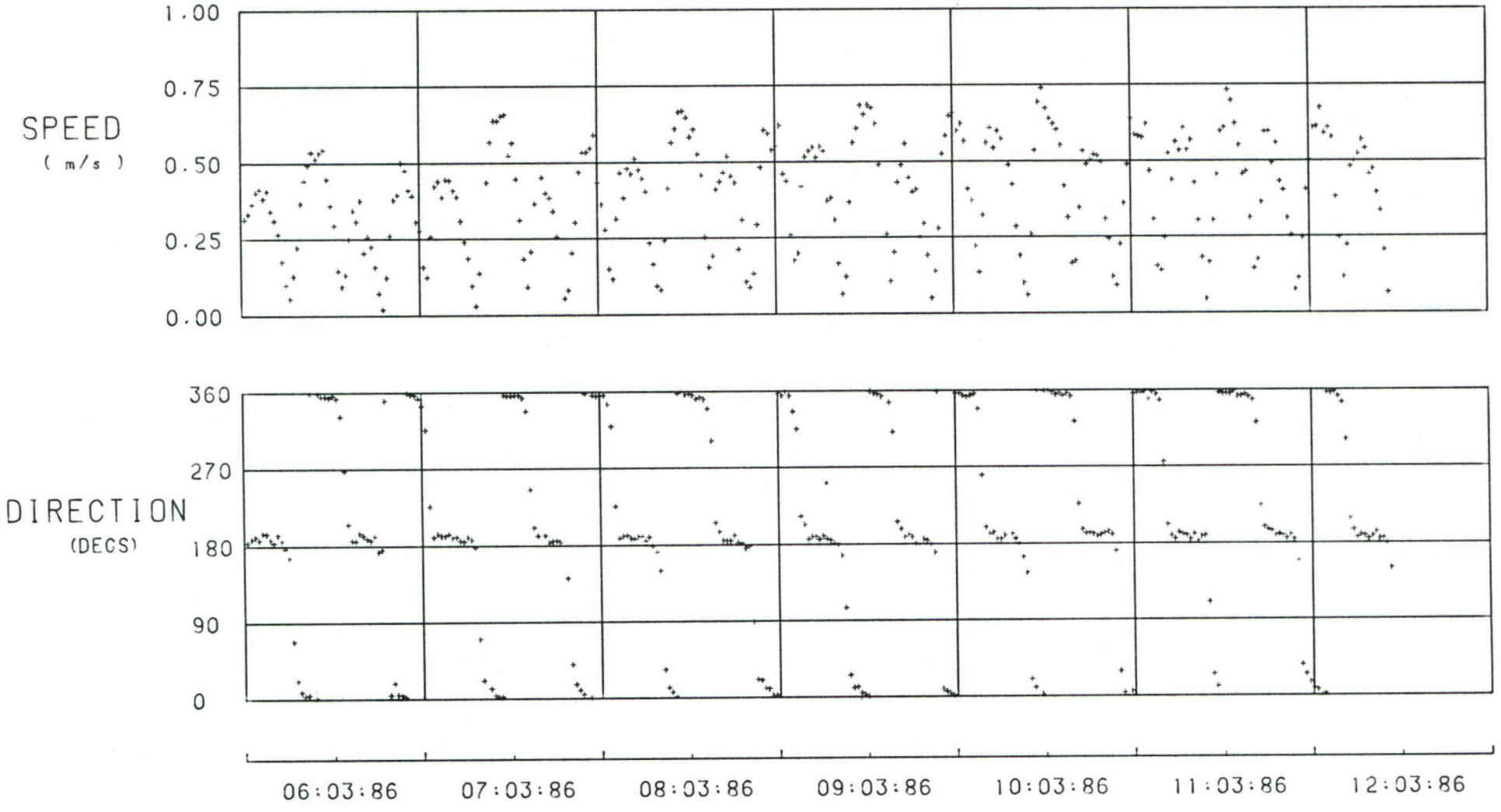
LAWSON AND TRELOAR PTY LTD.

DATE 08:05:86

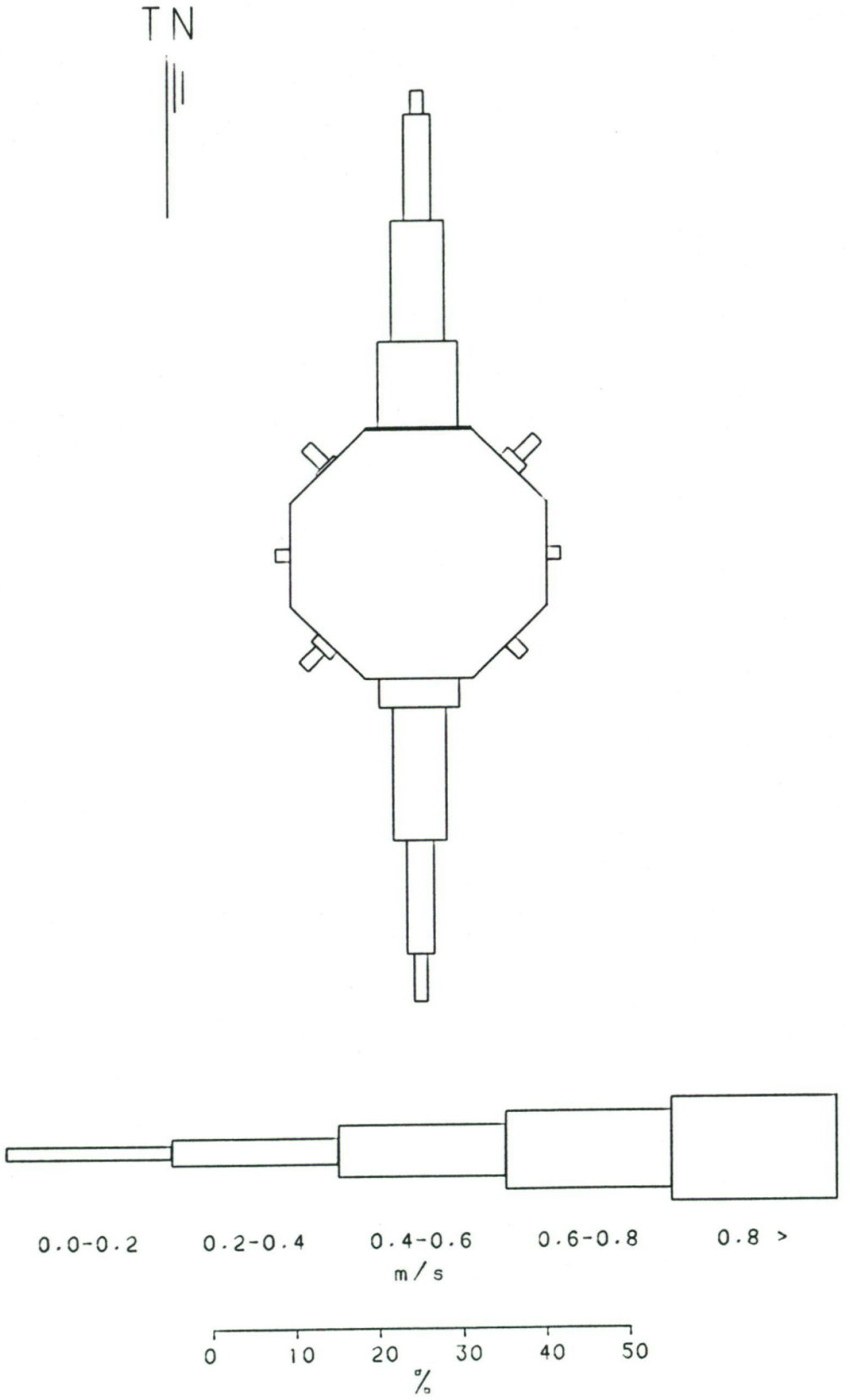
FIG. 30



LATITUDE : 27 degs 01' 08" S	PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY
LONGITUDE : 153 degs 20' 20" E	NORTH EAST CHANNEL NE6 CURRENT SPEED-DIRECTION TIME HISTORY PLOT
DATA START TIME : 1830 06:02:86	LAWSON AND TRELOAR PTY LTD.
DATA END TIME : 1030 12:03:86	DATE 08:05:86 / FIG. 31



LATITUDE : 27 degs 01' 08" S	PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY
LONGITUDE : 153 degs 20' 20" E	NORTH EAST CHANNEL NE6 CURRENT SPEED-DIRECTION TIME HISTORY PLOT
DATA START TIME : 1830 06:02:86	LAWSON AND TRELOAR PTY LTD.
DATA END TIME : 1030 12:03:86	DATE 08:05:86 — FIG. 32



LATITUDE : 27 degs 01' 08" S
LONGITUDE : 153 degs 20' 20" E

DATA START TIME : 1830 06:02:86
DATA END TIME : 1030 12:03:86

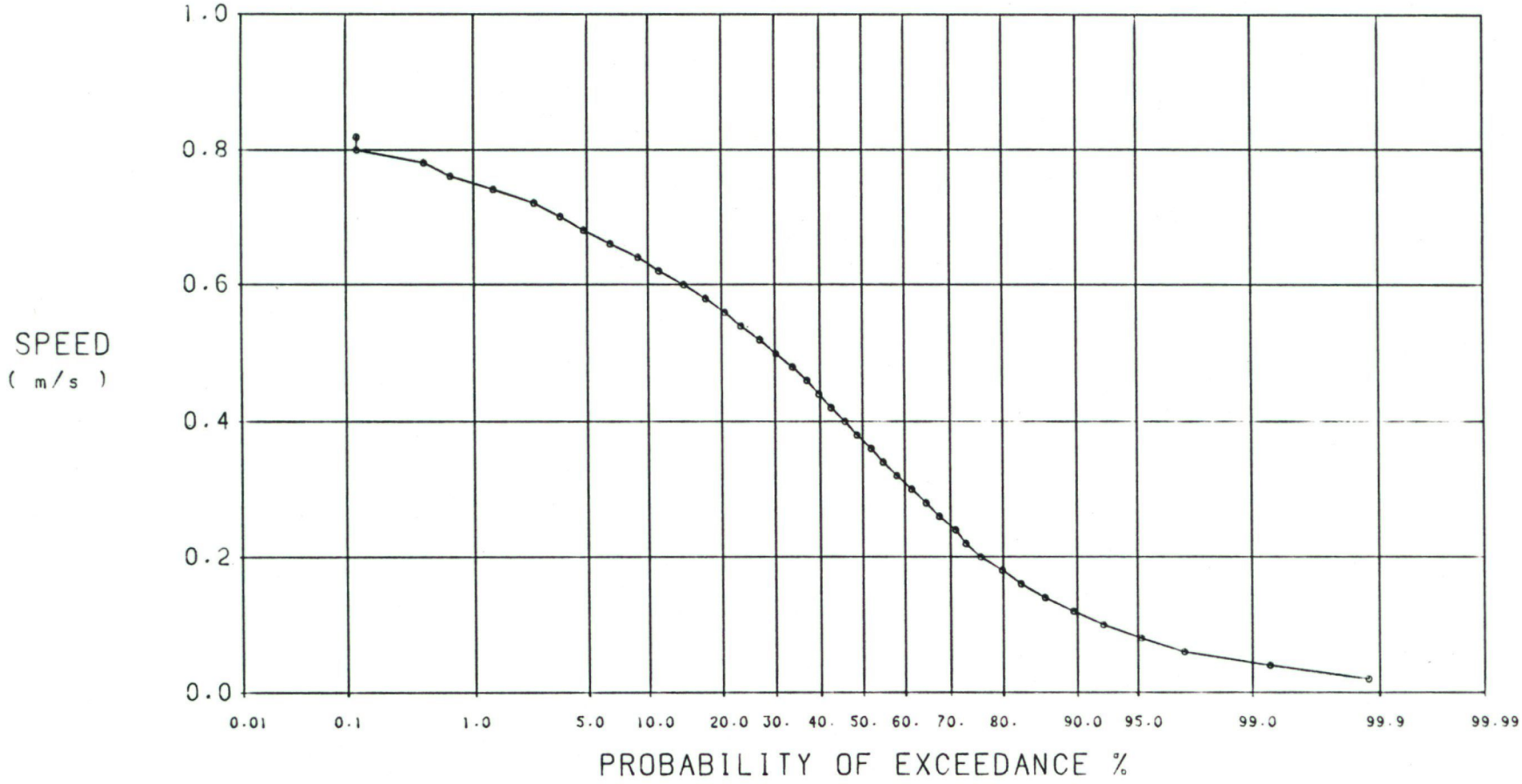
PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY

NORTH EAST CHANNEL NE6 CURRENT SPEED-DIRECTION FREQUENCY ROSE

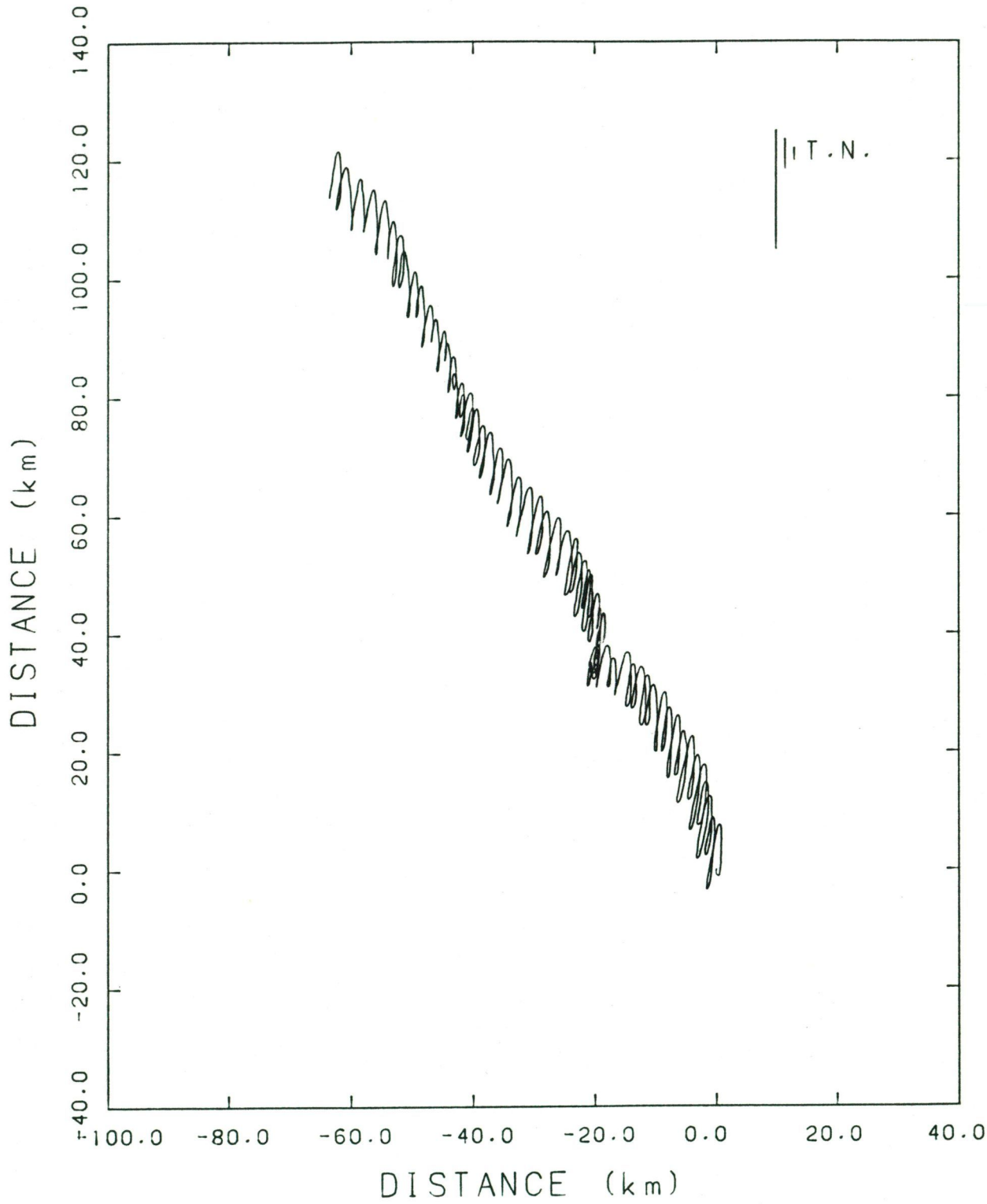
LAWSON AND TRELOAR PTY LTD.

DATE 08:05:86

FIG. 33



LOCATION : NORTH EAST CHANNEL NE6	START TIME : 1830 06:02:86	PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY	
TOTAL RECORDS: 1605	END TIME : 1030 12:03:86	NORTH EAST CHANNEL NE6 CURRENT SPEED EXCEEDANCE PLOT	LAWSON AND TRELOAR PTY LTD.
INSTRUMENT : SEA DATA 620A S/N 58			DATE 08:05:86 / FIG. 34



FROM ORIGIN

LATITUDE	:	27 degs 01' 08" S
LONGITUDE	:	153 degs 20' 20" E
DATA START TIME	:	1830 06:02:86
DATA END TIME	:	1030 12:03:86

PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY

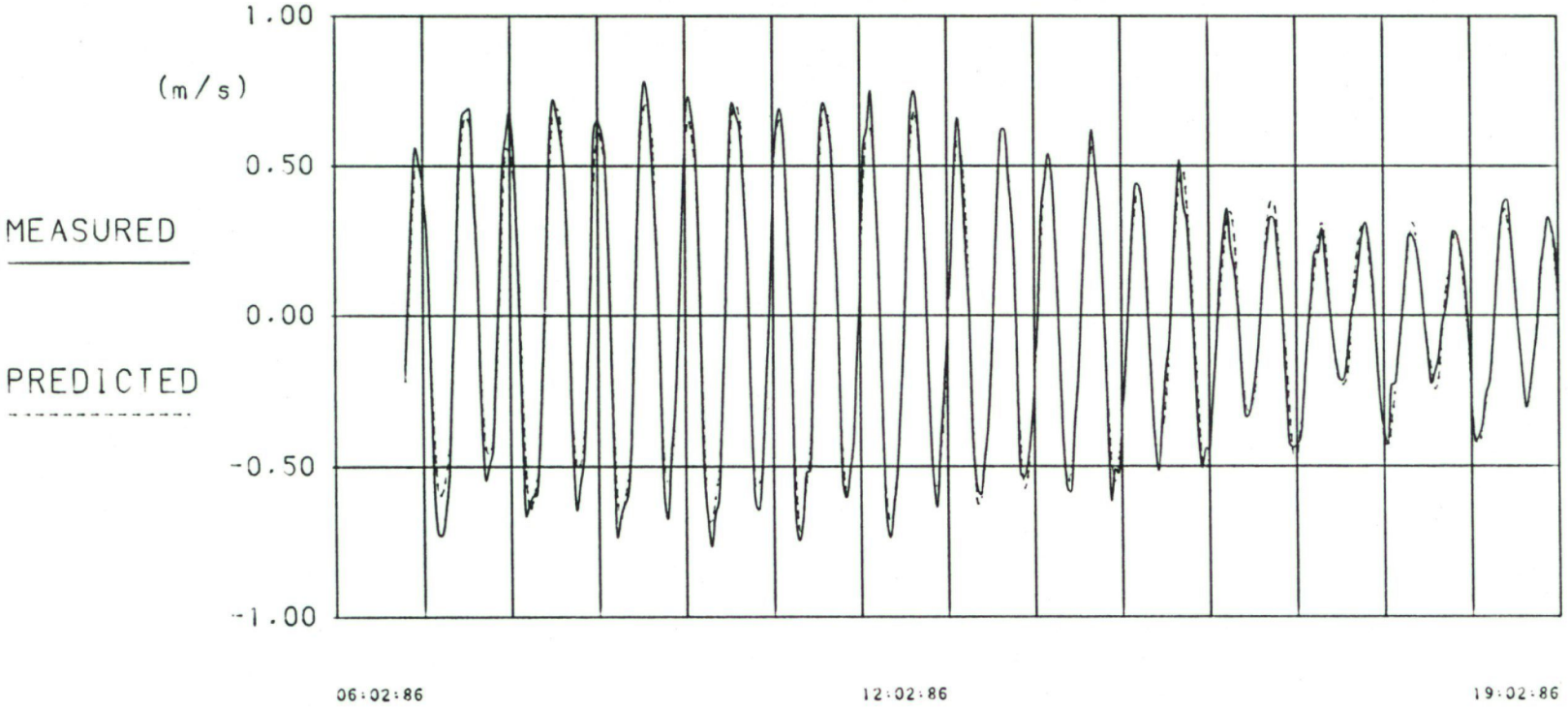
NORTH EAST CHANNEL NE6
PROGRESSIVE VECTOR
PLOT

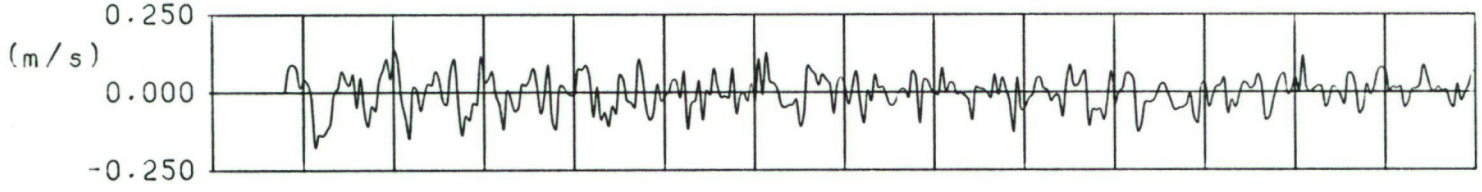
LAWSON AND TRELOAR PTY LTD.

DATE 08:05:86

FIG. 35

SPEED



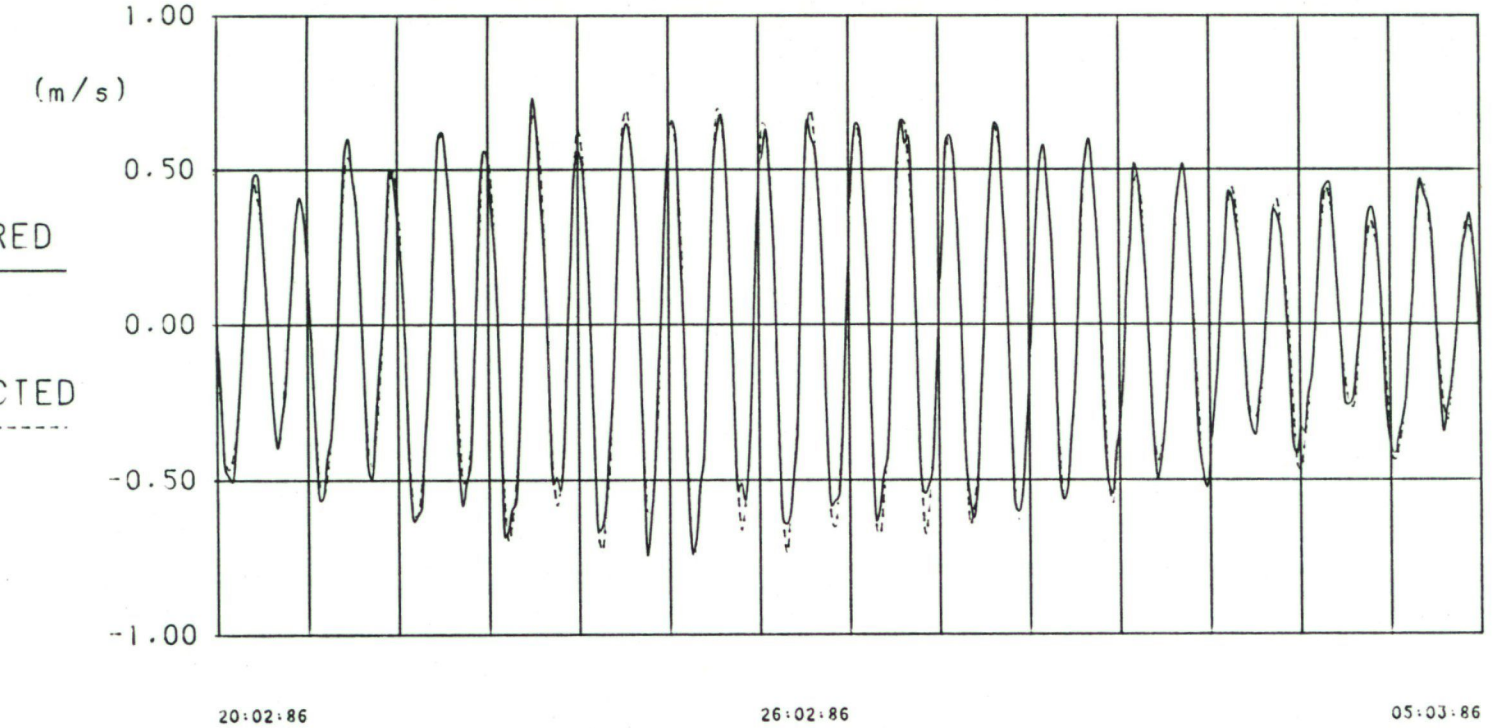


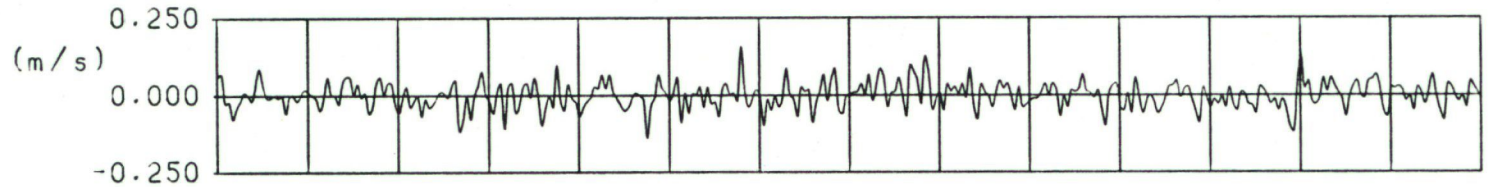
RESIDUALS

NOTE : MEAN CURRENT REMOVED.

	PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY	
NORTH EAST CHANNEL NE6 NORTH-SOUTH TIDAL CURRENTS MEASURED - PREDICTED	LAWSON AND TRELOAR PTY LTD.	
	DATE 08:05:86	FIG. 36

SPEED





RESIDUALS

NOTE : MEAN CURRENT REMOVED.

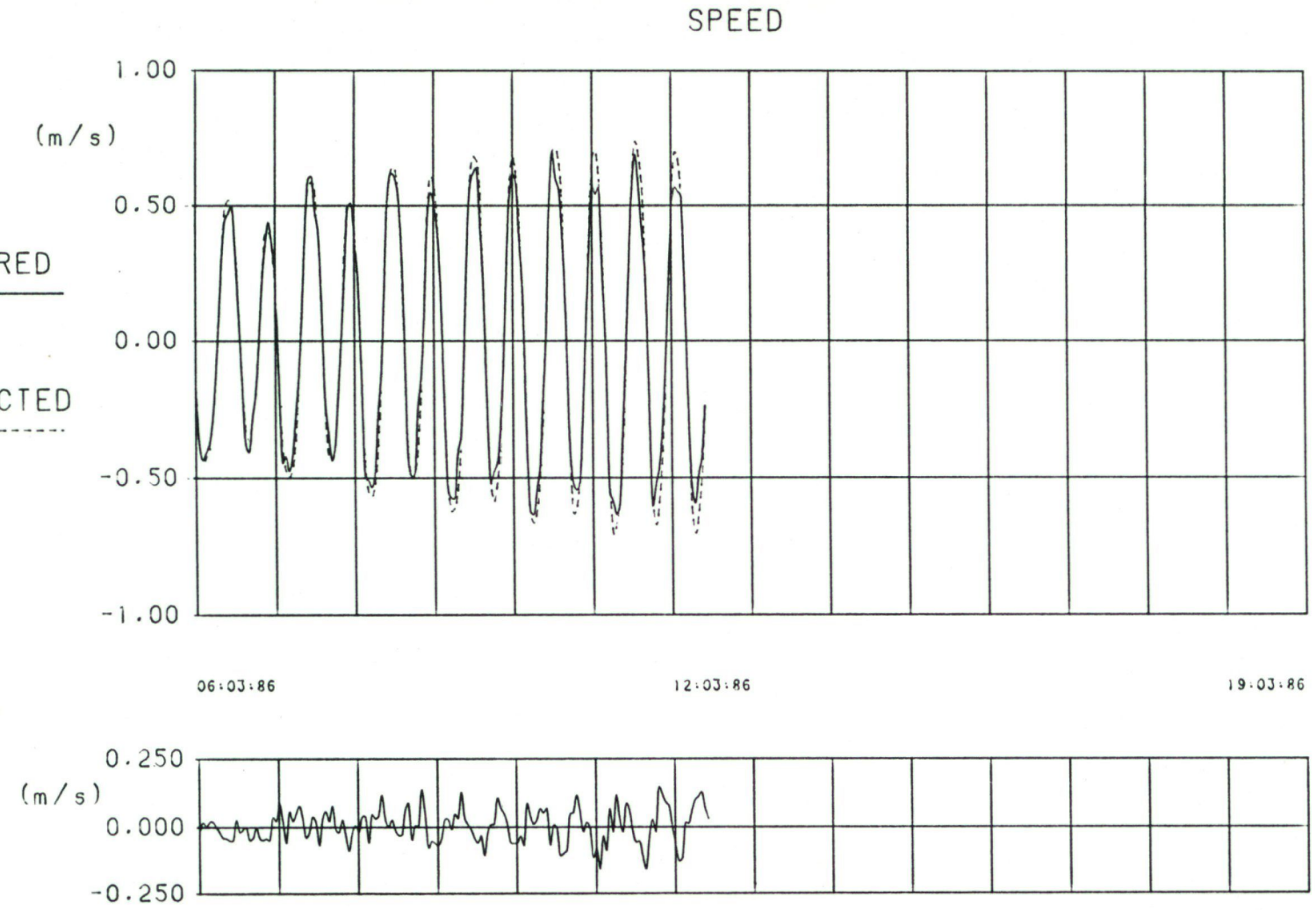
PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY

NORTH EAST CHANNEL NE6
NORTH-SOUTH TIDAL CURRENTS
MEASURED - PREDICTED

LAWSON AND TRELOAR PTY LTD.

DATE 08:05:86

FIG. 37



NOTE : MEAN CURRENT REMOVED.

PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY

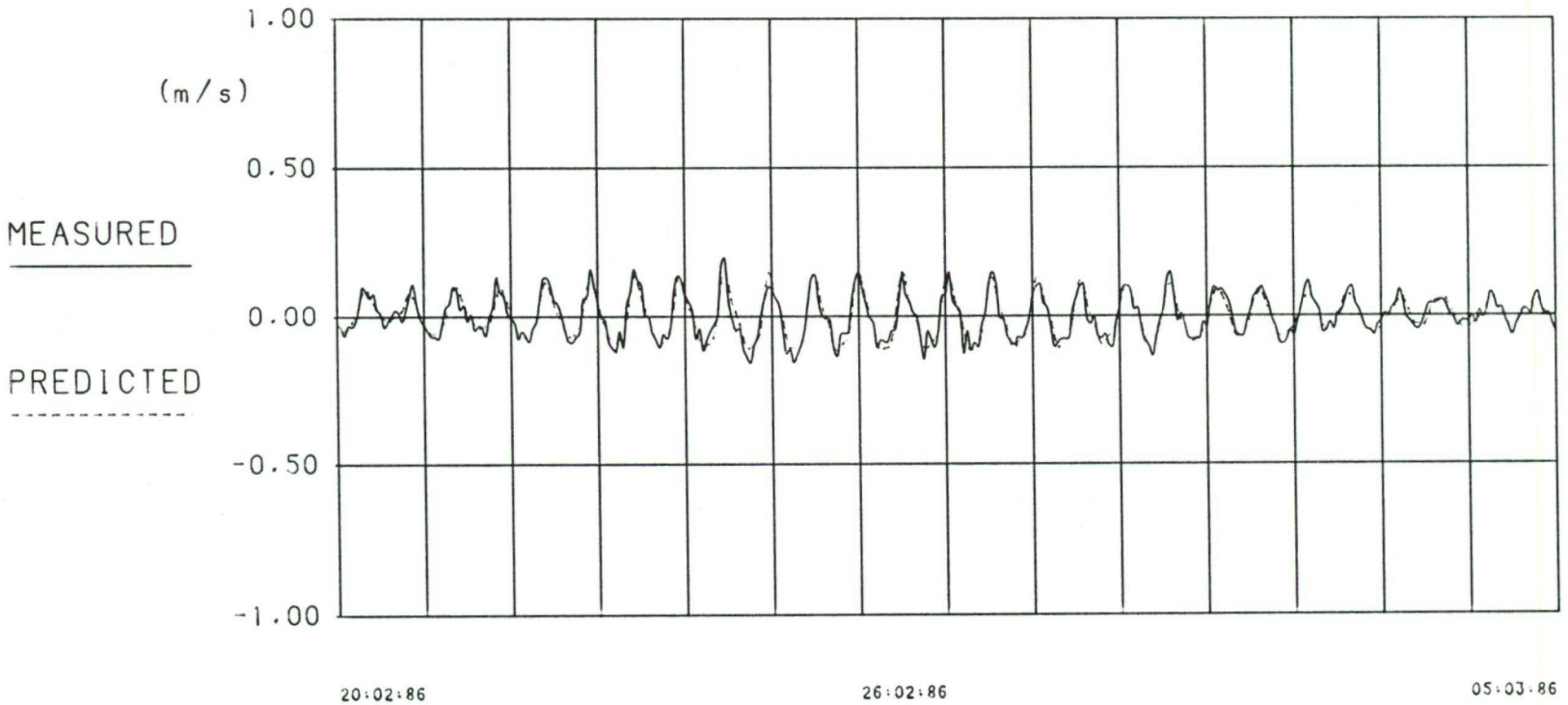
NORTH EAST CHANNEL NE6
NORTH-SOUTH TIDAL CURRENTS
MEASURED - PREDICTED

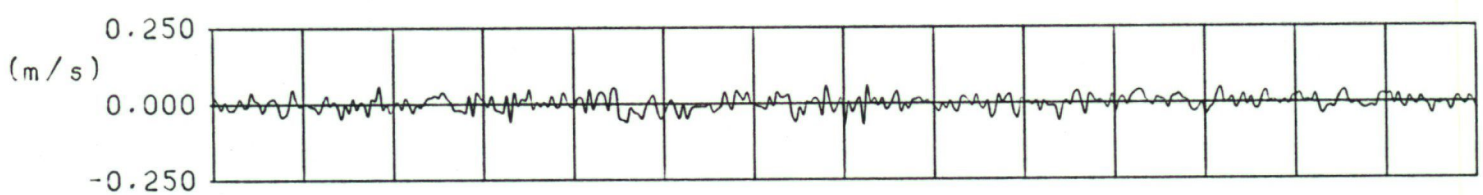
LAWSON AND TRELOAR PTY LTD.

DATE 08:05:86

FIG. 38

SPEED





RESIDUALS

NOTE : MEAN CURRENT REMOVED.

PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY

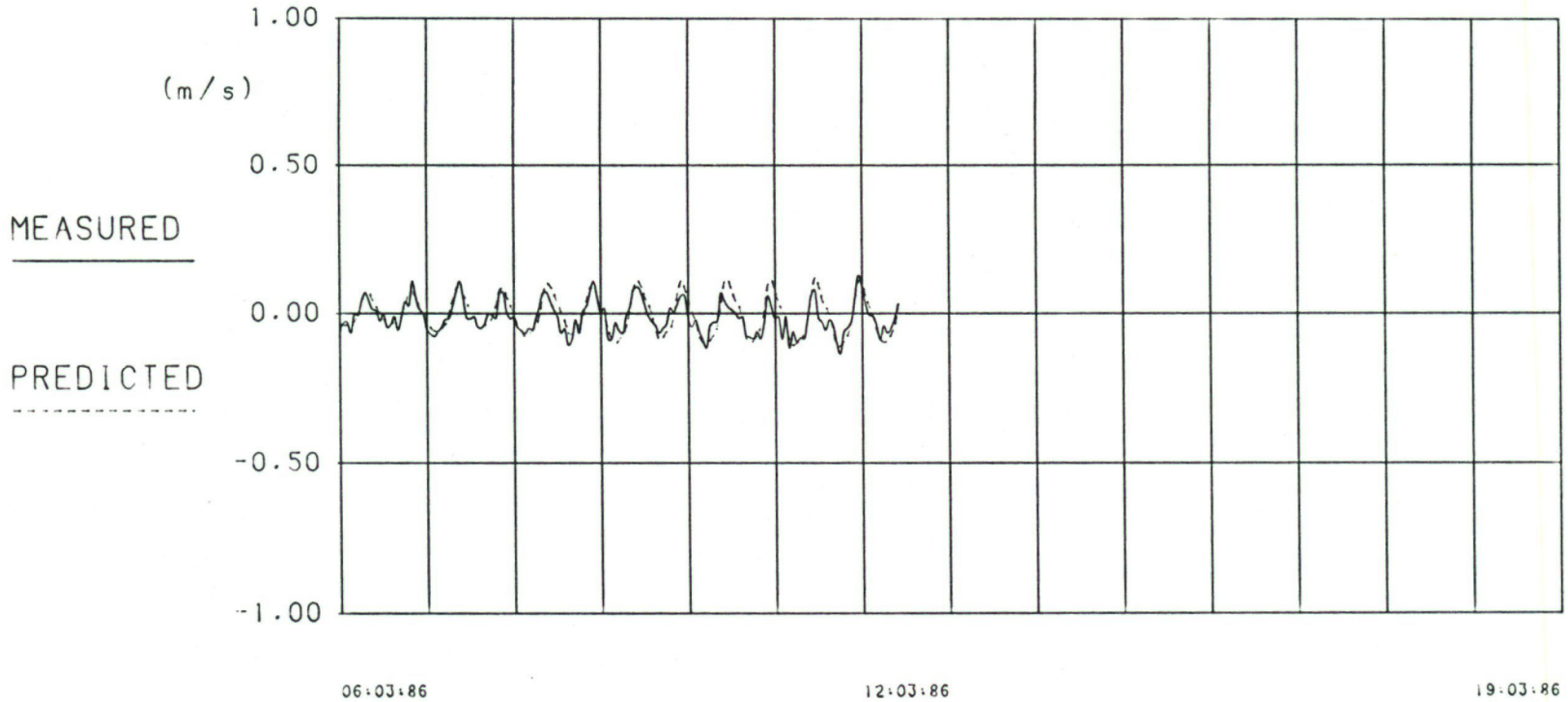
NORTH EAST CHANNEL NE6
EAST-WEST TIDAL CURRENTS
MEASURED - PREDICTED

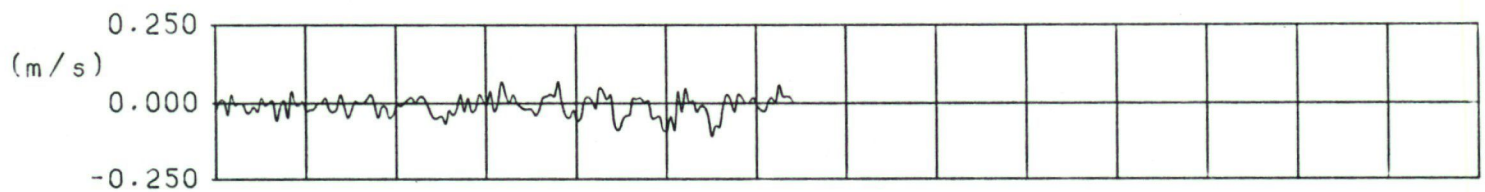
LAWSON AND TRELOAR PTY LTD.

DATE 08:05:86

FIG. 40

SPEED

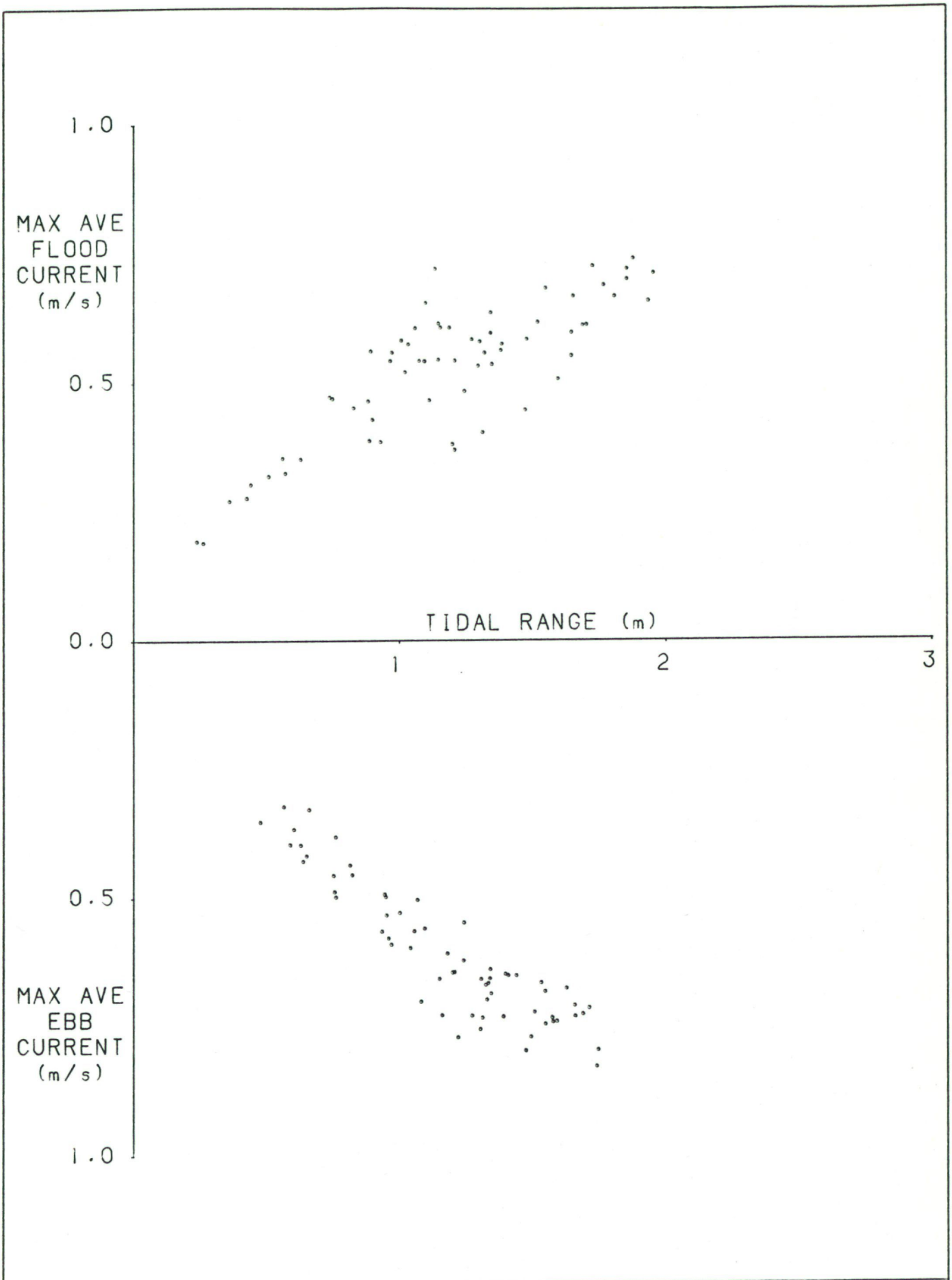




RESIDUALS

NOTE : MEAN CURRENT REMOVED.

	PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY	
NORTH EAST CHANNEL NE6 EAST-WEST TIDAL CURRENTS MEASURED - PREDICTED	LAWSON AND TRELOAR PTY LTD.	
	DATE 08:05:86	FIG. 41



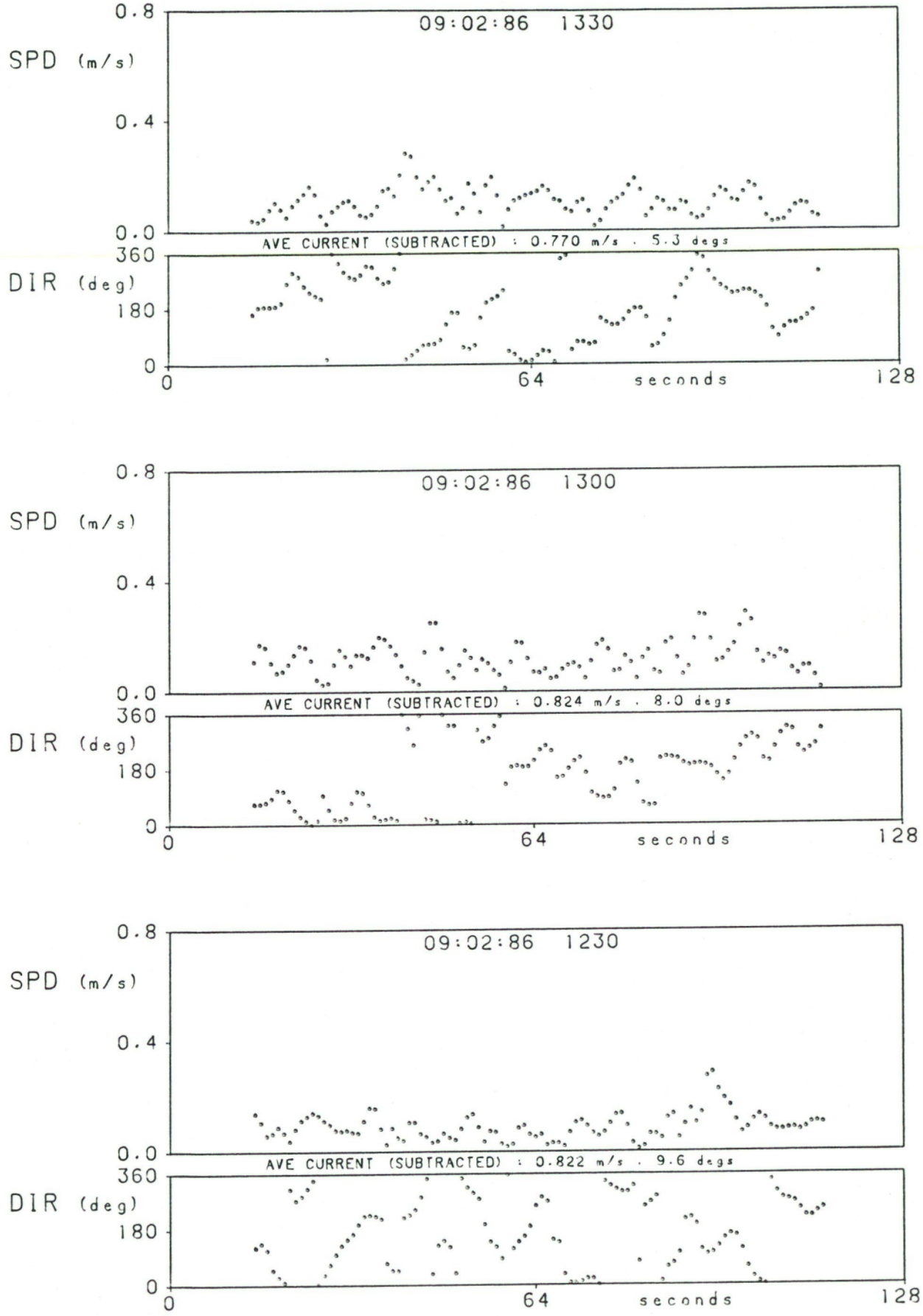
PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY

NORTH EAST CHANNEL NE6
MAX AVE CURRENT SPEED
TIDAL RANGE

LAWSON AND TRELOAR PTY LTD.

DATE 08:05:86

FIG. 42



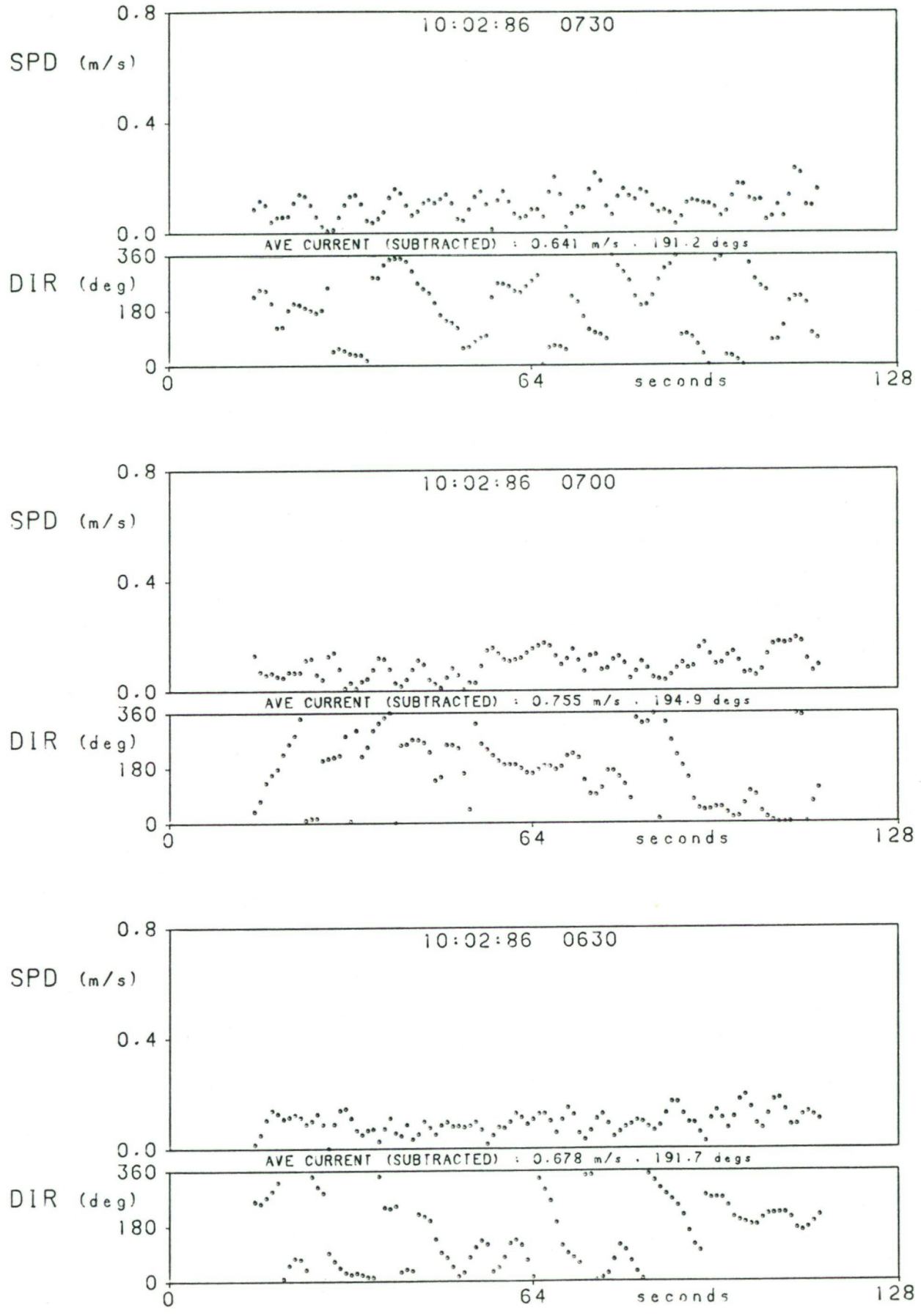
PORT OF BRISBANE AUTHORITY

NORTH EAST CHANNEL NE6
FILTERED 1 SEC CURRENTS
SPD - DIRN TIME HISTORY

LAWSON AND TRELOAR PTY LTD.

