ORIGINAL

MAKAH BAY OFFSHORE WAVE ENERGY PILOT PROJECT

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PREPARED FOR

AQUAENERGY GROUP LTD.

EHI JOB# 5294

MARCH, 2006

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1.0 INTRODUCTION

In 2002, AquaEnergy Group Ltd. contacted Evans-Hamilton, Inc. to conduct current measurements for three months during winter, deploy and recover a wave measuring buoy, and collect bottom sediment samples for analysis of grain size at locations within their intended project demonstration site located within Makah Bay, Washington. The purpose of their demonstration project was to install and test the hardware and efficiency of buoys designed to convert motion induced by waves into electricity. The purpose of the current and wave measurements were to confirm and describe these conditions at the site, both for system design purposes, and for environmental permitting. The purpose of the sediment samples was to understand the bottom sediment conditions, and assess the potential for sediment resuspension and scouring around the buoy anchors and electrical cable to shore.

In late October 2002 the three current meters and one wave measuring buoy were installed, and eight sediment samples collected. The wave measuring buoy was recovered in February 2003, and one current meter was recovered in March 2003. Two current meters were lost, although one meter was last known to be at its deployed site, but buried by sediment.

The results of the current measurements and sediment laboratory results are presented herein. Wave height information has been included for comparison to the current measurements.

2.0 MEASUREMENT PROCEDURES

2.1 Current Measurements

Measurements of currents were attempted at three locations (Sites 1-3; Figure 1) within Makah Bay, WA. The three sites were located in approximately 150, 75, and 30 ft. water depths. The deep site was located at the offshore location of the future buoys, while the mid-depth and shallow sites were located along the proposed cable route corridor. The specific Latitude and Longitude and State Plane coordinates for the sites are provided in Table 1.

Table 1. Current meter deployment locations.

	Geographic Coordinates		UTM Zone 10-meters		State Plane NAD83 WA North Zone - US Survey Feet	
	Latitude	Longitude	Easting	Northing	Easting	Northing
ADP - 150 ft (Deep)	48.33250987	124.7388361	371128.62	5354719.41	690939.516	509761.755
ADP - 75 ft (Mid)	48.33299913	124.7042112	373695.92	5354716.17	690835.945	510165.342
S4 - 30 ft (Shallow)	48.33281331	124.6821438	375330.89	5354659.41	690660.288	510079.941

2.1.1 - Site 1

Site 1 was located at the proposed pilot demonstration project's future buoy locations which are to be located in approximately 150 ft. water depth. At this site a SonTek 500 kHz ADP profiling current meter was mounted upward-looking on an anti-trawl, low relief bottom mount (see picture in Appendix 1.1). The footprint of this bottom mount is approximately 3 ft. by 5 ft., and the bottom of the mount is a grating material rather than a flat panel. The mount is made of aluminum to eliminate magnetic interference on the internal compass within the current meter.

The SonTek ADP meter measures currents throughout the water column by transmitting sound signals from three transducers, and measuring the Doppler shift of the returning sound signal. The distance above the meter from which the Doppler shift originates, and hence the current measurement is made, is calculated by time-gating the returning sound signals. Settings in the meter permit setting the meter to measure the average current speed and direction within selected vertical distances, called bin lengths. For this project, the bin lengths were set to one meter in length. The SonTek ADP meter's transducers were located 0.4m (1.3ft) above the bottom of the mount. There is a 1m (3.28ft) blanking distance above the transducer head. Thus the measurement bins began at 1.4m (4.59ft) above the bottom, and were spaced at 1m intervals. This meter averages the current values from two adjacent bins, thus the recorded current measurement nearest the bottom occurred at 2.4m (7.87ft) above the bottom (0.4m transducer height, 1m blanking distance, and the average of the results from the first bin). In summary, the meter measured currents at 1m (3.3 ft.) depth intervals from approximately 2 meters (6.56ft) above the seabed to near the water surface.

This mount was placed on the bottom at Site 1, and the current meter measured 4-minute average profiles of the current every 15 minutes from near-bottom to near the water surface. Each 4-minute average consisted of 480 measurements per depth interval, with a resulting standard deviation of approximately 1.9 cm/sec. based on manufacturer's specifications.

Deployment of this mount was accomplished October 29, 2002 by lowering it to the bottom using a winch cable that passed through an A-frame mounted on the stern of a vessel. An acoustic release was placed at the end of the lifting cable just above the mount to release the mount once it was on the bottom.