DATE 12:05:86

FIG. 43



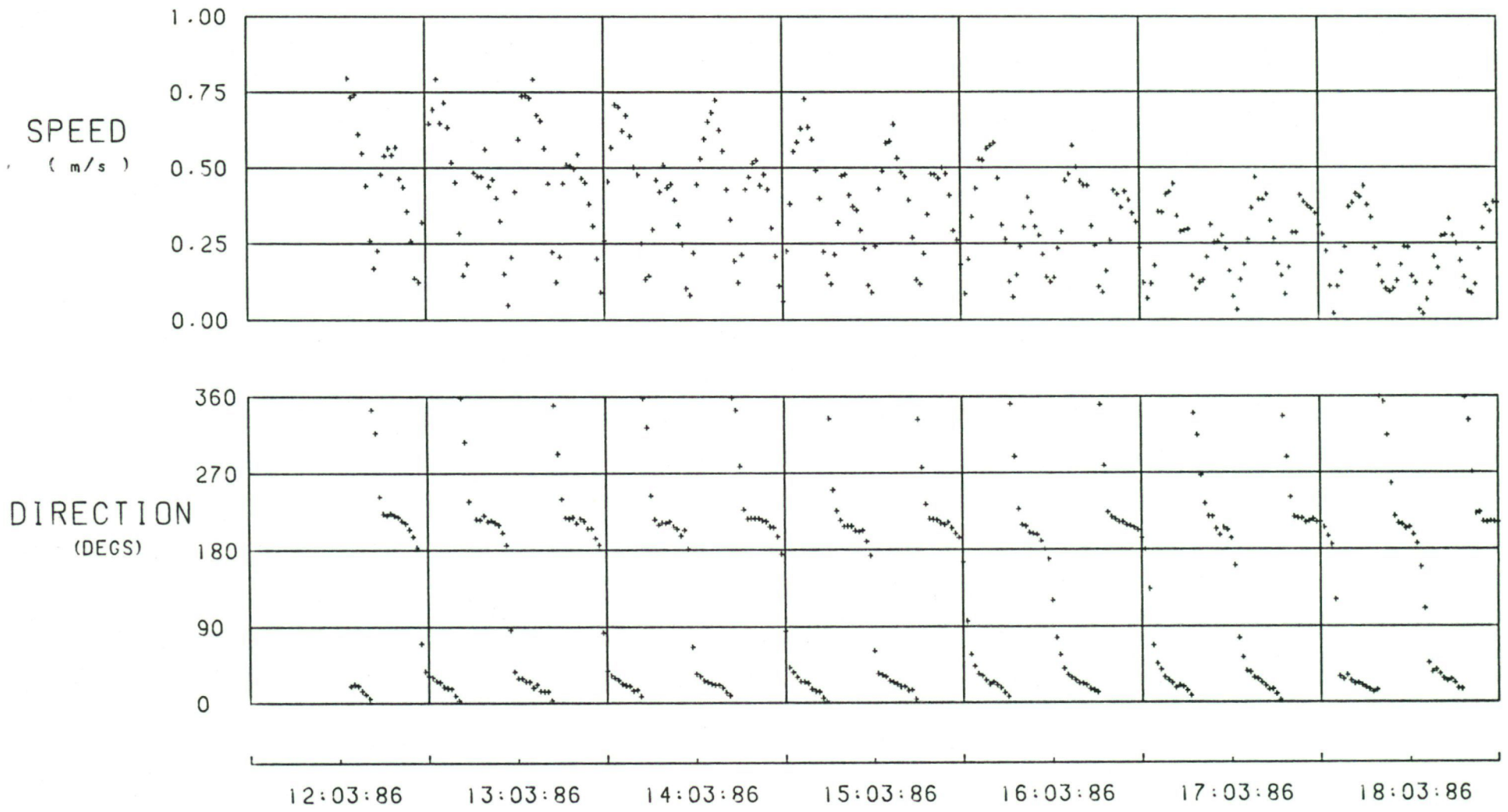
PORT OF BRISBANE AUTHORITY

NORTH EAST CHANNEL NE6
FILTERED 1 SEC CURRENTS
SPD - DIRN TIME HISTORY

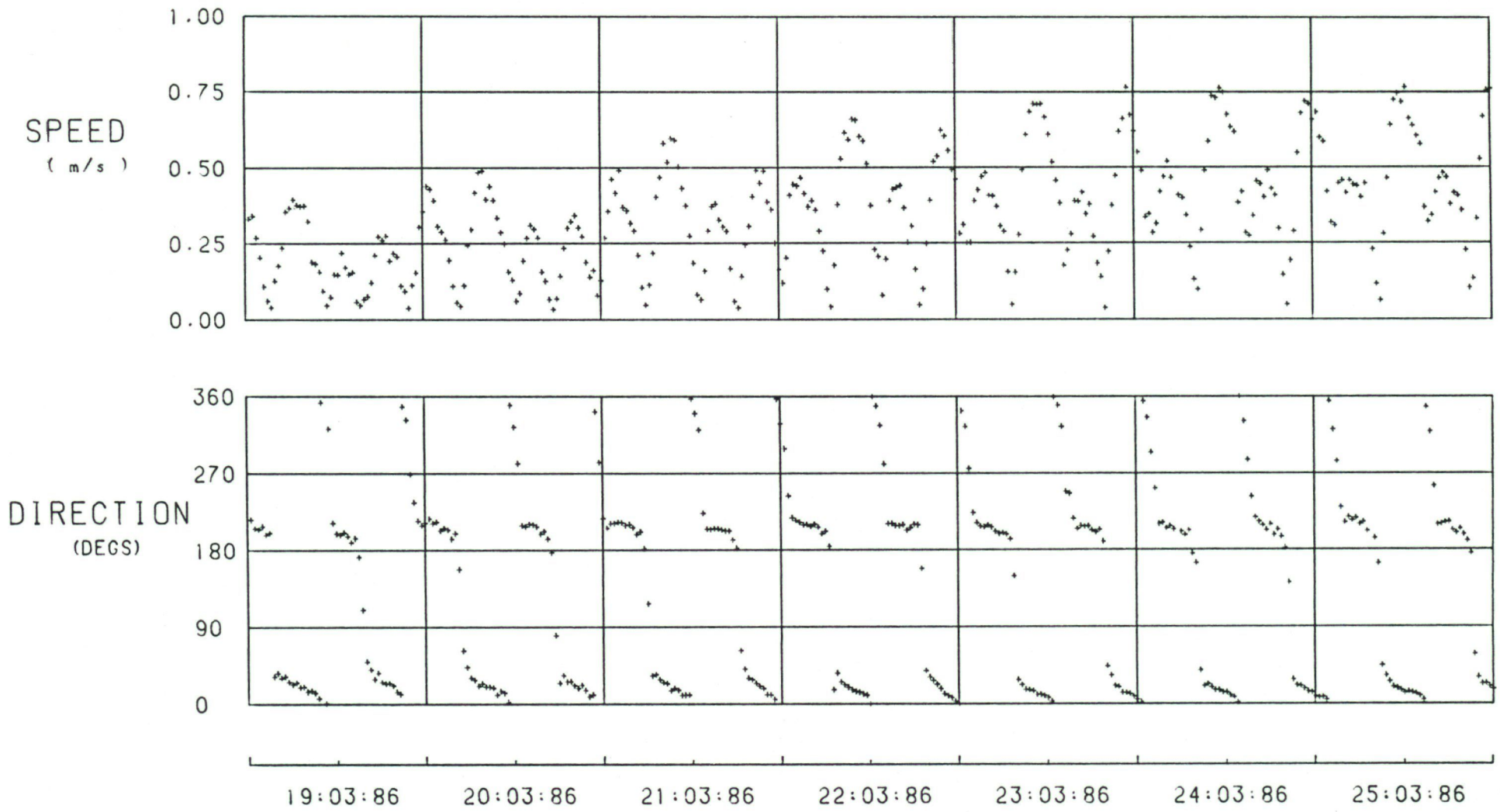
LAWSON AND TRELOAR PTY LTD.

DATE 12:05:86

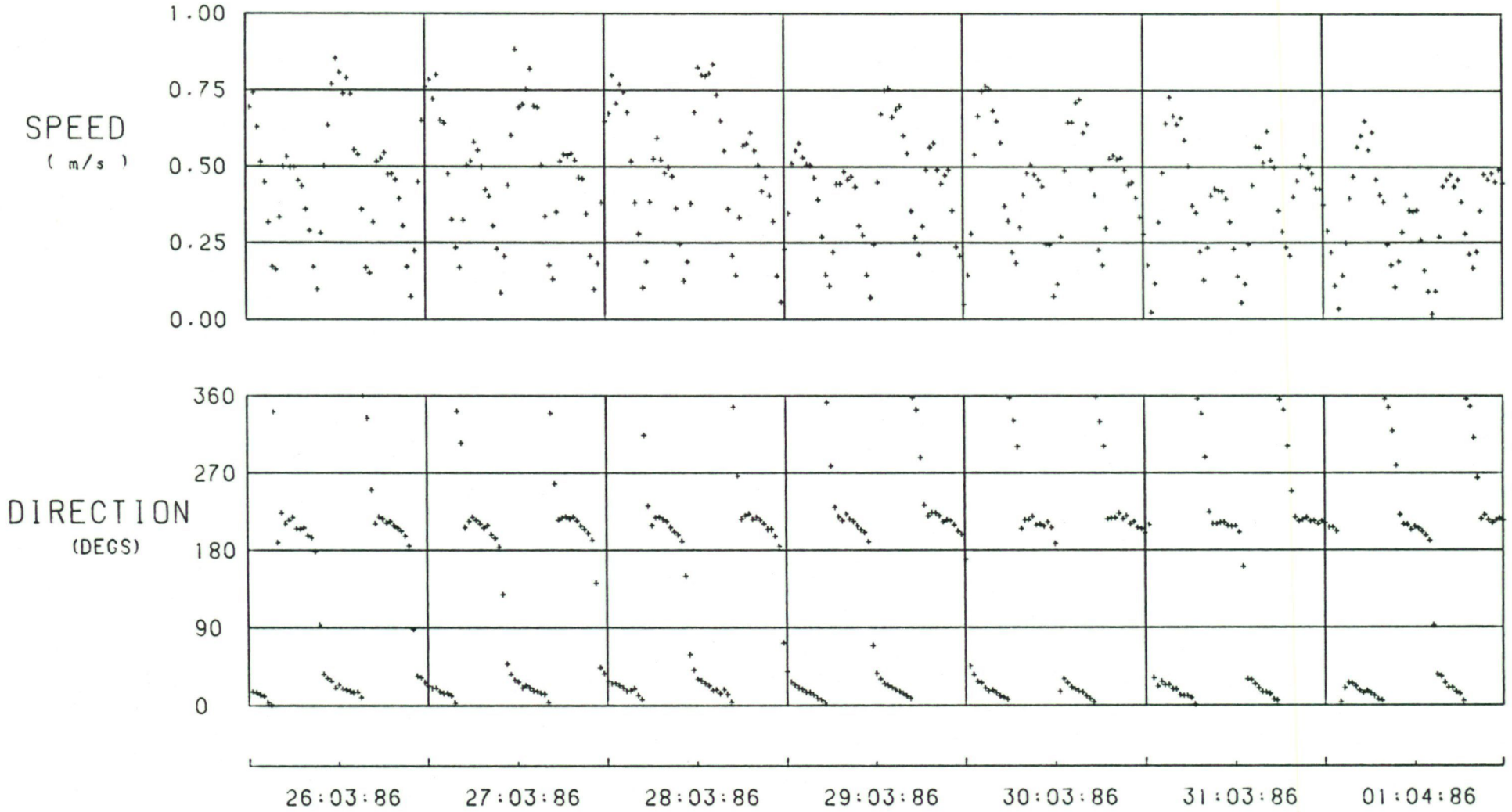
FIG. 44



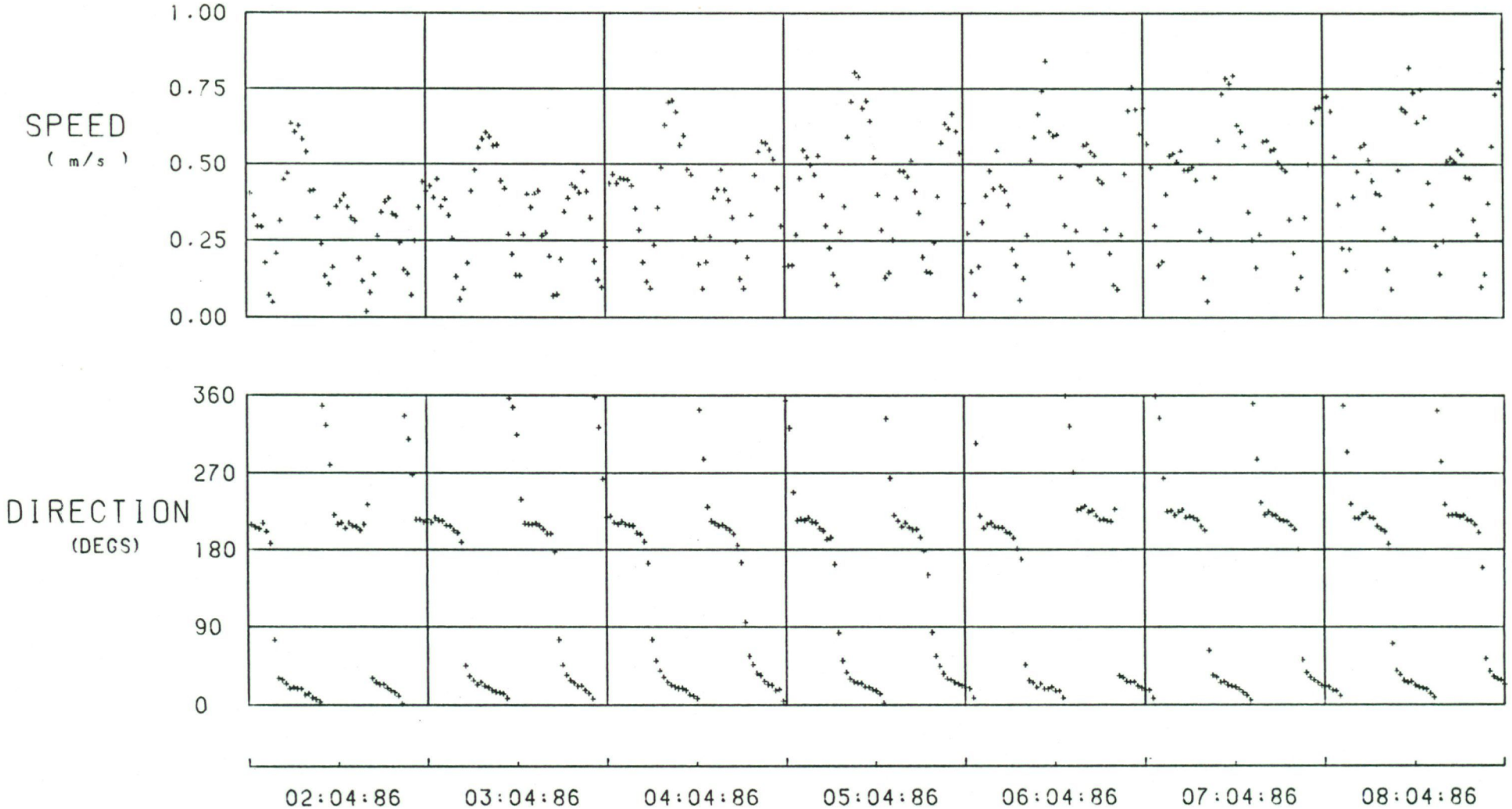
LATITUDE : 27 degs 02' 29" S	PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY
LONGITUDE : 153 degs 20' 22" E	NORTH EAST CHANNEL NE4 CURRENT SPEED-DIRECTION TIME HISTORY PLOT
DATA START TIME : 1330 12:03:86	LAWSON AND TRELOAR PTY LTD.
DATA END TIME : 0730 23:04:86	DATE 08:05:86 / FIG. 45



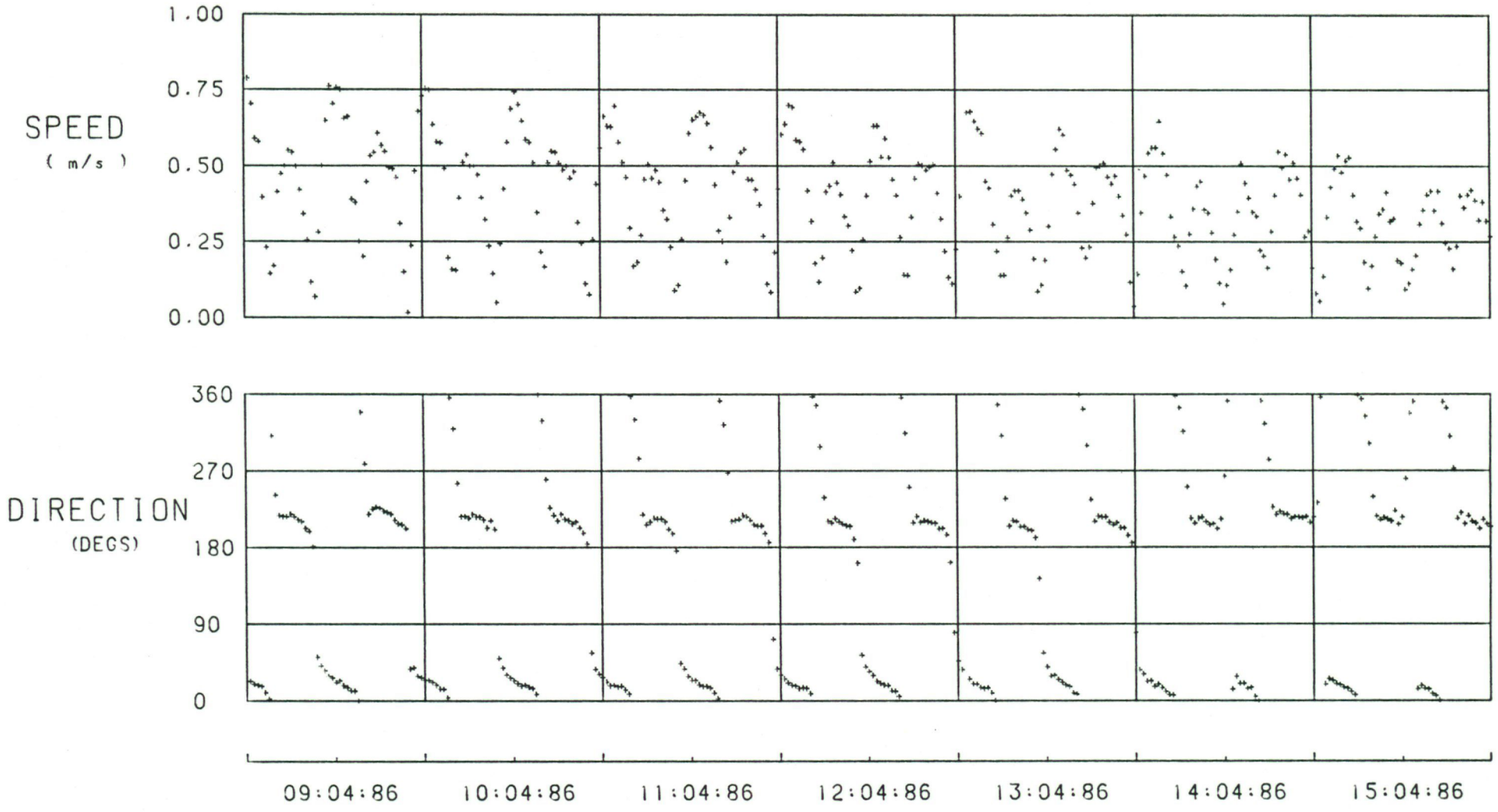
LATITUDE : 27 degs 02' 29" S	PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY
LONGITUDE : 153 degs 20' 22" E	NORTH EAST CHANNEL NE4 CURRENT SPEED-DIRECTION TIME HISTORY PLOT
DATA START TIME : 1330 12:03:86	LAWSON AND TRELOAR PTY LTD.
DATA END TIME : 0730 23:04:86	DATE 08:05:86 / FIG. 46



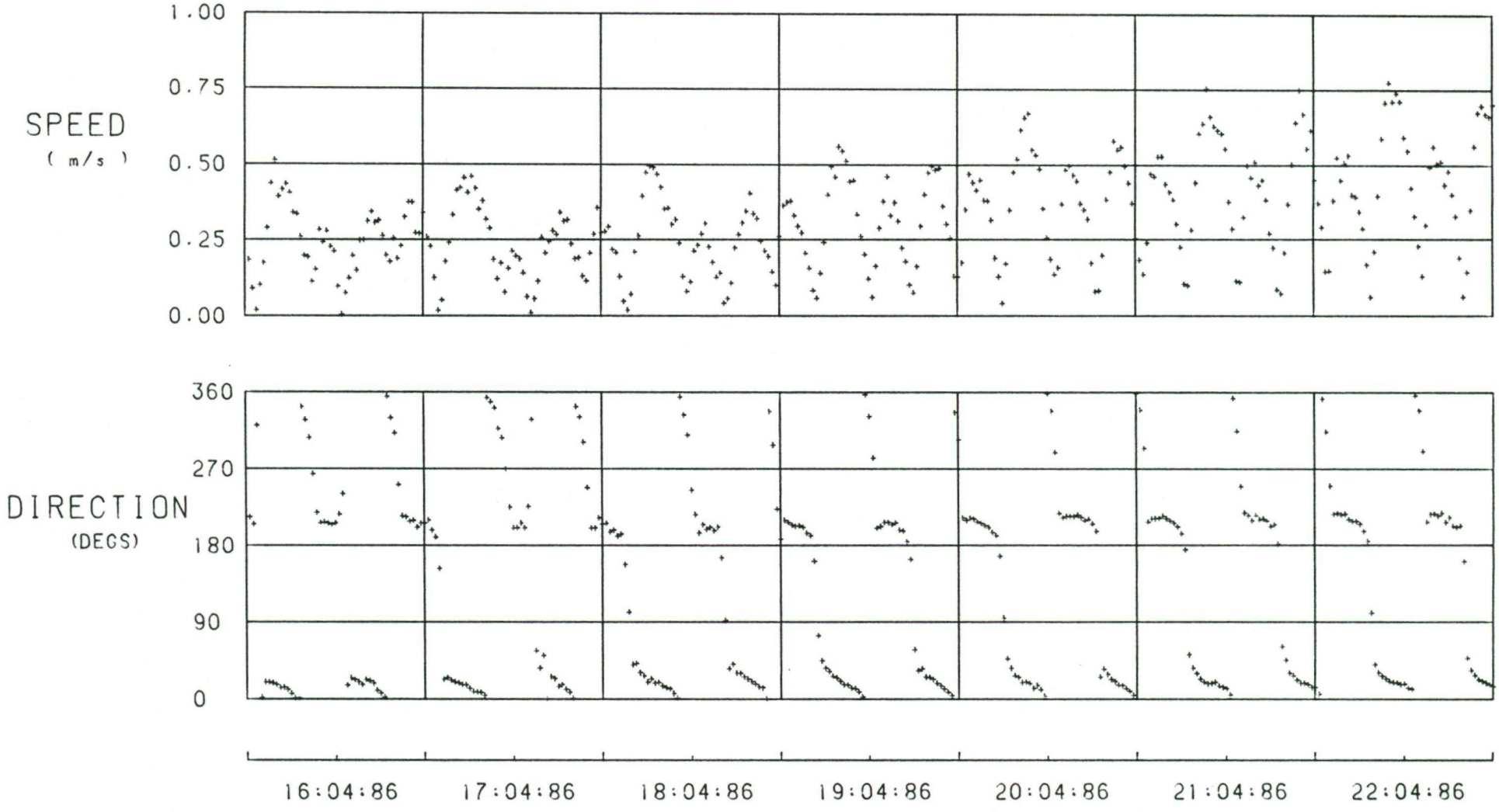
LATITUDE : 27 degs 02' 29" S	PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY
LONGITUDE : 153 degs 20' 22" E	NORTH EAST CHANNEL NE4 CURRENT SPEED-DIRECTION TIME HISTORY PLOT
DATA START TIME : 1330 12:03:86	LAWSON AND TRELOAR PTY LTD.
DATA END TIME : 0730 23:04:86	DATE 08:05:86 / FIG. 47



LATITUDE : 27 degs 02' 29" S	PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY
LONGITUDE : 153 degs 20' 22" E	NORTH EAST CHANNEL NE4 CURRENT SPEED-DIRECTION TIME HISTORY PLOT
DATA START TIME : 1330 12:03:86	LAWSON AND TRELOAR PTY LTD.
DATA END TIME : 0730 23:04:86	DATE 08:05:86 / FIG. 48



LATITUDE : 27 degs 02' 29" S	PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY
LONGITUDE : 153 degs 20' 22" E	NORTH EAST CHANNEL NE4 CURRENT SPEED-DIRECTION TIME HISTORY PLOT
DATA START TIME : 1330 12:03:86	LAWSON AND TRELOAR PTY LTD.
DATA END TIME : 0730 23:04:86	DATE 08:05:86 — FIG. 49



LATITUDE	: 27 degs 02' 29" S
LONGITUDE	: 153 degs 20' 22" E
DATA START TIME	: 1330 12:03:86
DATA END TIME	: 0730 23:04:86

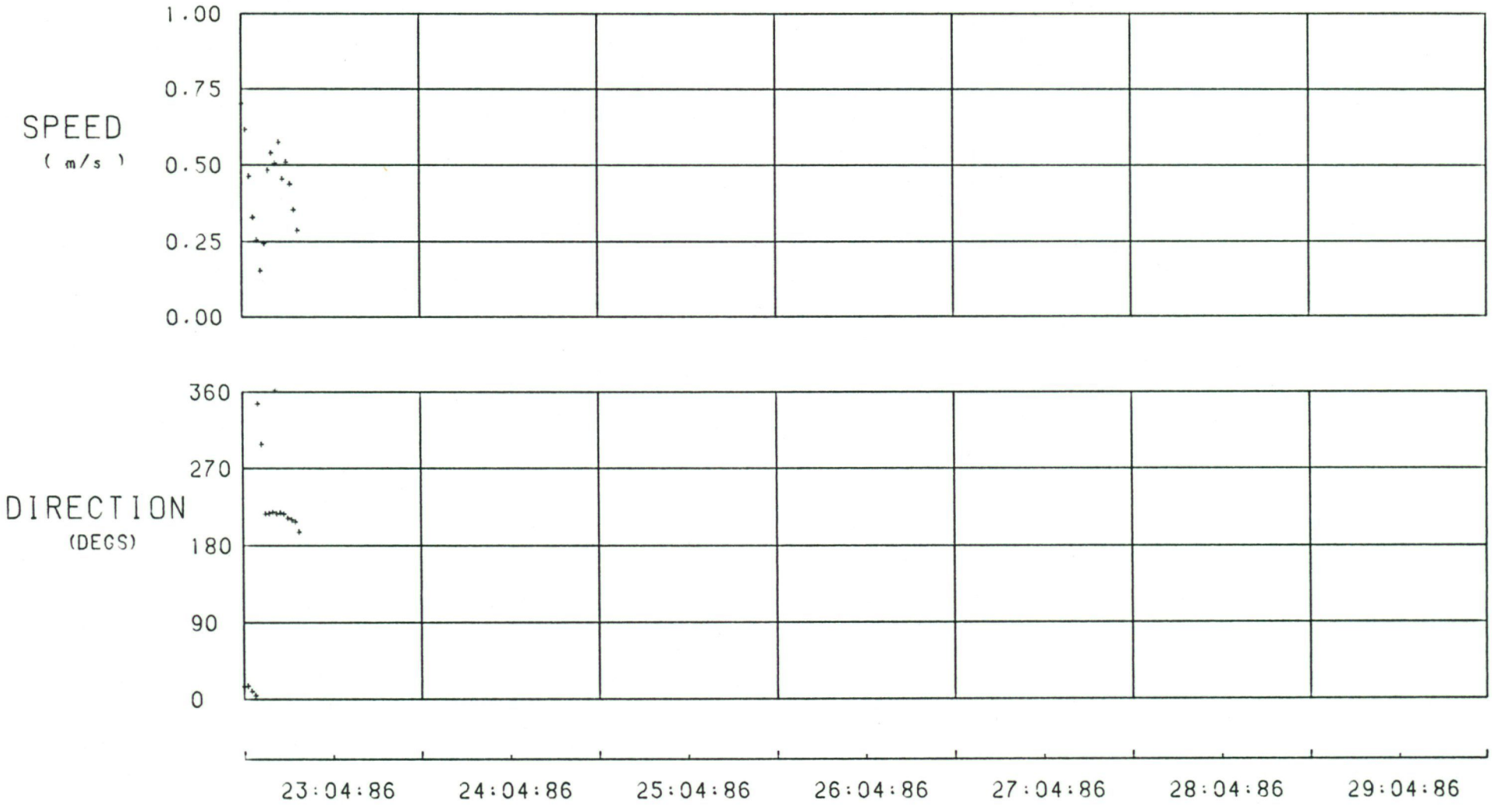
PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY

NORTH EAST CHANNEL NE4
CURRENT SPEED-DIRECTION
TIME HISTORY PLOT

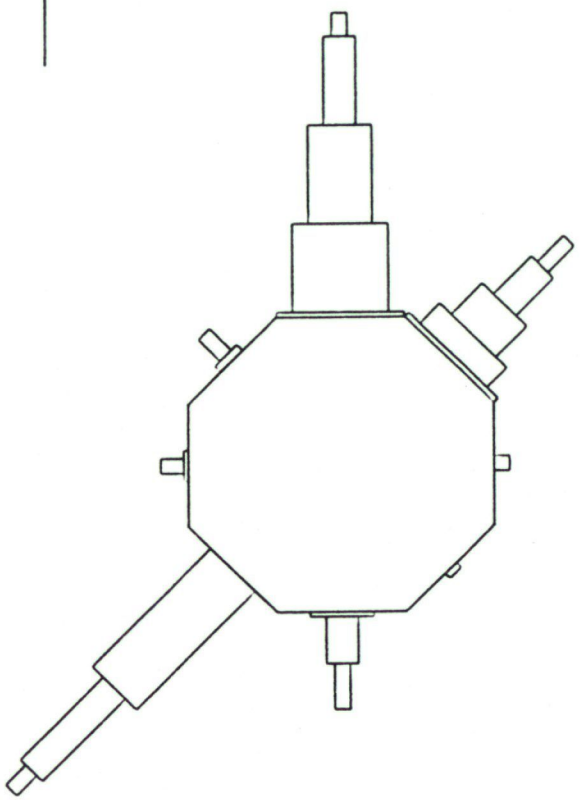
LAWSON AND TRELOAR PTY LTD.

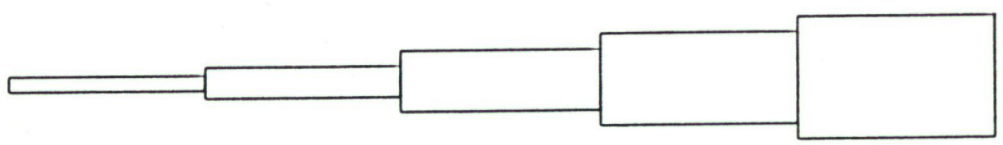
DATE 08:05:86

FIG. 50



LATITUDE : 27 degs 02' 29" S	PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY
LONGITUDE : 153 degs 20' 22" E	NORTH EAST CHANNEL NE4 CURRENT SPEED-DIRECTION TIME HISTORY PLOT
DATA START TIME : 0000 23:04:86	LAWSON AND TRELOAR PTY LTD.
DATA END TIME : 0730 23:04:86	DATE 08:05:86 / FIG. 51





0.0-0.2 0.2-0.4 0.4-0.6 0.6-0.8 0.8 >

m/s



%

LATITUDE : 27 degs 02' 29" S

LONGITUDE : 153 degs 20' 22" E

DATA START TIME : 1330 12:03:86

DATA END TIME : 0730 23:04:86

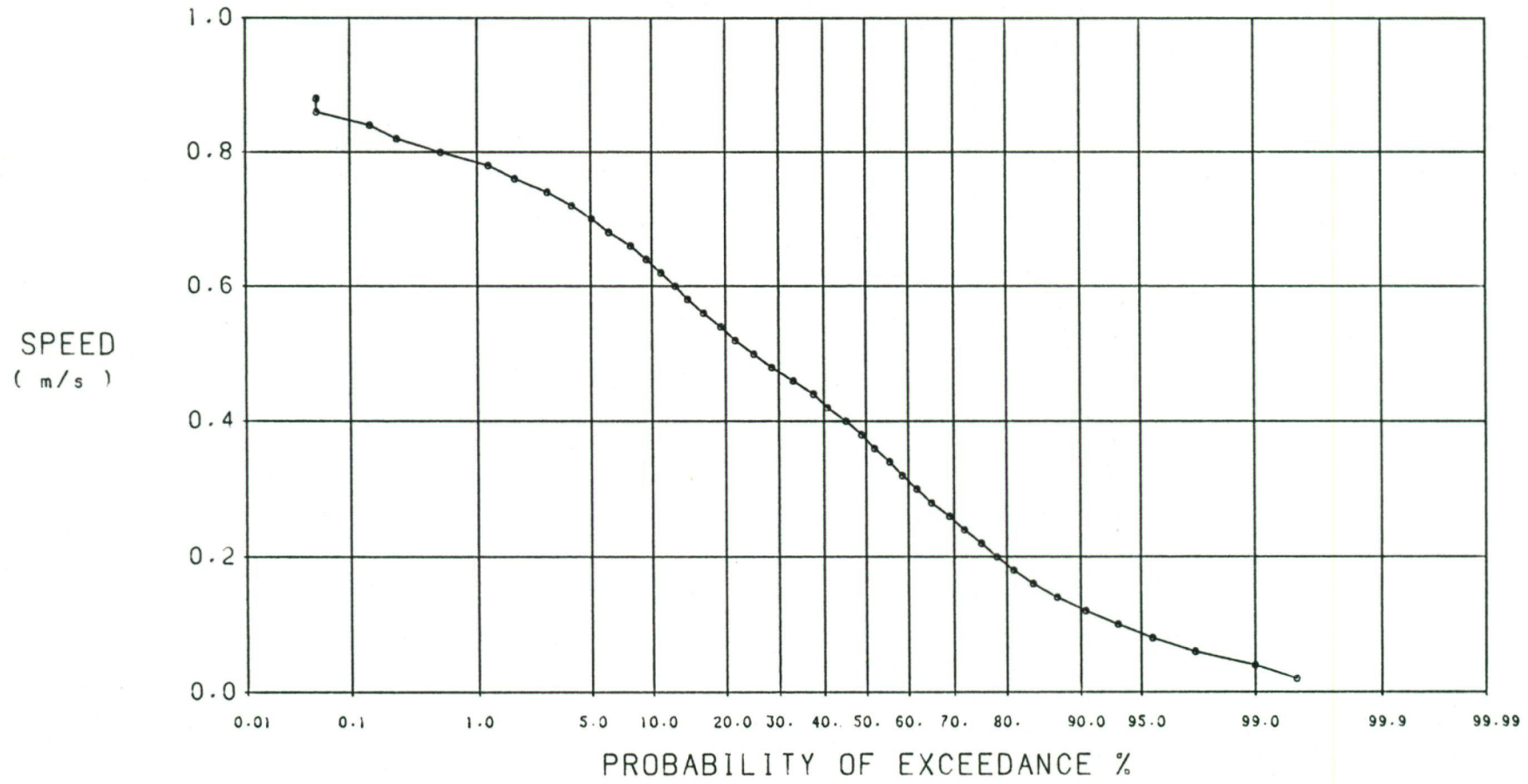
PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY

NORTH EAST CHANNEL NE4 CURRENT SPEED-DIRECTION FREQUENCY ROSE

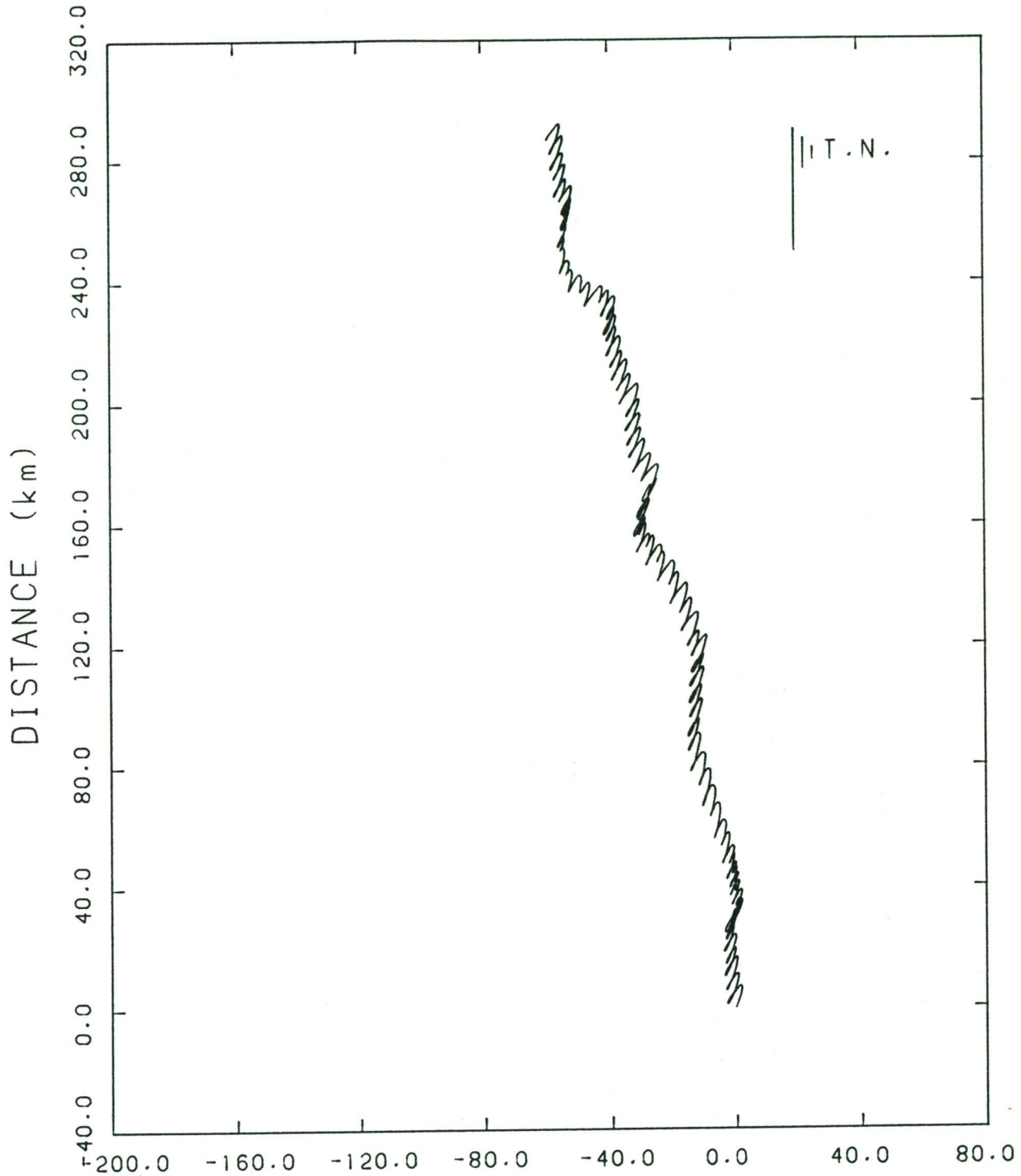
LAWSON AND TRELOAR PTY LTD.

DATE 08:05:86

FIG. 52



LOCATION : NORTH EAST CHANNEL NE4	START TIME : 1330 12:03:86	PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY	
TOTAL RECORDS: 2001	END TIME : 0730 23:04:86	NORTH EAST CHANNEL NE4 CURRENT SPEED EXCEEDANCE PLOT	LAWSON AND TRELOAR PTY LTD.
INSTRUMENT : SEA DATA 620A S/N 58			DATE 08:05:86 / FIG. 53



FROM ORIGIN

LATITUDE	:	27 degs 02' 29" S
LONGITUDE	:	153 degs 20' 22" E
DATA START TIME	:	1330 12:03:86
DATA END TIME	:	0730 23:04:86

PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY

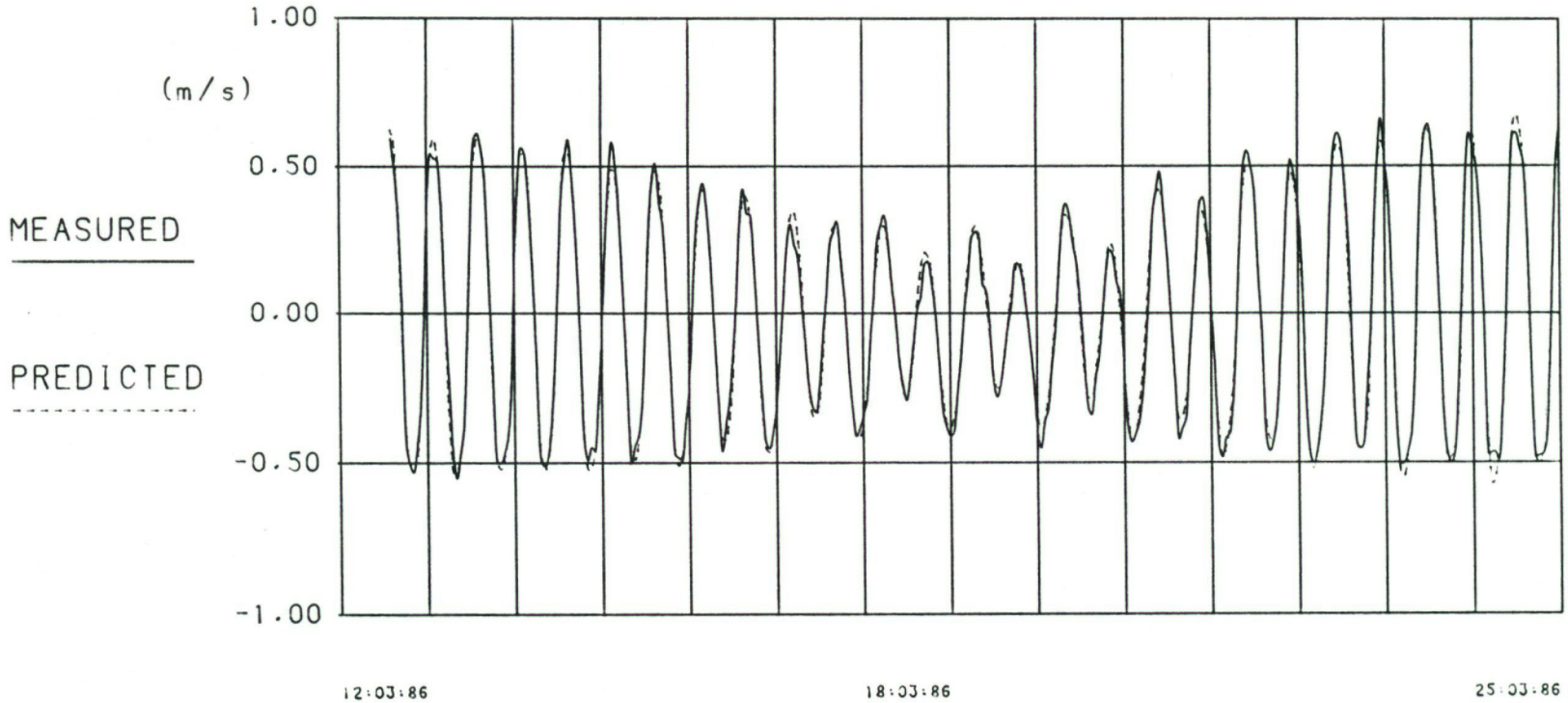
NORTH EAST CHANNEL NE4
PROGRESSIVE VECTOR
PLOT

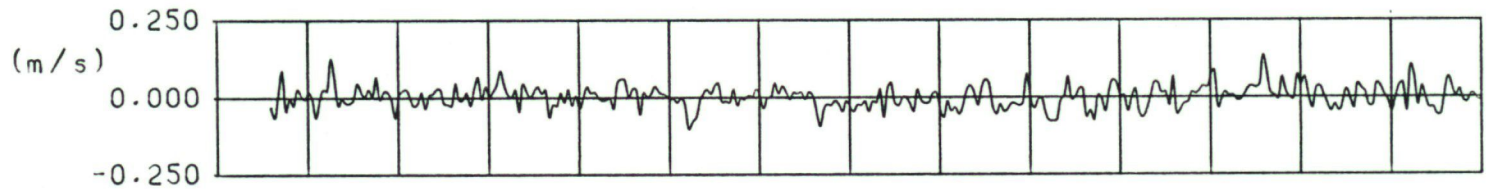
LAWSON AND TRELOAR PTY LTD.

DATE 08:05:86

FIG. 54

SPEED





RESIDUALS

NOTE : MEAN CURRENT REMOVED.

PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY

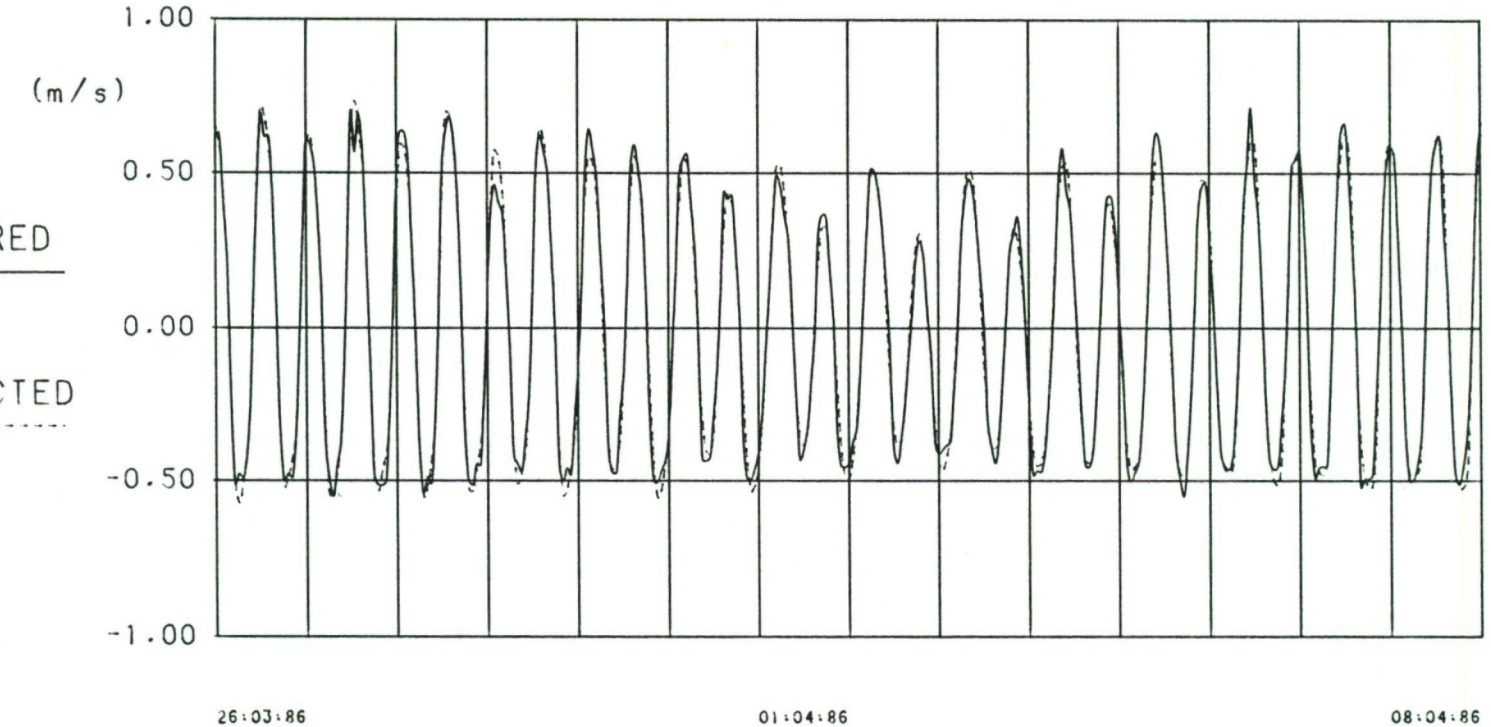
NORTH EAST CHANNEL NE4
NORTH-SOUTH TIDAL CURRENTS
MEASURED - PREDICTED

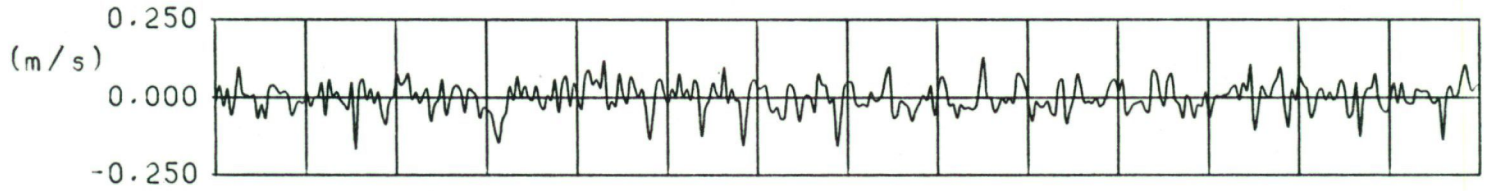
LAWSON AND TRELOAR PTY LTD.