The meter was originally scheduled to collect measurements from late October through December, 2002; however, the first recovery attempt was not held until February 10, 2003 due to weather conditions and boat availability. During normal recovery of this type of mount, the position of the mount is first confirmed to be at the GPS deployment coordinates by means of ranging on the signals of the acoustic release contained in the bottom mount, as well as the signals of a separate pinger contained in the bottom mount. Once the mount position is confirmed, the acoustic release contained within the bottom

mount is triggered, which then releases a buoy and recovery rope, by which the entire package is lifted to the surface and recovered and nothing remains on the seabed.

During the first recovery attempt, the mount was located at its deployment location, the acoustic release was triggered, and the recovery buoy and rope came to the surface. Recovery attempts were made using this recovery rope; however, it became apparent that the mount was buried in sediment and would not dislodge. The recovery attempt was aborted due to fears that the recovery rope would break. The rope and buoy were then re-deployed with the buoy remaining at the water surface.

Because of the difficulties encountered in the recovery effort of this mount, and those at the other sites, it was deemed necessary to secure the use of a remotely operated vehicle (ROV) and water jetting apparatus for future attempts to recover the mounts. The ROV is equipped with a video camera and mechanical arm allowing underwater site assessments and operations. This is especially useful for areas not accessible to divers (e.g., too deep or too high currents). The water jetting apparatus works like a high powered garden hose washing sand and sediment away from under water equipment.

A second recovery attempt on September 18, 2003 was successful at recovering the unit. The delay in the second recovery attempt was due to a combination of factors including weather conditions, the need for a larger boat with good lifting capacity and the room to conduct ROV and water jetting operations. Upon reaching the site, the surface buoy and rope were no longer present. The mount was located using the DGPS position, and ranging on the acoustic release and pinger. Final location of the mount was made by use of an underwater video camera aboard the ROV. Upon finding the mount, the video camera showed that only the transducer heads of the meter and the mount's lifting bracket were exposed above the sediment surface. The entire rest of the bottom mount was buried under the sediment. The ROV attached a new lifting line to top of the mount, and a water jetting hose was slid down the lifting line. By a combination of water jetting and pulling on the recovery line, the mount was slowly pulled free of the sediment and recovered.

The meter collected measurements from October 29, 2002 until March 12, 2003 when its battery power reached a cutoff level.

2.1.2 - Site 2

Current measurement Site 2 was located in approximately 75 ft. of water depth within the proposed cable corridor at a location approximately half way between Site 1 and Site 3. This site had an identical mooring configuration as Site 1, a SonTek 500 kHz ADP profiling current meter mounted upward-looking in an anti-trawl, lower relief bottom mount.

The current meter was set to record measurements identically to the meter at Site 1. The deployment and recovery methods for this meter and bottom mount were also identical to those for Site 1, however, this meter and mount were never recovered during the two

separate recovery attempts even though signals from the acoustic release indicated that the release had triggered, but no buoy came to the surface. During the 2nd attempt, the acoustic release continued to respond to commands of the deck box, and provide ranges (distances) to it. When directly over the site and at minimum acoustic ranges, a video camera system aboard the ROV was lowered and the area visually searched; however, no sign of the bottom mount could be found. Due to the characteristics of the acoustic release signal and the video inspection, the current meter and mount are considered completely buried. No report of the recovery float reaching the surface has ever occurred, even though a reward for its siting leading to the recovery of the mount was posted and notification of such was made around Neah Bay. No data was therefore recovered for this site.

2.1.3 - Site 3

Current measurement Site 3 was located in approximately 30 ft. water depth just outside the anticipated surf zone. At this site, an InterOcean S4 current meter was used which measures currents at the depth of the current meter only. Currents are measured by four electromagnetic sensors located around the equator of the instrument. This meter was mounted at approximately 1 m above the bottom on a third type of bottom mount where the sides of the mount permit unobstructed water flow around the meter (see picture in Appendix 1.2). This meter collected 4-minute average measurements of the current every 30 minutes. Each 4-minute average consisted of 480 measurements (one measurement every half second).

The deployment method for this meter and bottom mount varied slightly from sites 1 and 2. For this site, the recovery rope was used to lower the mount to the bottom, and the recovery buoy was attached to the recovery rope and left at the water surface. No acoustic release was attached to the bottom mount. A pinger was attached to the mount for acoustically locating the mount if the recovery buoy and rope were missing.