DATE 08:05:86

FIG. 55

SPEED





RESIDUALS

NOTE : MEAN CURRENT REMOVED.

PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY

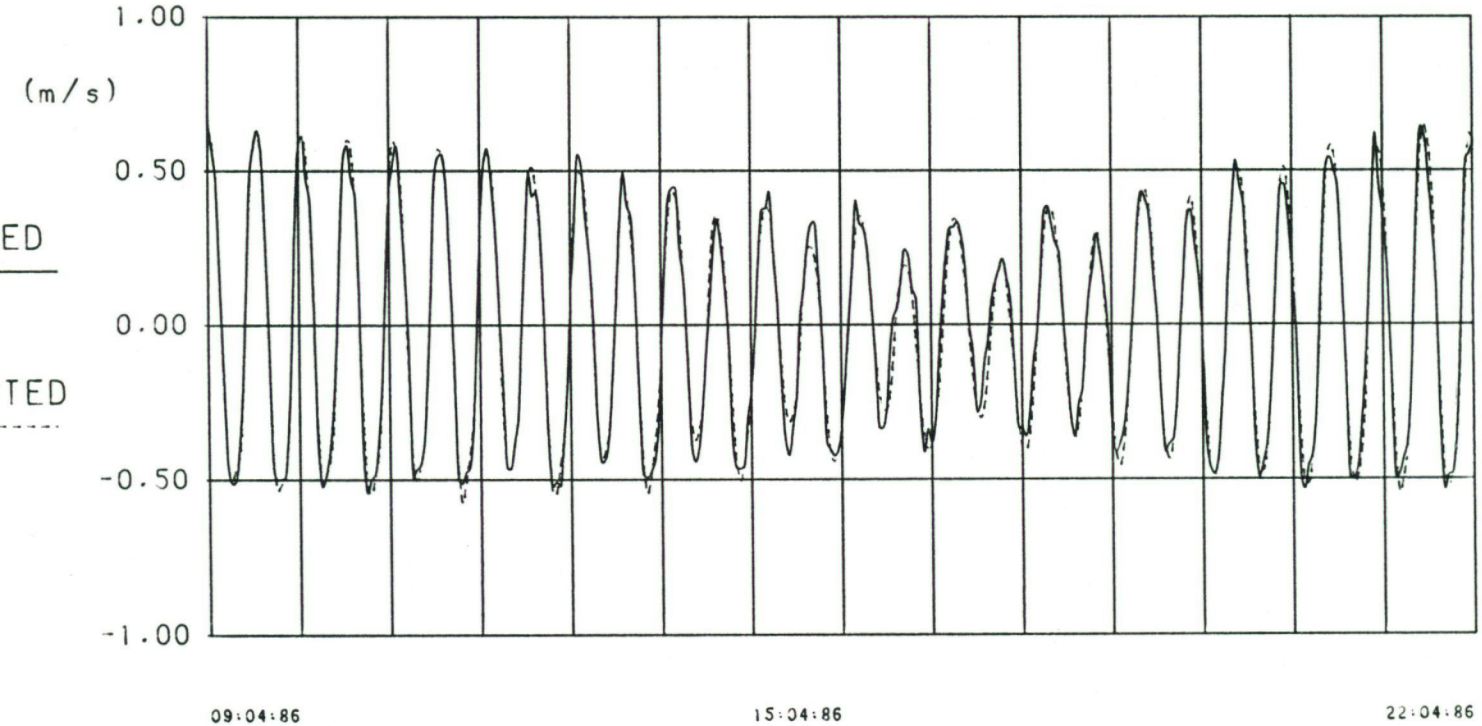
NORTH EAST CHANNEL NE4
NORTH-SOUTH TIDAL CURRENTS
MEASURED - PREDICTED

LAWSON AND TRELOAR PTY LTD.

DATE 08:05:86

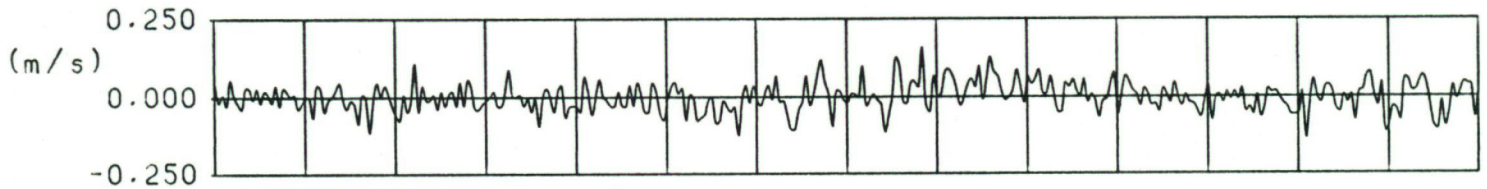
FIG. 56

SPEED



MEASURED

PREDICTED



RESIDUALS

NOTE : MEAN CURRENT REMOVED.

PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY

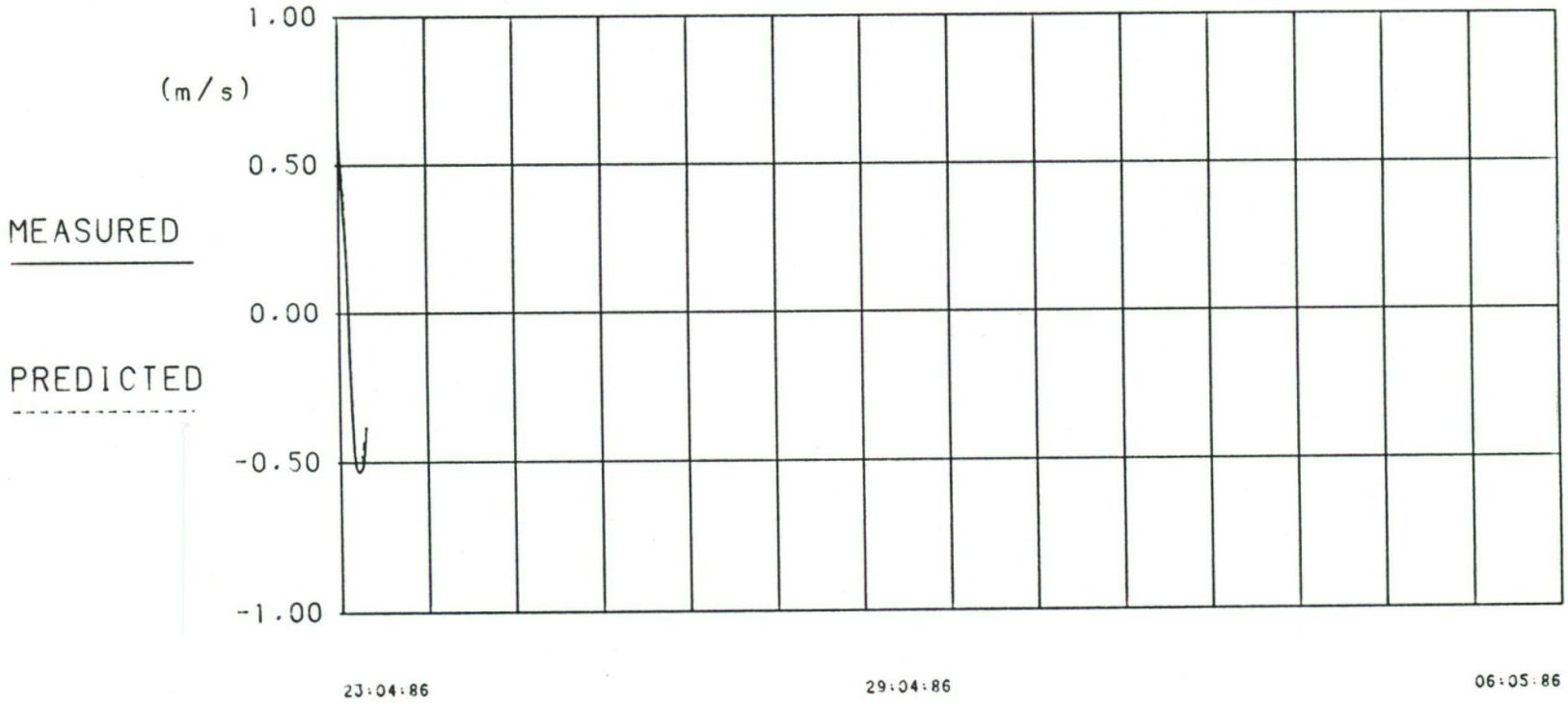
NORTH EAST CHANNEL NE4
NORTH-SOUTH TIDAL CURRENTS
MEASURED - PREDICTED

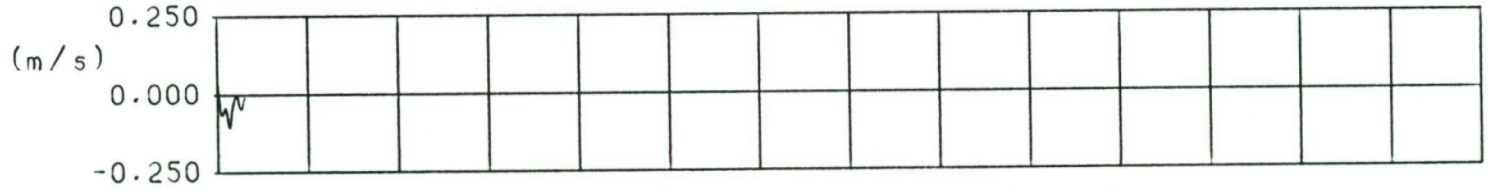
LAWSON AND TRELOAR PTY LTD.

DATE 08:05:86

FIG. 57

SPEED





RESIDUALS

NOTE : MEAN CURRENT REMOVED.

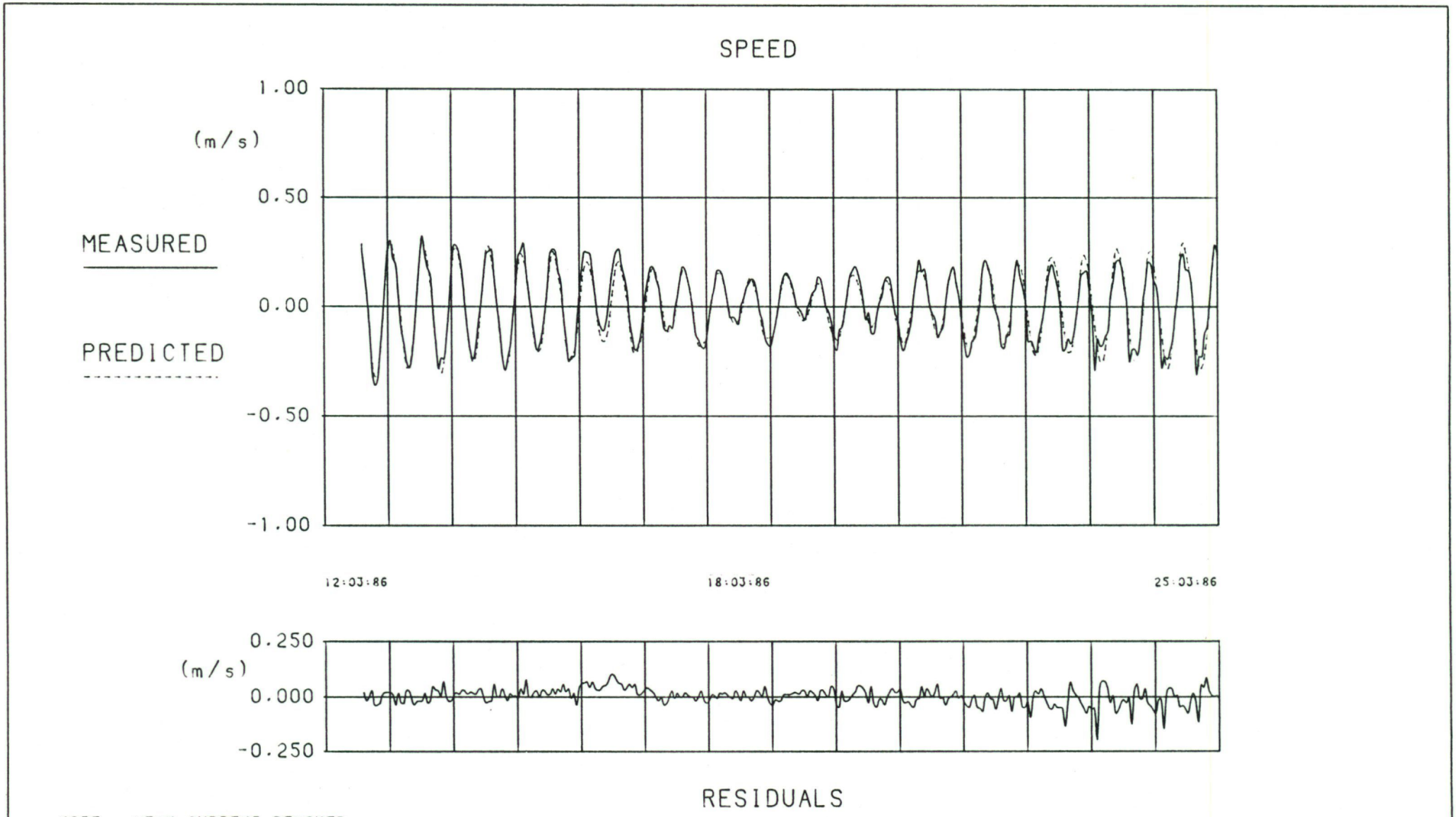
PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY

NORTH EAST CHANNEL NE4
NORTH-SOUTH TIDAL CURRENTS
MEASURED - PREDICTED

LAWSON AND TRELOAR PTY LTD.

DATE 08:05:86

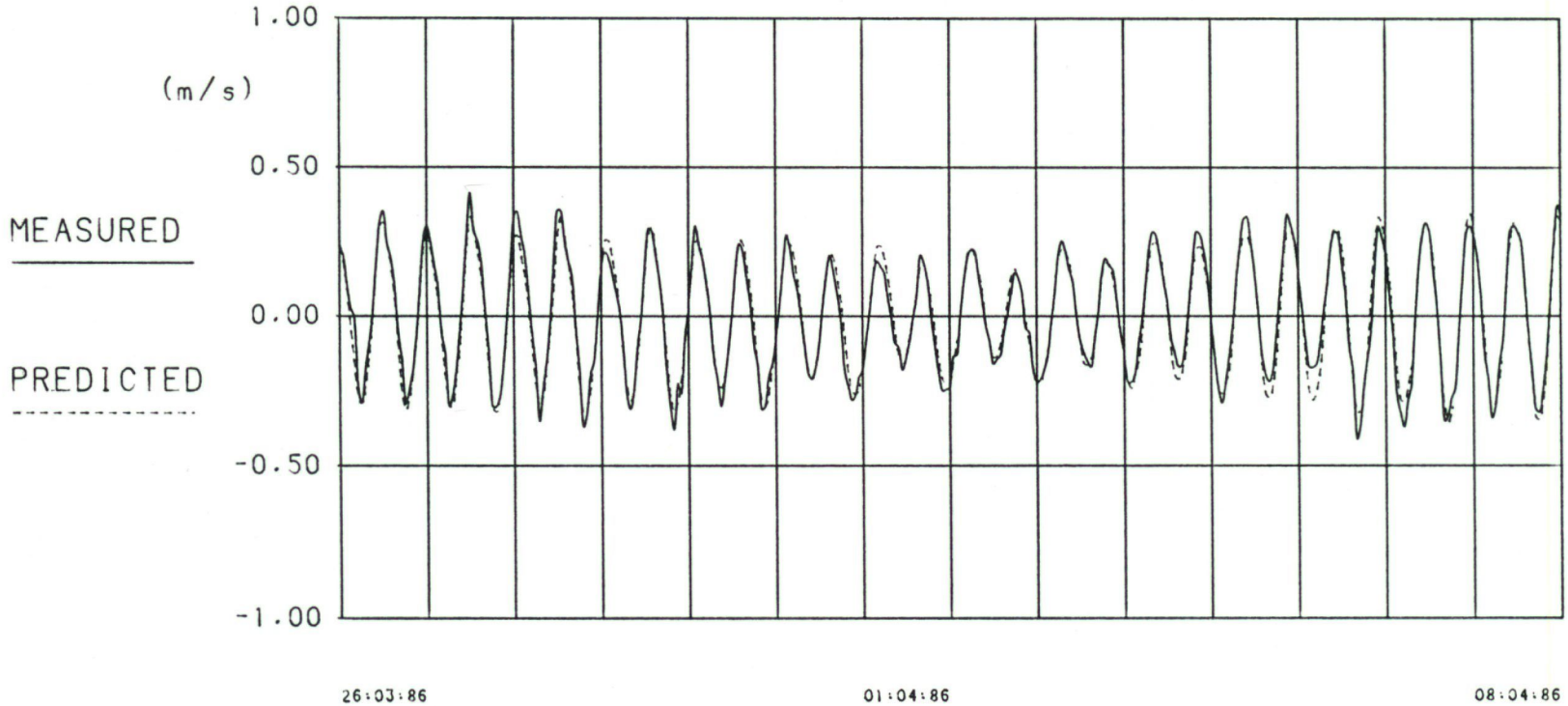
FIG. 58

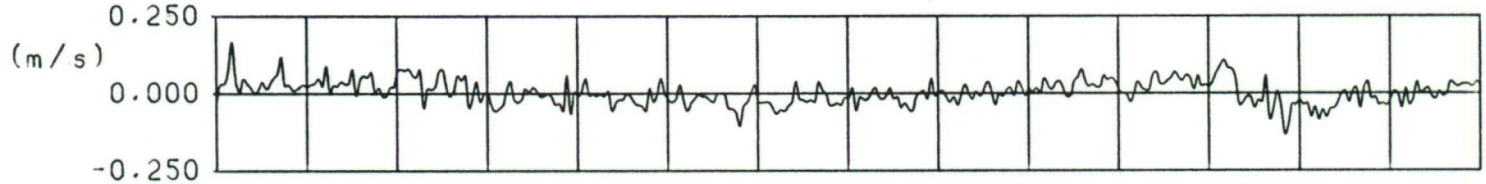


NOTE : MEAN CURRENT REMOVED.

	PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY	
NORTH EAST CHANNEL NE4 EAST-WEST TIDAL CURRENTS MEASURED - PREDICTED	LAWSON AND TRELOAR PTY LTD.	
	DATE 08:05:86	FIG. 59

SPEED





RESIDUALS

NOTE : MEAN CURRENT REMOVED.

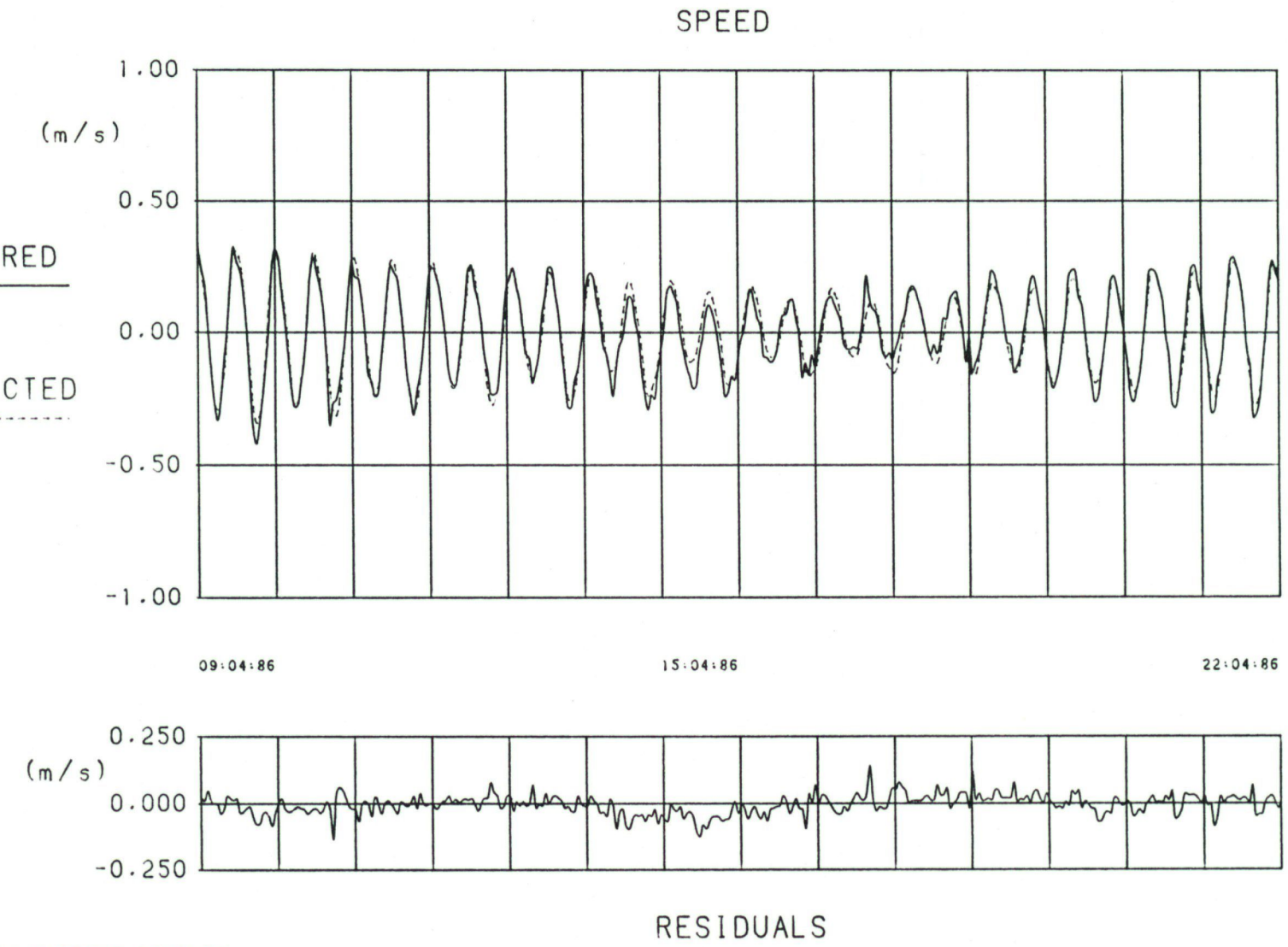
PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY

NORTH EAST CHANNEL NE4
EAST-WEST TIDAL CURRENTS
MEASURED - PREDICTED

LAWSON AND TRELOAR. PTY LTD.

DATE 08:05:86

FIG. 60



NOTE : MEAN CURRENT REMOVED.