This meter and mount were never recovered during the two separate recovery attempts. During the first recovery attempt, the mount was found to be missing from the deployment location. A search of the nearby area was conducted and the surface buoy of this mount was located approximately 1 nmi. west of its original deployed position, close to Site 2. An attempt was made to recover the mount, however, the mount was either buried or hung up on a rock such that recovery was not possible. During the second recovery attempt in September 2003, no sign of the recovery buoy or of the meter and mount could be found anywhere in the area, nor any acoustic signal from its pinger received.

2.2 Wave Measurements

Wave measurements were collected at one location in approximately 150 ft. depth near current measurement Site 1. The location is shown on Figure 1, and the Latitude and Longitude and State Plane coordinates are listed in Table 2. The measurements were collected using an AXYS TEchnologies Inc. (ATI) TRIAXYS™ Directional Wave Buoy.

A picture of the buoy is included in Appendix 1.3. ATI personnel prepared the buoy for deployment. Evans-Hamilton personnel helped deploy the buoy, and recovered the buoy and shipped it back to ATI.

Table 2. Wave buoy deployment location.

	Geographic Coordinates		UTM Zone 10-meters		State Plane NAD83 WA North Zone-US Survey Feet	
	Latitude	*Longitude*	*Easting*	*Northing*	*Easting*	*Northing*
WAVEBUOY	48.3314194	124.738327	371163.62	5354597.35	690930.531	509557.021

2.3 Sediment Sampling

Sediment samples for grain size analysis were collected at eight locations. These locations are shown on Figure 1, and their Latitude and Longitude and State Plane coordinates are listed in Table 3. These samples were collected during the current meter deployment cruise. They were collected using a standard Van Veen sediment sampler. The Van Veen was visually checked for consistency of the sediment within it, and a representative sample collected and placed in a standard sample jar. These samples were transferred to the custody of Parametrix for analysis.

Table 3. Sediment grab sample locations.

	UTM Zone 10-meters		State Plane NAD83 WA North Zone-US Survey Feet		Geographic Coordinates	
	Easting	Northing	Easting	Northing	Latitude	Longitude
VV-1	375505.05	5354904.52	696092.067	509919.724	48.33505191	124.6798673
VV-2	375478.26	5354488.66	704614.018	509581.436	48.33130689	124.6801057
VV-3	373751.16	5354694.99	704500.277	509565.283	48.33281967	124.7034597
VV-4	372731.92	5354689.55	705081.692	509007.804	48.33256631	124.7172042
VV-5	374135.35	5354636.48	705207.868	510369.382	48.33237019	124.6982608
VV-DADCP	371075.84	5354691.89	700690.492	509616.384	48.33225164	124.7395395
VV-S4	375296.37	5354653.51	699435.729	509843.674	48.3327535	124.6826075
VV-WB	371162.64	5354534.9	699256.455	509918.248	48.33085762	124.7383209

3.0 DATA PROCESSING

3.1 Current Measurements

Data were obtained from the instrument deployed at Site 1. The specific details of the measurement site, instrument setup, measurement periods, and file names used for processing the data are contained in Tables 4 and 5.

Table 4. Site 1 Data File Information.

Site:	Aqua Energy, Station 1
Latitude:	48° 19.885165' N
Longitude:	124° 44.299605' W
Magnetic Declination:	18.467°
File Name:	AE15002.adp
File Size:	9.85 MB

Table 5. Instrument Setup Parameters.

PARAMETER	SETTING	COMMENTS
Current Meter Type & Frequency:	SonTek 500 kHz ADP	
Instrument Serial Number:	4078	
Pressure Sensor:	N/A	
Number of Bins:	60	
Bin Size:	1 meter	
Range of First Bin from Instrument:	2 meters	
Range of First Bin from Bottom:	2.41 meters	
Sampling Interval:	15 minutes	
Raw File Start Date & Time:	Oct 29, 2002 - 12:00:00 PST	
Clean Data Start Date & Time:	Oct 30, 2002 - 12:45:00 PST	In water Oct 29, 2002 - 20:45:00 PST; however, compass data settled at listed time
Raw File End Date & Time:	Mar 12, 2002 - 15:30:00 PST	
Clean Data End Date & Time:	Mar 12, 2002 - 15:30:00 PST	Battery ran out before instrument was retrieved