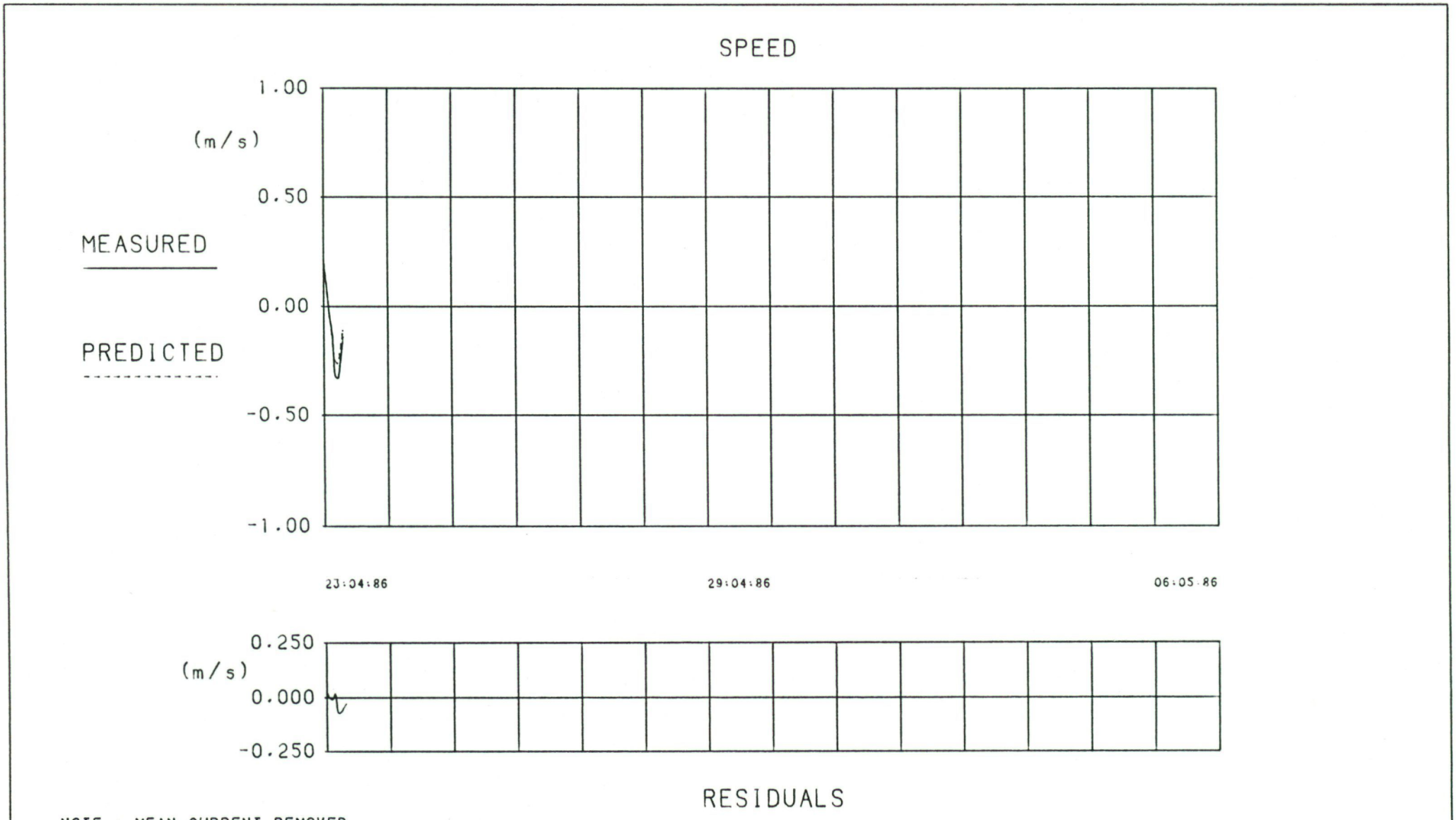
PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY

NORTH EAST CHANNEL NE4
EAST-WEST TIDAL CURRENTS
MEASURED - PREDICTED

LAWSON AND TRELOAR PTY LTD.

DATE 08:05:86

FIG. 61



NOTE : MEAN CURRENT REMOVED.

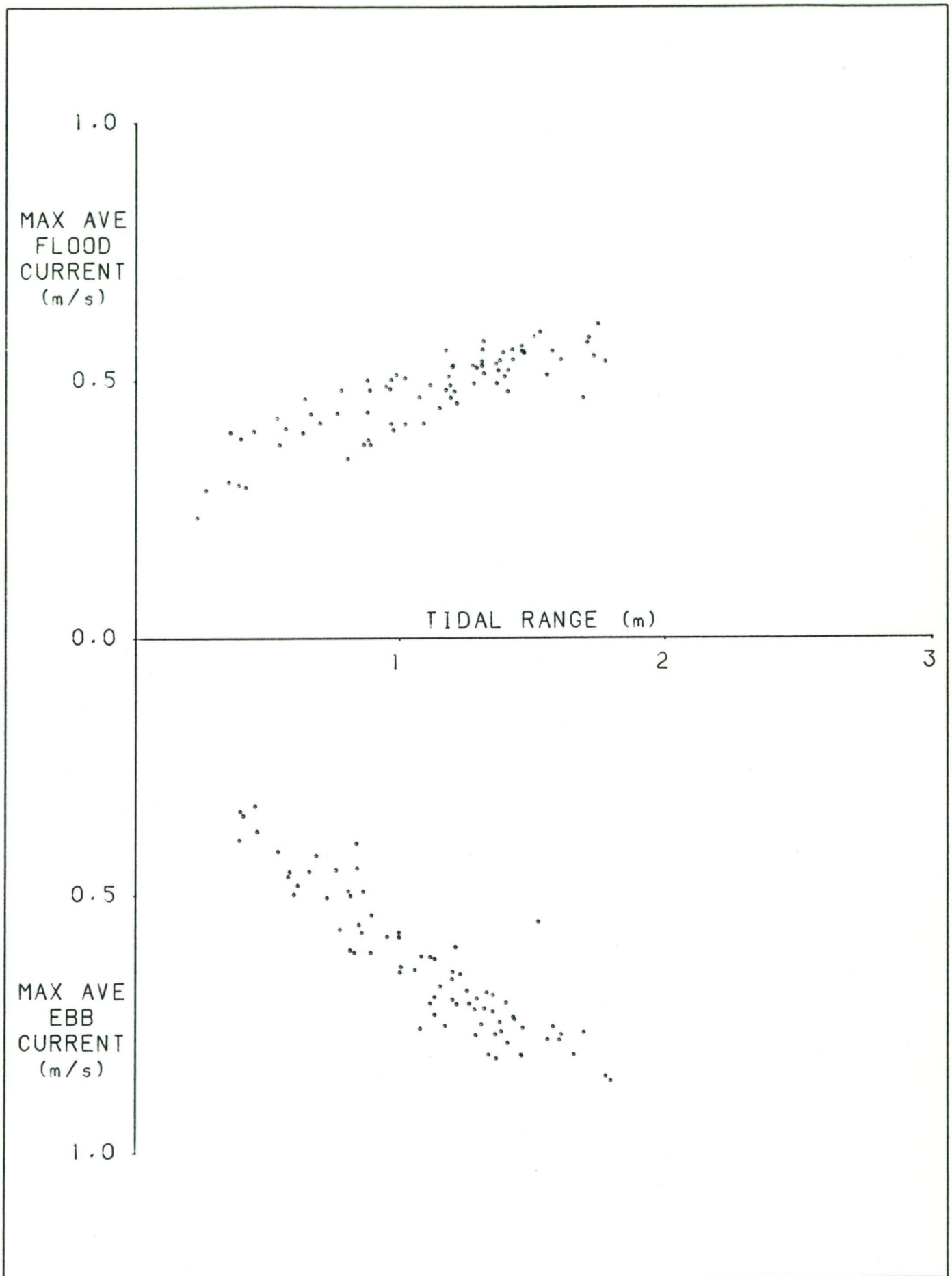
PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY

NORTH EAST CHANNEL NE4
EAST-WEST TIDAL CURRENTS
MEASURED - PREDICTED

LAWSON AND TRELOAR PTY LTD.

DATE 08:05:86

FIG. 62



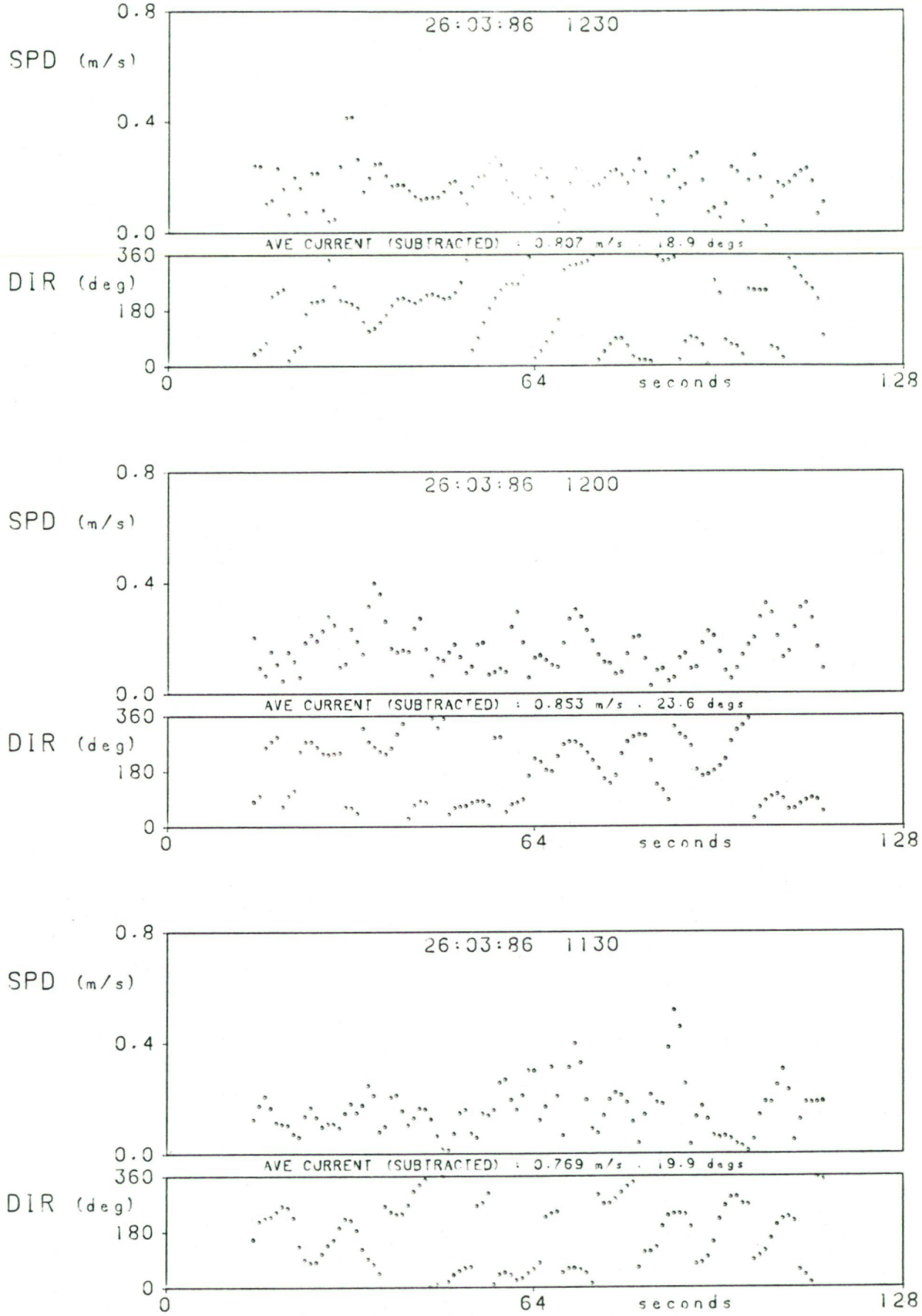
PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY

NORTH EAST CHANNEL NE4
MAX AVE CURRENT SPEED
TIDAL RANGE

LAWSON AND TRELOAR PTY LTD.

DATE 08:05:86

FIG. 63



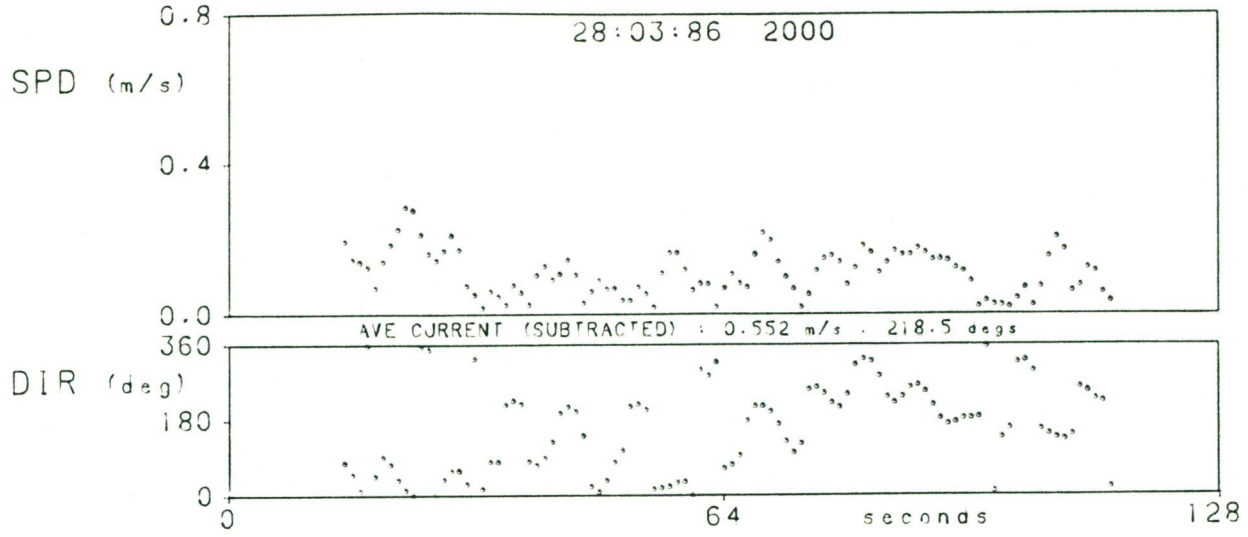
PORT OF BRISBANE AUTHORITY

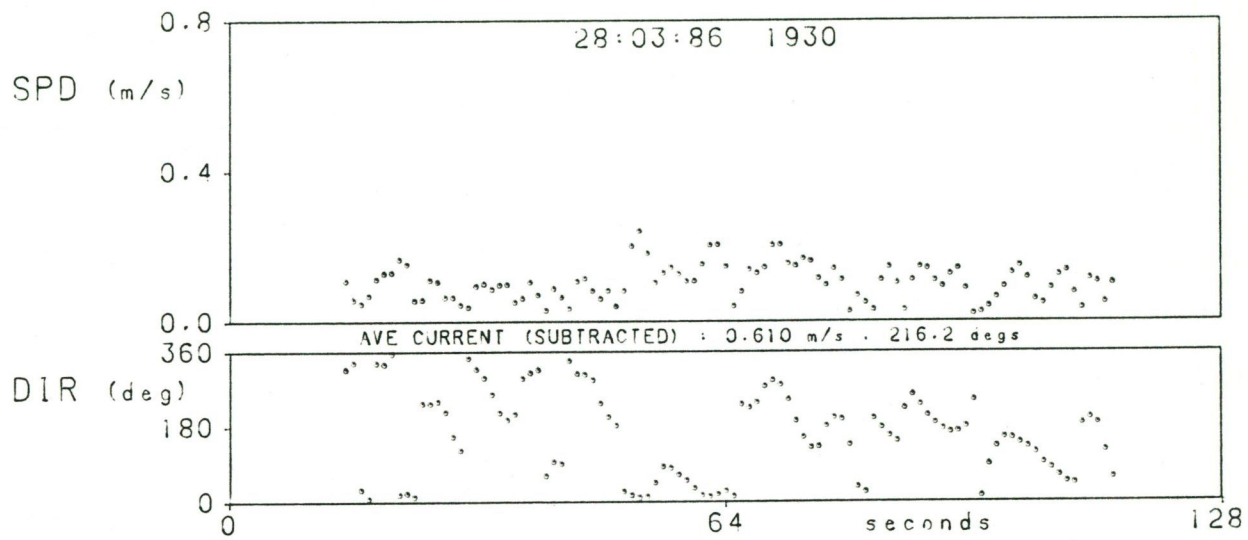
NORTH EAST CHANNEL NE4
FILTERED 1 SEC CURRENTS
SPD - DIRN TIME HISTORY

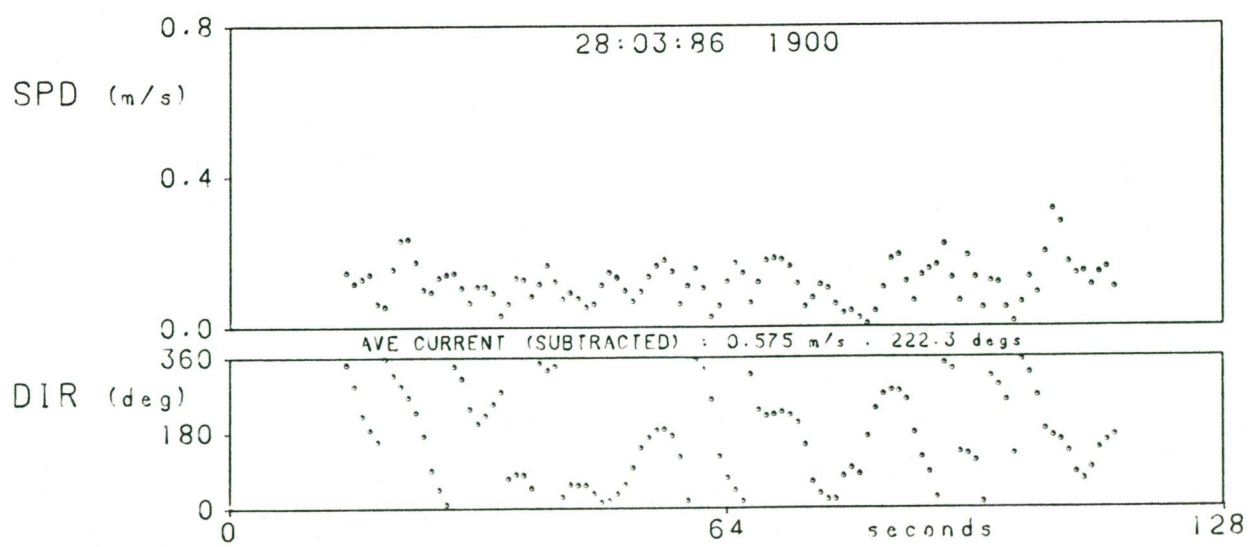
LAWSON AND TRELOAR PTY LTD.

DATE 12:05:86

FIG. 64







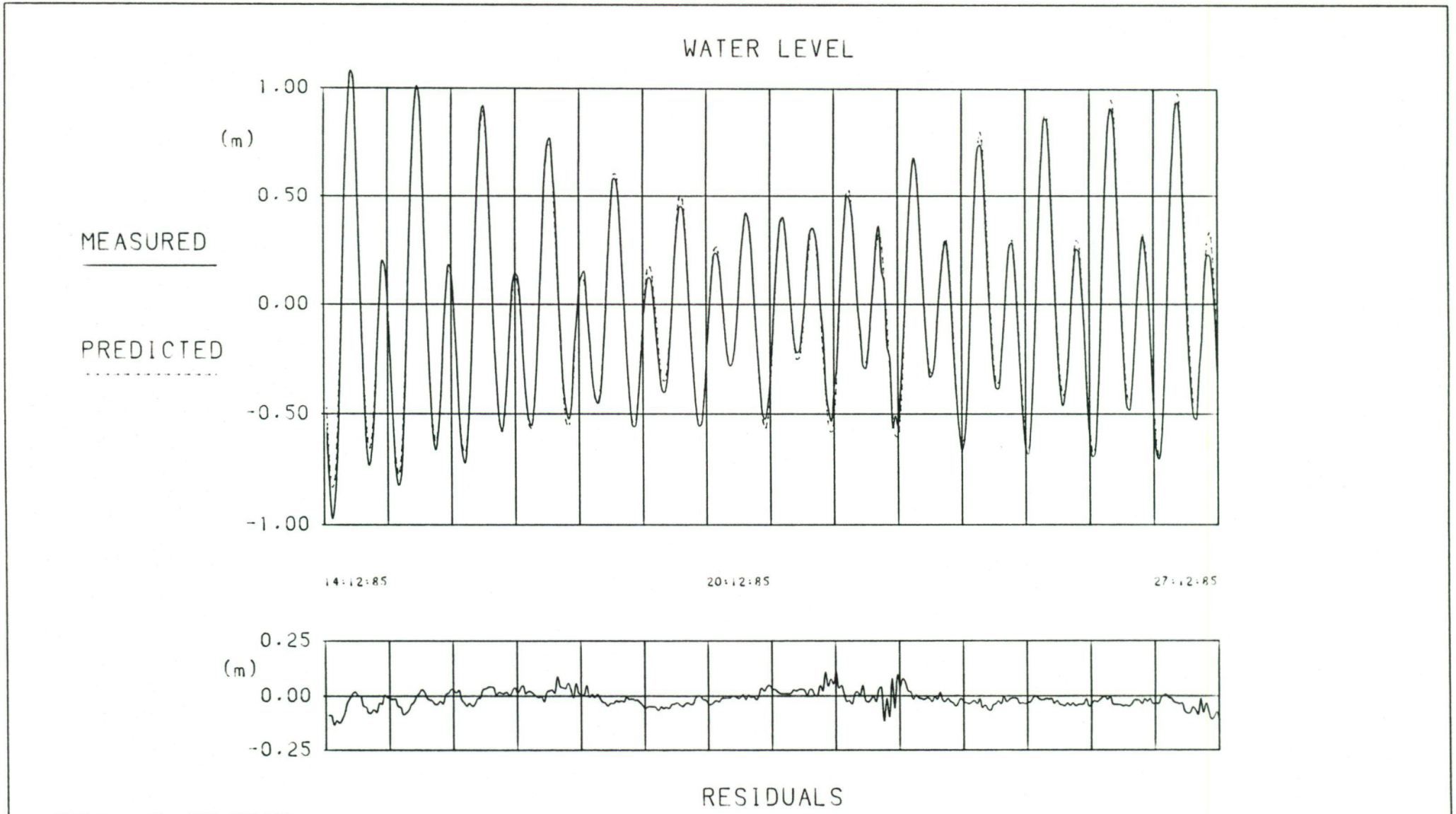
PORT OF BRISBANE AUTHORITY

NORTH EAST CHANNEL NE4
FILTERED 1 SEC CURRENTS
SPD - DIRN TIME HISTORY

LAWSON AND TRELOAR PTY LTD.

DATE 12:05:86

FIG. 65



DATUM : MSL FOR PERIOD.

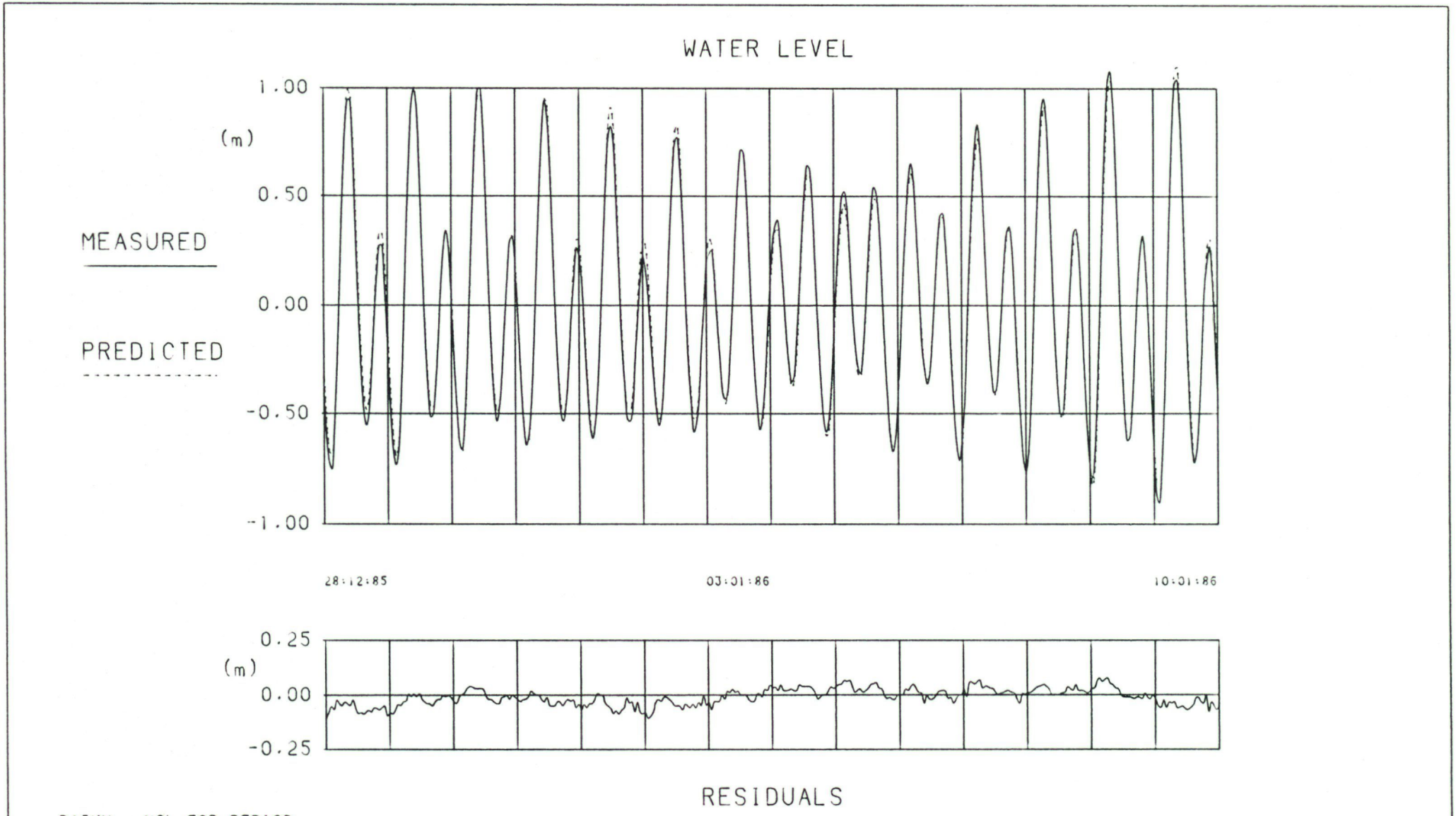
PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY

NORTH EAST CHANNEL
TIDES AT NE8
MEASURED - PREDICTED

LAWSON AND TRELOAR PTY LTD.

DATE 08:05:86

FIG. 66



DATUM : MSL FOR PERIOD.

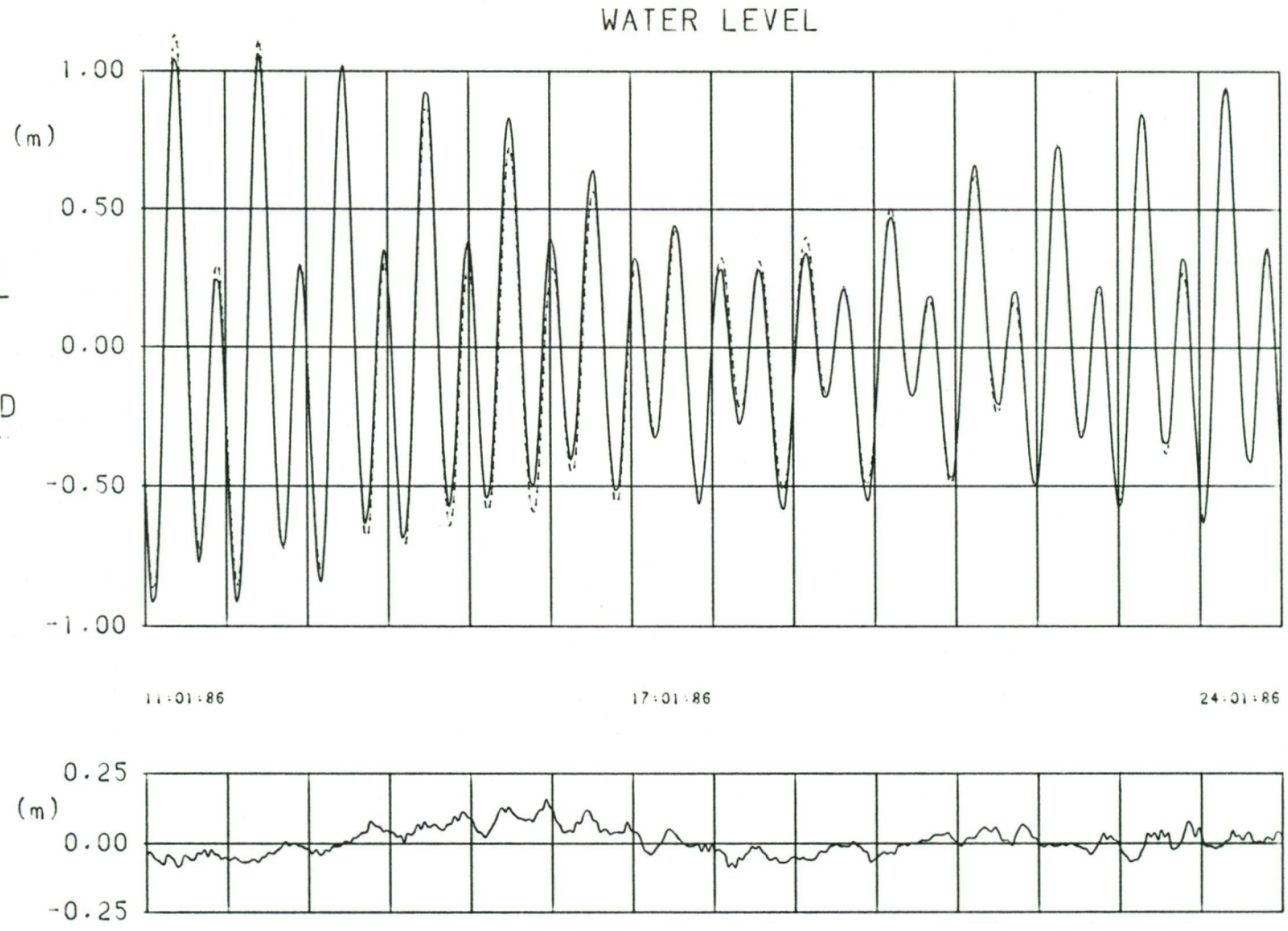
PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY

NORTH EAST CHANNEL
TIDES AT NE8
MEASURED - PREDICTED

LAWSON AND TRELOAR PTY LTD.

DATE 08:05:86

FIG. 67



DATUM : MSL FOR PERIOD.

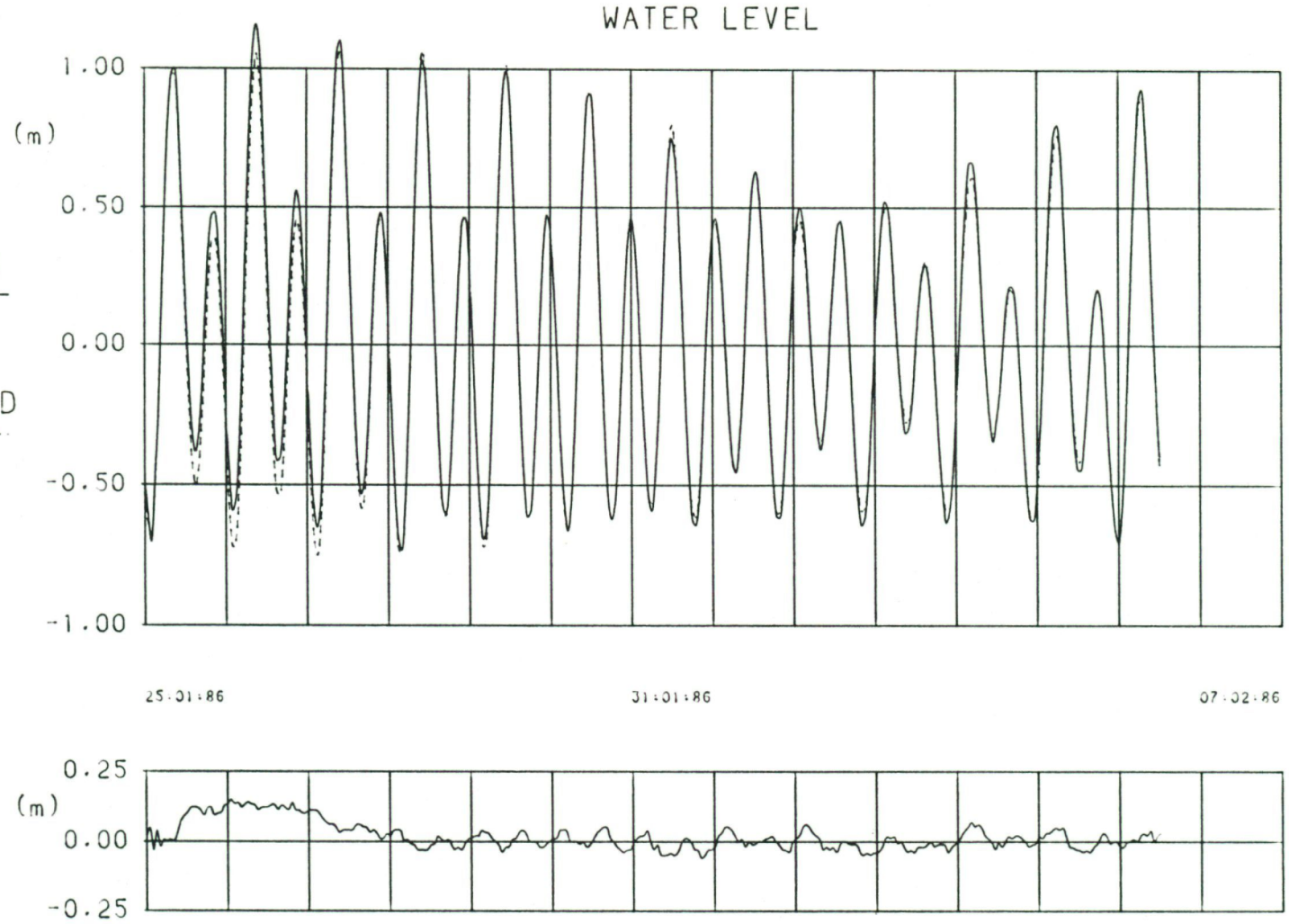
PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY

NORTH EAST CHANNEL
TIDES AT NE8
MEASURED - PREDICTED

LAWSON AND TRELOAR PTY LTD.

DATE 08:05:86

FIG. 68



MEASURED

PREDICTED

DATUM : MSL FOR PERIOD.

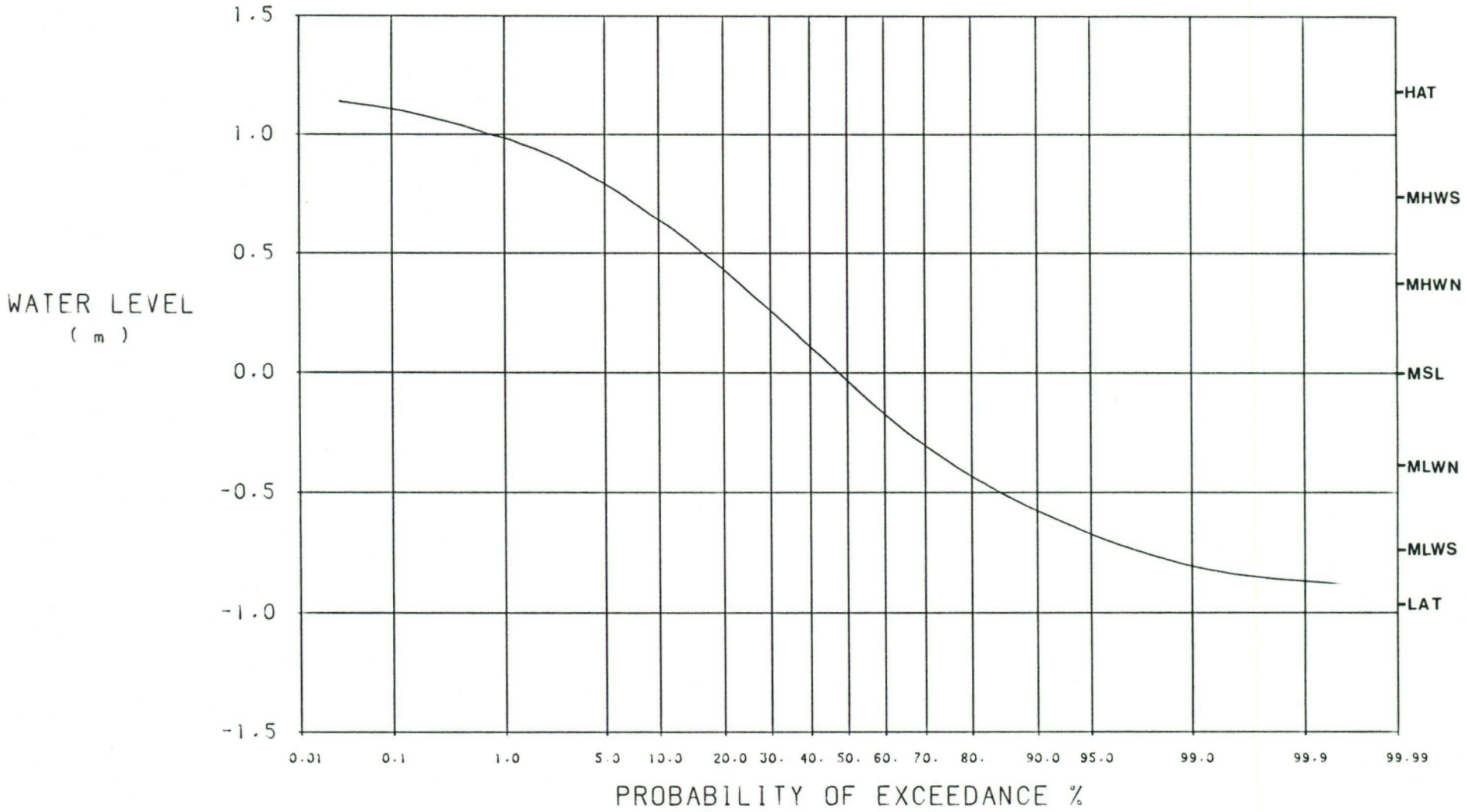
PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY

NORTH EAST CHANNEL
TIDES AT NE8
MEASURED - PREDICTED

LAWSON AND TRELOAR PTY LTD.

DATE 08:05:86

FIG. 69



DATUM : MSL FOR PERIOD.

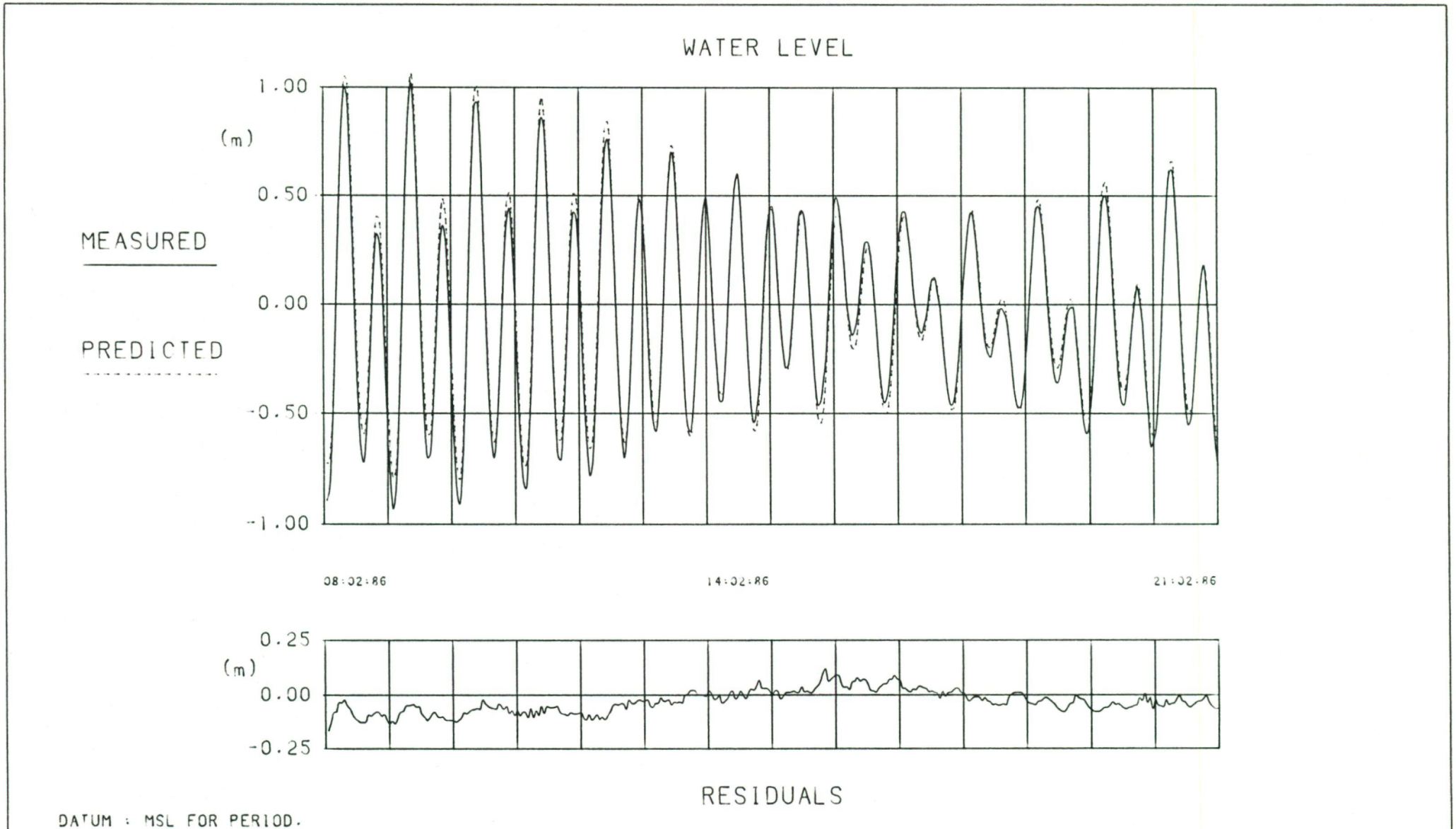
PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY

NORTH EAST CHANNEL
WATER LEVELS AT NE8
EXCEEDANCE PLOT

LAWSON AND TRELOAR PTY LTD.

DATE 12:05:86

FIG. 70



DATUM : MSL FOR PERIOD.

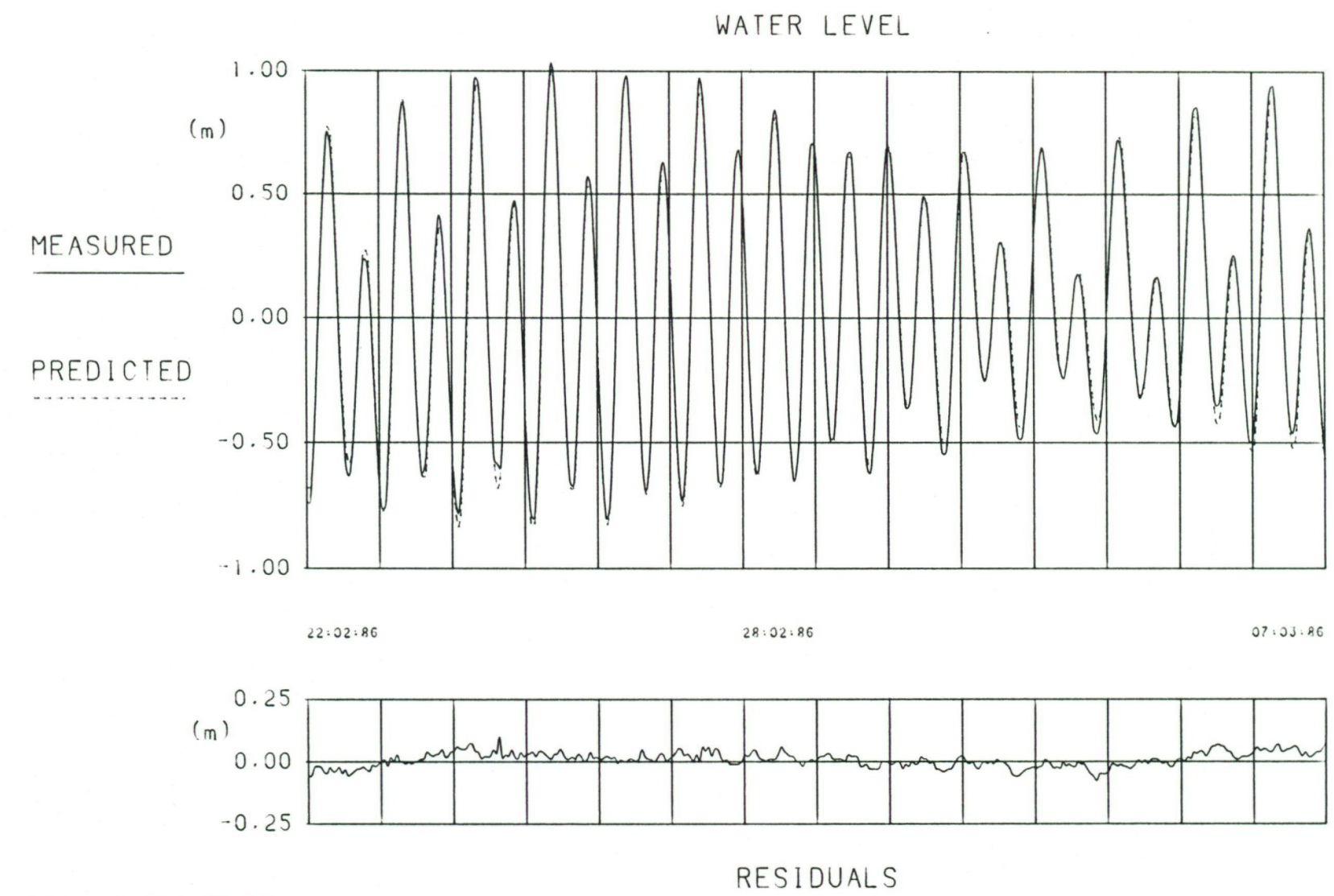
PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY

NORTH EAST CHANNEL
TIDES AT NE6
MEASURED - PREDICTED

LAWSON AND TRELOAR PTY LTD.

DATE 08:05:86

FIG. 71



DATUM : MSL FOR PERIOD.

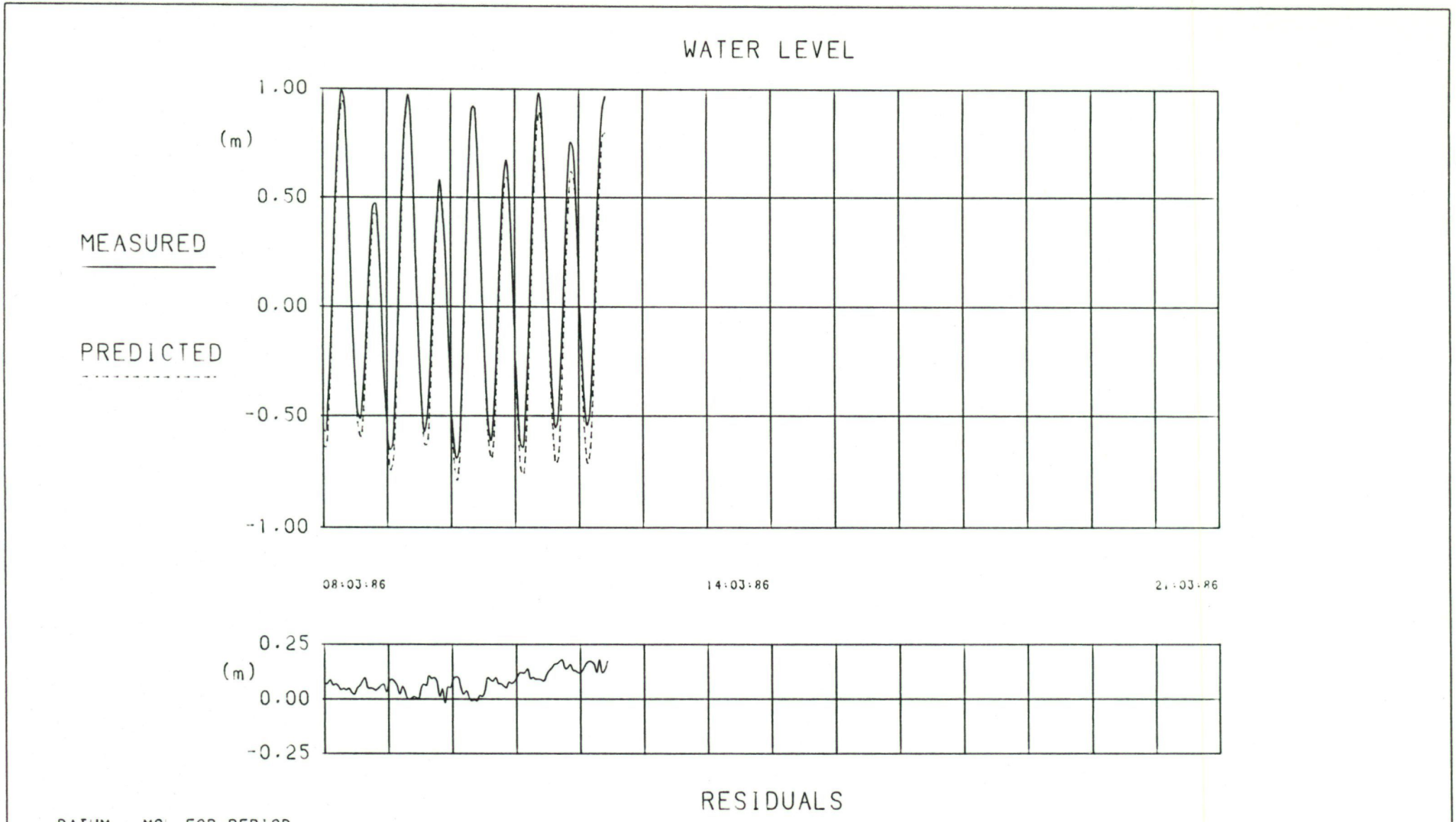
PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY

NORTH EAST CHANNEL
TIDES AT NE6
MEASURED - PREDICTED

LAWSON AND TRELOAR PTY LTD.

DATE 08:05:86

FIG. 72



DATUM : MSL FOR PERIOD.