Upon recovery of the instrument, the data were downloaded and a backup copy of the raw data was immediately created. The first step in the data processing was then to conduct a preliminary assessment of the data quality. This was done in two ways. First, parameters such as instrument pitch, roll, heading, Signal to Noise Ratio (SNR), Return Signal Amplitude (amplitude), and water temperature, all of which are recorded along with current speed and direction, were plotted and reviewed to assess the stability of the meter during the deployment, and to identify any potential problems that would affect the quality of the current measurements. These parameters can identify common problems such as movement or disturbance of the bottom mount, burial of the instrument, beam interference, or excess roll or tilt. Plots of these parameters are provided in Appendix 2. These parameters showed that upon initial deployment, the current meter mount took several days to become steady, however, its initial movement was well within the pitch, roll, and heading sensor limits, and the meter automatically corrects the current measurement data for the readings of these sensors. The other parameters showed no problems.

Second, the structure of the current velocity and direction vertically through the water column and over time were examined to look for consistency of current changes, unusual

spikes in current velocity, or unusual rapid changes in current direction. Nothing unusual was found.

The third step in the data processing involved deleting the data in the record file prior to the instrument's deployment and after its recovery, plus deleting data from bins at or above the water surface from which the meter cannot properly resolve the current due to changes in the water level with tide, or acoustic side-lobe interference very near the water surface. The primary parameters used to determine good quality data near the water surface were SNR and amplitude from each Doppler beam. The SNR cut off value was set to 12, so that all data with a per-bin SNR difference greater than 12 was cut from the data set. The amplitude gate value was set to 10, so that all data with a per-bin amplitude difference greater than 10 was cut from the data set. Remaining questionable data points not cut by the before mentioned procedures were cut using a box-car style sea surface calculation algorithm. All cut data were flagged using "99999".

The edited data set was next plotted for a second visual inspection. As no other questionable data values were evident, final plots and statistical tables of the data were created, and the data file format was converted to our standard deliverable format.

The deliverable data file format corresponds to the following:

Table 6. Current Data Deliverable File Format.

Date Month	Day	Year	Time (UTC) Hour	Minute	Second	Bin range from bottom	Current Speed	Current Direction	Current E-W component	Current N-S component
MM	DD	YY	HH	MM	SS	m	cm/s	Deg wrt True N	cm/s – E is positive	cm/s – N is positive

*wrt = with respect to

All the data QA/QC and processing were performed with our standard routines, which include a combination of SonTek software and Evans-Hamilton, Inc. software.

3.2 Wave Measurements

Wave measurements from the TRIAXYS buoy were downloaded and processed by ATI. The processed data were provided to Evans-Hamilton by AquaEnergy Group. Evans-Hamilton has done no processing or modifications to these data. These data for wave height, period, and direction were plotted and reviewed, and the wave height data selected to plot at the same time scale as the current measurements data for comparison.

3.3 Sediment Samples

Processing of the sediment samples for grain size analysis by a laboratory was done under the direction of Parametrix.

The sediment grain size results were provided to Evans-Hamilton, Inc. by Aqua Energy for inclusion in this report. Based on the laboratory report, it appears standard grain size

analysis was performed on the sediment samples. The laboratory also ran duplicate analysis from sub-samples of one sample, and achieved good agreement.

3.4 Wind and River Discharge Data

No measurements of wind and river discharge were made for this study, however, due to their value in understanding current variations, publicly available wind data for the Tatoosh Island Weather Service station were obtained from the National Data Buoy Center, and discharge data for the Columbia River and Hoh River were obtained from the U.S. Geological Survey for the period of the current measurements. These data were plotted on the same time scale as the current measurements for comparison.

4.0 RESULTS

4.1 Current Measurements

Since the measurements span from late October, 2002 through mid-March, 2003, they provide an excellent data set of currents during winter conditions. In this section we will describe the key features of the current during the measurement period, then describe expected variations in those features during spring to summer seasons.

4.1.1 Key Measurement Results

Currents in the study area are driven by three main forces: tides, wind, and runoff from the Columbia River and coastal rivers. There are occasionally other forces, such as migration northward of warmer water masses during El Nino's, or current reversals after long periods of winds, but these factors are not generally dominant in the current records.

The wind, wave, and Columbia and Hoh river discharges during the period of the current measurements were plotted at the same time scale as the current measurement data to provide an understanding of these forcing functions (Appendix 3). Tide effects can be seen directly in the current measurements.

Appendix 4 contains vector plots of the current at every fourth bin from near-bottom to near-surface. The current measurements at Site 1 show both the influence of the tides, as well as periods of dominance by winds from winter storms. Tidal currents are strong, reaching 75 cm/sec near surface, and 50 cm/sec near bottom during periods of weaker winds. The tidal currents are semi-diurnal, and vary in strength on a fortnightly basis due to periods of spring and neap tides. Currents are generally uniform in direction with depth, and run predominantly north and south. Even during periods of light wind, the dominant current direction appears northward, and approximately every 14 days, the twice daily southward current nearly disappears. This is likely due to the normal variations of a semi-diurnal tidal current over the spring-neap cycle.

During the measurement period, the site experienced several major wind storms, as evidenced by the wind and wave height measurements, as well as increases in river discharge, particularly for the Hoh River. Nearly all these wind storms contained winds from the south. The effect of these storms was to increase the speed of the current toward the north, and decrease the current speeds directed southward. The following dates in Table 7 show periods when strong winds directed northward showed a substantial boost to the northward flowing current, and at times nearly eliminated the southward current.

Table 7. Start and end dates and times of northward wind events.

Northward Wind Events	
Start	End
November 6, 2002	November 20, 2002
December 12, 2002	December 19, 2002
December 25, 2002	December 27, 2002
January 2, 2003	January 6, 2003
January 22, 2003	January 28, 2003

During these wind periods, northward current speeds were boosted considerably, and the effect was seen through the entire water column, though to lesser effect at depth and near bottom. This can be also seen in contour plots of the current speed and current direction, where these values versus depth are contoured by color over time (Appendix 5).

Table 8 presents information on the average, minimum, maximum, and net current speeds and associated directions versus depth at Site 1. This table shows how the maximum and net current speeds were normally highest near the surface, and lowest near bottom. The maximum current speeds generated during the storms were 142 cm/sec near-surface, and 81 cm/sec near-bottom headed northward. The net current speed reached 17 cm/sec near surface and 2 cm/sec near bottom, again directed generally northward. Of interest is the average current speed computed from all the current measurements at a depth ranged only from 20 cm/sec near bottom to 30 cm/sec near surface.

Table 8. Statistics from the Current Measurements at Site 1.