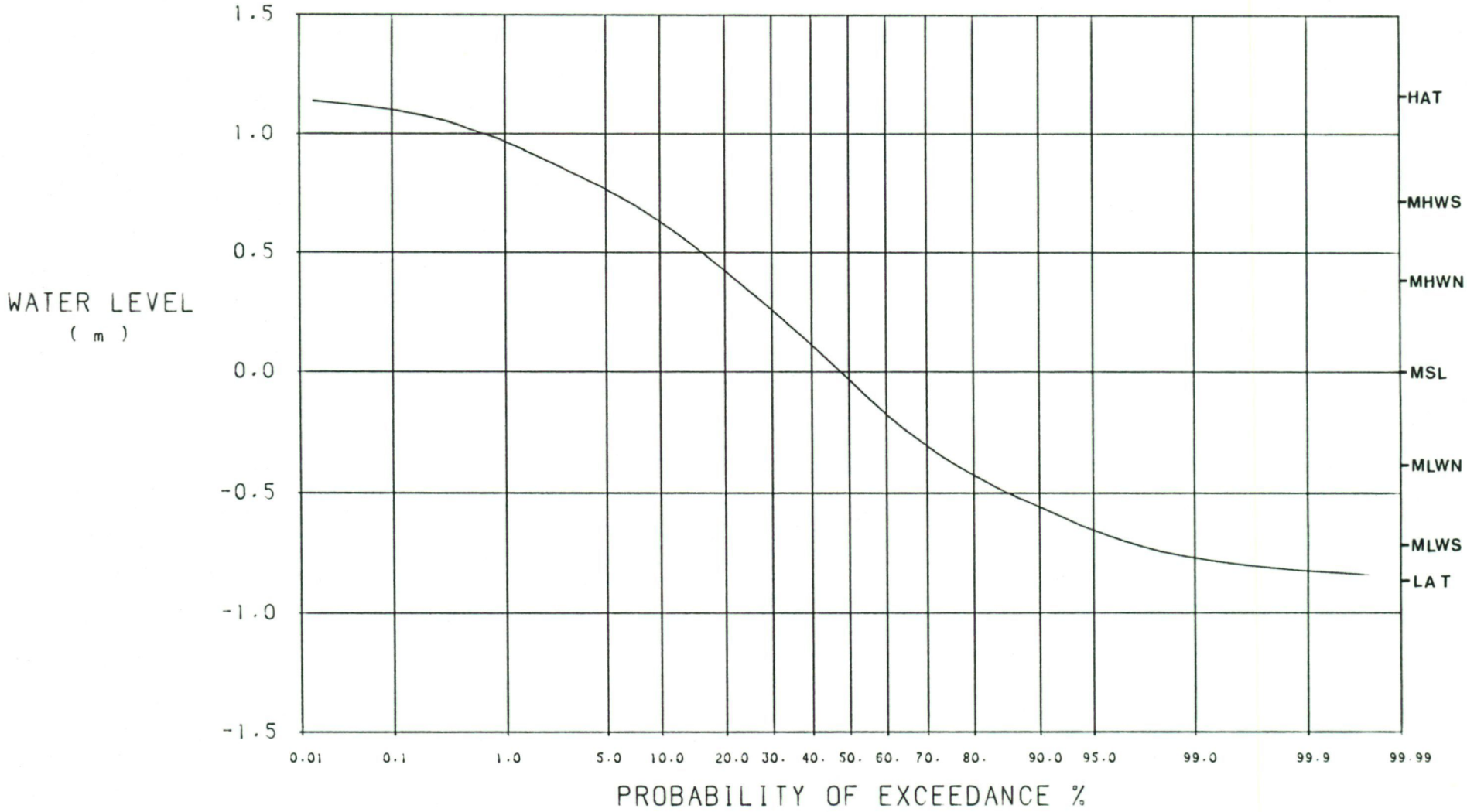
PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY

NORTH EAST CHANNEL
TIDES AT NE6
MEASURED - PREDICTED

LAWSON AND TRELOAR PTY LTD.

DATE 08:05:86

FIG. 73



DATUM : MSL FOR PERIOD.

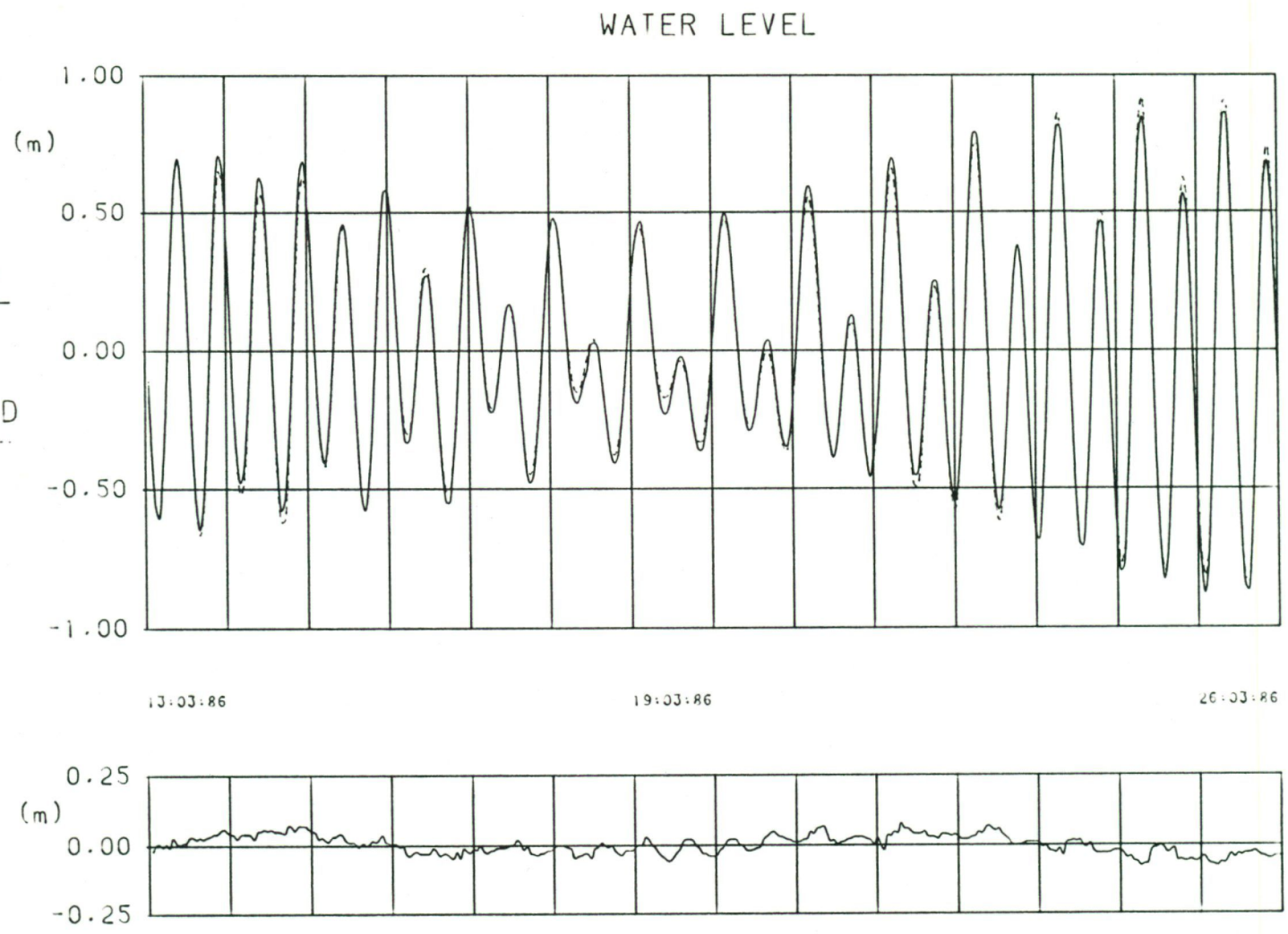
PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY

NORTH EAST CHANNEL
WATER LEVELS AT NE6
EXCEEDANCE PLOT

LAWSON AND TRELOAR PTY LTD.

DATE 12:05:86

FIG. 74



DATUM : MSL FOR PERIOD.

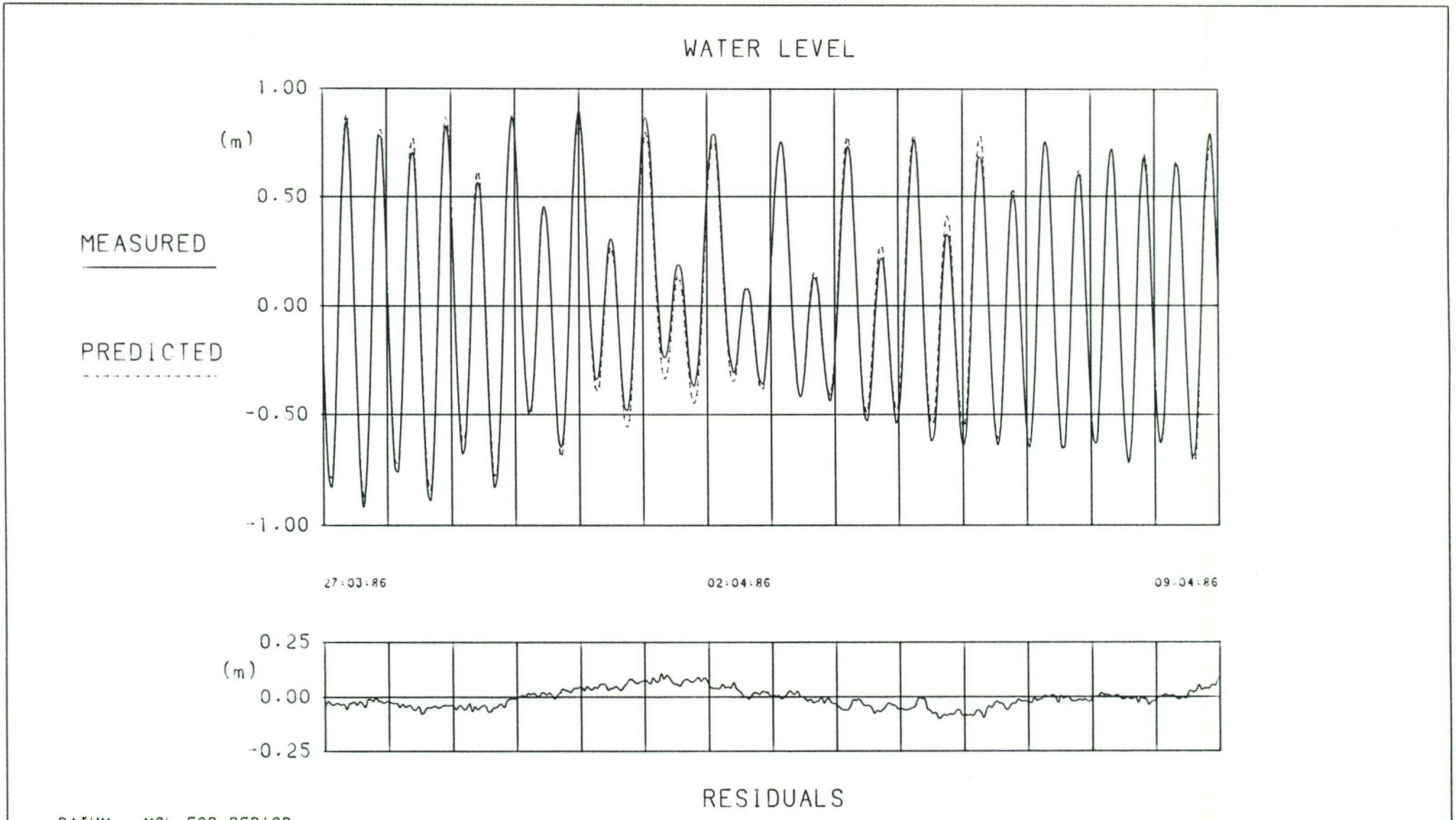
PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY

NORTH EAST CHANNEL
TIDES AT NE4
MEASURED - PREDICTED

LAWSON AND TRELOAR PTY LTD.

DATE 08 05:86

FIG. 75



DATUM : MSL FOR PERIOD.

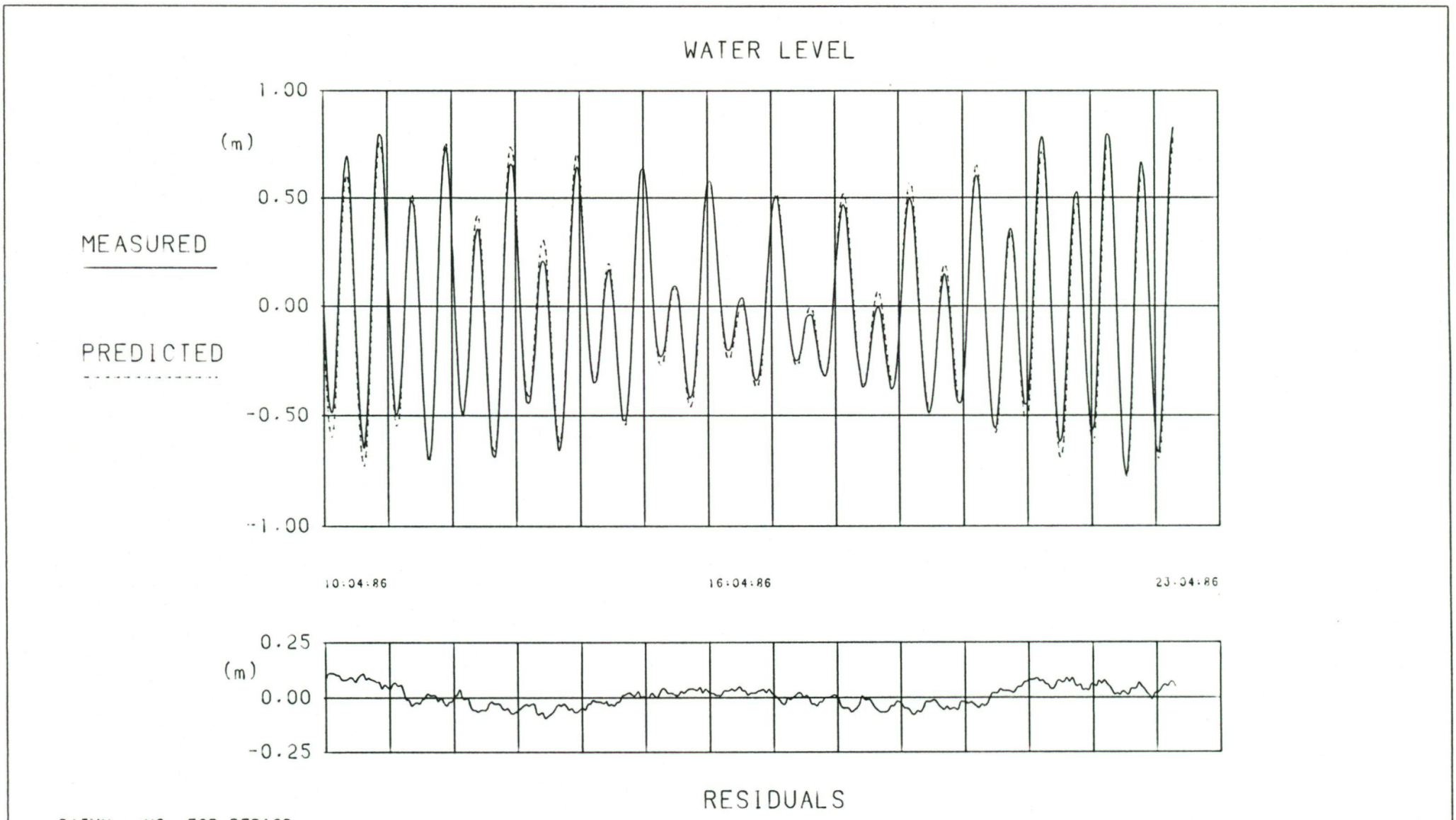
PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY

NORTH EAST CHANNEL
TIDES AT NE4
MEASURED - PREDICTED

LAWSON AND TRELOAR PTY LTD.

DATE 08:05:86

FIG. 76



DATUM : MSL FOR PERIOD.

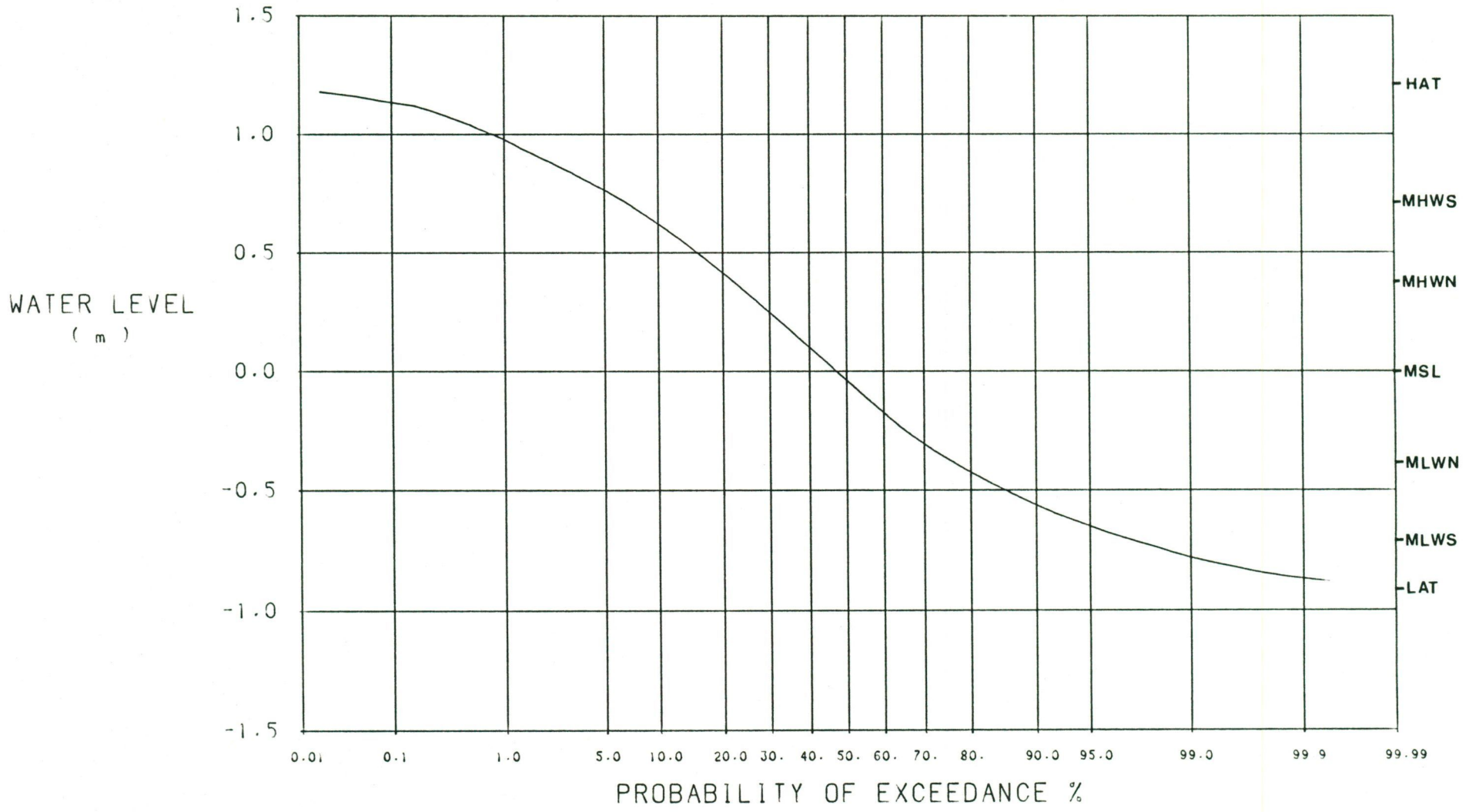
PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY

NORTH EAST CHANNEL
TIDES AT NE4
MEASURED - PREDICTED

LAWSON AND TRELOAR PTY LTD.

DATE 08:05:86

FIG. 77



DATUM : MSL FOR PERIOD.

PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY

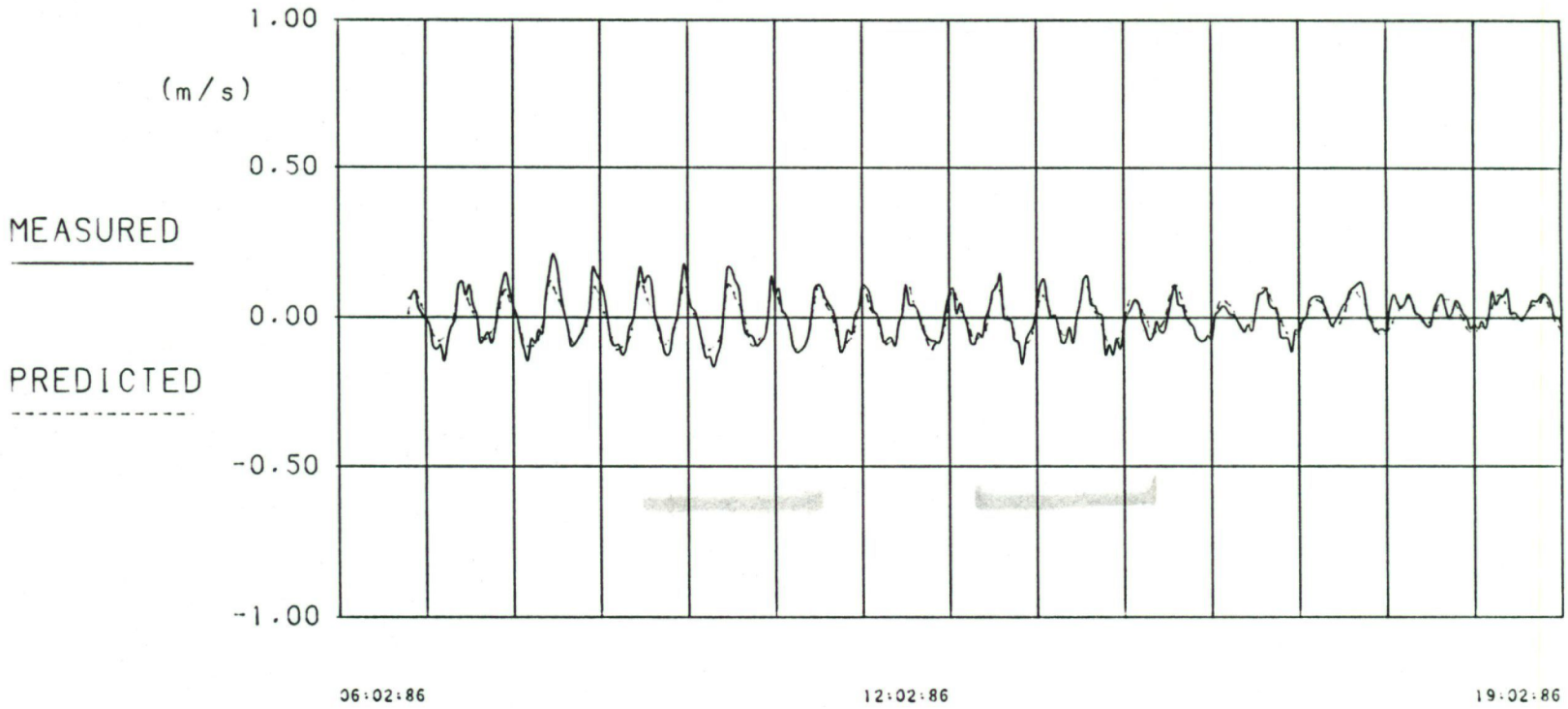
NORTH EAST CHANNEL
WATER LEVELS AT NE4
EXCEEDANCE PLOT

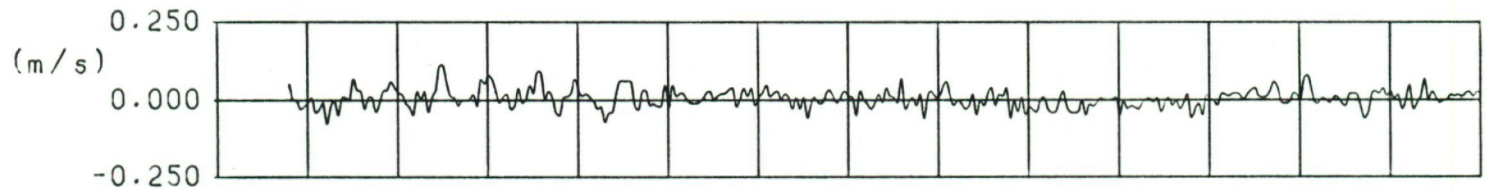
LAWSON AND TRELOAR PTY LTD.

DATE 12:05:86

FIG. 78

SPEED





RESIDUALS

NOTE : MEAN CURRENT REMOVED.

PORT OF BRISBANE AUTHORITY - N.E. CHANNEL STUDY

NORTH EAST CHANNEL NE6
EAST-WEST TIDAL CURRENTS
MEASURED - PREDICTED

LAWSON AND TRELOAR PTY LTD.

DATE 08:05:86

FIG. 39