Height Above Bottom (m)	Data Points	Avg East (cm/s)	Avg North (cm/s)	Avg Spd (cm/s)	Max Spd (cm/s)	Dir of Max (deg wrtN)	Min Spd (cm/s)	Dir of Min (deg wrtN)	Net Spd (cm/s)	Net Dir (deg wrtN)	Total Var
43.41	10202	3.6	16.7	27.6	141.8	18.9	0.2	108.5	17.1	12.1	1.48E+09
42.41	11876	3.6	14.2	26.9	131.4	22.0	0.1	288.5	14.6	14.3	4.83E+08
41.41	12487	3.5	12.4	26.5	127.1	7.8	0.0	0.0	12.9	15.8	1.47E+08
40.41	12780	3.4	11.2	26.2	129.4	19.0	0.1	198.5	11.7	17.1	18232.5
39.41	12780	3.3	10.3	25.9	126.6	17.5	0.1	288.5	10.8	17.9	18128.25
38.41	12780	3.3	9.5	25.8	125.0	1.5	0.0	0.0	10.0	19.0	18470.14
37.41	12780	3.2	8.8	25.8	120.0	5.0	0.2	18.5	9.3	19.8	18574.58
36.41	12780	3.0	8.0	25.7	118.8	2.8	0.0	0.0	8.5	20.8	19406.38
35.41	12780	2.9	7.3	25.5	120.9	5.3	0.1	18.5	7.8	21.5	19357.94
34.41	12780	2.7	6.6	25.5	118.5	357.8	0.3	0.1	7.2	22.2	19936.83
33.41	12780	2.5	6.0	25.5	119.9	359.8	0.0	0.0	6.5	22.3	20528.92
32.41	12780	2.3	5.5	25.5	120.2	1.7	0.0	0.0	5.9	23.1	21213.28
31.41	12780	2.1	5.0	25.5	113.9	359.2	0.2	108.5	5.4	23.4	21726.61
30.41	12780	2.0	4.5	25.6	118.0	1.7	0.1	108.5	4.9	24.4	21915.12
29.41	12780	1.8	4.1	25.5	113.1	358.9	0.1	18.5	4.5	23.9	22555.2
28.41	12780	1.7	3.8	25.6	117.0	355.3	0.1	18.5	4.2	23.5	23413.47
27.41	12780	1.5	3.5	25.7	114.3	356.8	0.1	108.5	3.8	23.2	24358.27
26.41	12780	1.3	3.2	25.8	119.2	355.4	0.0	0.0	3.5	21.7	25122.82
25.41	12780	1.2	2.9	25.8	112.1	355.8	0.1	198.5	3.2	21.7	25547.16
24.41	12780	1.0	2.7	25.9	109.8	353.4	0.1	333.5	2.9	20.1	26312.39
23.41	12780	0.8	2.6	26.1	106.5	351.0	0.2	18.5	2.7	16.9	26743.04
22.41	12780	0.7	2.4	26.2	110.6	349.3	0.1	198.5	2.5	15.5	27300.73
21.41	12780	0.4	2.2	26.4	113.3	348.9	0.1	198.5	2.2	11.6	27537.03
20.41	12780	0.3	2.1	26.4	107.0	353.1	0.0	0.0	2.1	9.0	28006.6
19.41	12780	0.1	2.0	26.6	105.2	349.7	0.2	315.1	2.0	4.2	28183.07
18.41	12780	-0.1	1.9	26.6	103.4	340.5	0.0	0.0	1.9	356.8	28392.71
17.41	12780	-0.2	1.8	26.6	103.3	349.3	0.2	135.1	1.8	352.7	28827.62
16.41	12780	-0.4	1.7	26.7	105.4	341.6	0.2	288.5	1.8	348.1	28905.2
15.41	12780	-0.6	1.6	26.6	104.2	349.5	0.0	0.0	1.7	341.5	29048.11
14.41	12780	-0.6	1.5	26.6	105.9	334.0	0.2	45.1	1.6	338.8	29374.27
13.41	12780	-0.7	1.5	26.6	108.6	332.3	0.0	0.0	1.7	333.5	29346.45
12.41	12780	-1.0	1.4	26.5	98.4	348.8	0.1	18.5	1.7	325.1	29484.4
11.41	12780	-1.0	1.4	26.3	99.4	337.4	0.0	0.0	1.7	324.1	29530.04
10.41	12780	-1.2	1.2	26.1	106.0	348.6	0.4	198.5	1.7	315.0	29295.41
9.41	12780	-1.2	1.2	25.8	101.2	338.2	0.1	198.5	1.7	314.1	29045.65
8.41	12780	-1.2	1.0	25.5	102.8	334.4	0.1	198.5	1.6	309.2	29197.6
7.41	12780	-1.3	1.0	25.1	95.9	327.3	0.1	198.5	1.7	305.8	28913.7
6.41	12780	-1.3	0.9	24.5	101.6	332.8	0.0	0.0	1.6	303.9	28479.39
5.41	12780	-1.3	0.9	23.8	100.0	345.8	0.0	0.0	1.6	305.1	28197.82
4.41	12780	-1.2	1.0	22.9	97.4	333.7	0.1	18.5	1.6	311.2	27909.18
3.41	12780	-1.1	1.1	21.6	96.5	331.1	0.0	0.0	1.6	316.7	27954.83
2.41	12780	-0.9	1.4	19.7	80.8	330.0	0.2	288.5	1.7	327.2	27681.27

Appendix 6 presents tables for every fourth measurement depth (for every vector plot depth shown in Appendix 4), of the percent occurrence of the current speed versus directions.

From these tables, surface flow was predominantly north-northeast during the study period. For the entire record, 45% of the time currents were greater than 25 cm/s, 10% of the time currents exceeded 50 cm/s, and 1.4% of the time currents exceeded 75 cm/s. The predominant current direction was to the north, between 320° and 40°. Surface currents rarely exceeded 100 cm/s (Table 9).

Bottom flow was predominantly north-northwest and south-southeast during the study period. Twenty-eight percent of the time currents were greater than 25 cm/s, and 1.3% of the time currents exceeded 50 cm/s. The predominant current direction was to the north, between 320° and 40°. Bottom currents rarely exceeded 75 cm/s (Table 9).

Table 9. Summary of percent occurrence tables for the surface and bottom bins.

	Surface Currents (42.4 mab)				Bottom Currents (2.4 mab)			
Current Speed (cm/s)	Northward Flow (320°-40°)	Southward Flow (140°-220°)	Eastward Flow (40°-140°)	Westward Flow (220°-320°)	Northward Flow (300°-20°)	Southward Flow (120°-200°)	Eastward Flow (20°-120°)	Westward Flow (200°-300°)
< 25	**19.34%**	**12.85%**	14.15%	7.66%	**22.95%**	**25.04%**	13.22%	9.69%
> 25	**35.16%**	**7.00%**	3.43%	< 1 %	**15.49%**	**11.42%**	< 1 %	1.56%
> 50	**10.14%**	< 1 %	< 1 %	< 1 %	< 1 %	< 1 %	< 1 %	< 1 %
> 75	1.42%	< 1 %	< 1 %	0%	< 1 %	0%	< 1 %	0.00%
> 100	< 1 %	0%	0%	0%	0%	0%	0%	0%

*mab = meters above bottom

In summary, current speeds at the site are quite rapid, even near bottom, and especially when influenced by winter storms. The strongest currents were directed northward during the measurement period, as was the overall net current.

4.1.2 Seasonal Variations Expected

Seasonal variations in the current flow in Makah Bay will occur for mainly two reasons, tide variations through the year, and wind variations winter to summer. The largest tide ranges, and hence tidal currents, normally occur during late December to January, and in June of each year. As the current measurements spanned the December to January period, they will have measured the largest tidal currents to affect the area during winter. Typically, the summer tide ranges are similar to those in December/January, and thus similar tidal current speeds are expected during summer. Since the strongest currents at the site were generated by winter storms and winds from the south, seasonal variations of the tidal currents will not affect the maximum current speeds the site experiences.

Winds do change seasonally. During winter, the coastal wind during storms is predominately from the south, as seen in the measurements from the Tatoosh Island Weather Service station. During summer, winds change and generally blow out the Strait

of Juan de Fuca, causing winds from the north along the coast much of the time. This in turn changes the direction of the dominant current flow, and directs the net flow southward. Currents directed northward become weaker, and currents directed southward become stronger. The net current direction is southward during summer. The timing of the shift is dependent on the timing of the wind changes. Since winds during the summer are generally weaker than during the winter, and coastal river discharge is normally lower, current speeds during summer are expected to be less than during the winter measurements obtained.

4.2 Sediments

4.2.1 Sediment results

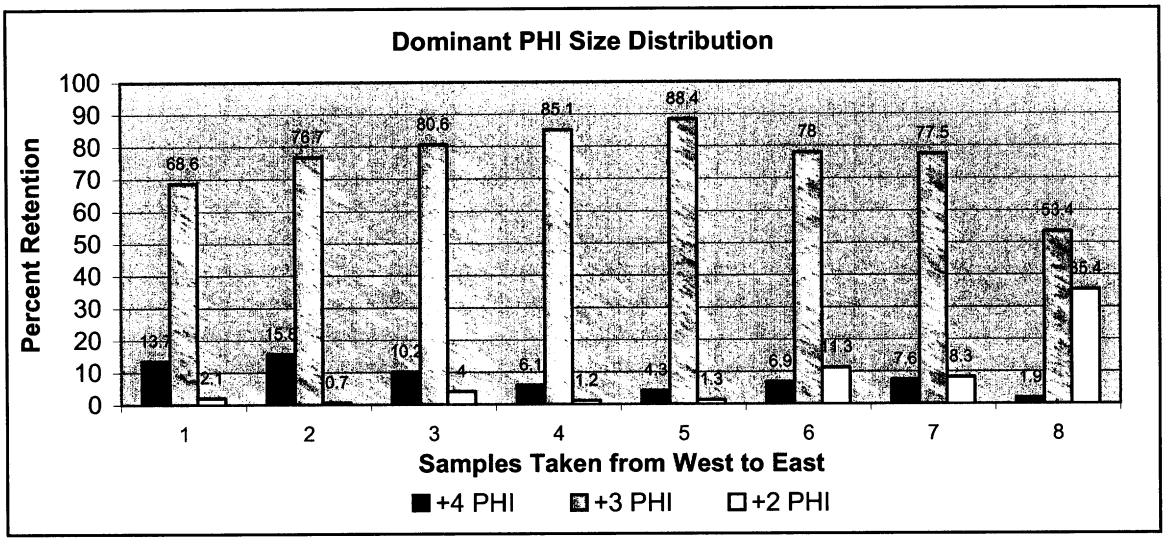
Table 10 shows the grain size distribution results for the sediment samples. Figure 2 displays this information graphically for the three main grain sizes found.

The sediment at all sites consists of nearly all sand, with +3 Phi size being by far the dominant grain size at all sites. Nearshore, larger grain size (+4 Phi) increases in percentage, and offshore, smaller grain sizes (such as silt and clay) increases. However, at all sites, sand constitutes greater than 85 to as high as 97 percent of the grain sizes.

Table 10. Percent of sediment within standard sediment grain size classifications.

		Percent Retention							
PHI Size	Opening (mm)	Deep ADCP Site	Wave Buoy	Station VV-4	Station VV-3	Station VV-5	S4 Site	Station VV-2	Station VV-1
	4.750	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.1	< 0.1	1.5
-2	4.00	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.4
-1	2.00	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
+0	1.00	0.1	< 0.1	0.1	0.1	< 0.1	0.1	< 0.1	0.1
+1	0.50	0.1	0.1	0.1	0.1	0.1	0.3	0.3	0.3
+2	0.25	2.1	0.7	4	1.2	1.3	11.3	8.3	35.4
+3	0.125	68.6	76.7	80.6	85.1	88.4	78	77.5	53.4
+4	0.063	13.7	15.8	10.2	6.1	4.3	6.9	7.6	1.9
+5	0.032	7.4	2.4	2.3	3.4	3	0.3	2.8	4.4
+6	0.016	3	< 0.1	< 0.1	0.4	< 0.1	< 0.1	< 0.1	< 0.1
+7	0.008	1.9	1.7	0.5	0.5	1	< 0.1	1.7	0.5
+8	0.004	1.5	1	0.8	0.2	1	1.3	0.4	0.8
+9	0.002	0.1	0.1	0.1	< 0.1	0.1	0.2	< 0.1	0.1
+10	0.001	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
>+10	<0.001	1.3	1.4	1.3	2.9	0.7	1.4	1.4	1.3
Gravel: < -2 to -1 Phi		< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.1	< 0.1	1.9
Sand: 0 to +4 Phi		**84.6**	**93.3**	**95**	**92.6**	**94.1**	**96.6**	**93.7**	**91.1**
Silt: +5 to +8 Phi		13.8	4.1	3.6	4.5	5	1.6	5.9	5.7
Clay: +9 to >+10 Phi		1.4	1.5	1.4	2.9	0.8	1.6	1.4	1.4

Figure 2. Offshore (west) to Nearshore (east) Sediment Grain Size Percentages for Three Phi Sizes.



4.2.2 Potential for resuspension & scour

An analysis was performed on the potential for the currents measured at the site to become re-suspended, and which direction they would be transported if resuspended. To do this, the grain size results were compared to published charts (Miller et al., 1977) that show the expected current speed at 1 m above the seabed needed to re-suspend unconsolidated grain sizes. Two such evaluations (charts) were used.

Table 11 lists the top 5 grain sizes found in the sediment samples, and the associated current speeds required for resuspension. For example, the +3 Phi size (sand) was used for comparison to these charts due to the dominance of this grain size in the sediment samples. Comparison to the charts shows that current speeds of 35 cm/sec will resuspend this grain size. Current speeds near bottom (2.4m above the seabed) exceeded this threshold speed 11% of the time. Of this time, 4.3% was directed southward, while 6.1% of the time the currents would have carried the re-suspended sand northward (Table 11).

Table 11. Summary of percent occurrence tables for the surface and bottom bins with focus on current speeds inducing sediment resuspension.

		Bottom Currents (2.4 mab)			
Current Speed	**Sediment transported**	**Northward Flow**	**Southward Flow**	Eastward Flow	Westward Flow
(cm/s)		**(300°-20°)**	**(120°-200°)**	(20°-120°)	(200°-300°)
< 20	+6 phi (mud)	16.6%	19.5%	12.2%	8.6%
> 20	+5 phi (mud)	21.8%	16.9%	1.7%	2.6%
> 25	+4 phi (sand)	15.5%	11.4%	< 1%	1.6%
> 35	+3 phi (sand)	6.1%	4.3%	< 1%	< 1%
> 40	+2 phi (sand)	3.2%	2.3%	< 1%	< 1%

During summer, the percentage of time re-suspension would occur would be expected to be less, and the direction of movement would be southward much more of the time.

Due to the high percentage of time the currents must re-suspend sediments in this area, scouring could occur around structures on the seabed. However, as evidenced by the near-burial of the current meter and mount at Site 1, and the complete burial of the current meter and mount at Site 2, deposition of the traveling sand must be also occurring throughout the area.

5.0 SUMMARY

Currents in the Makah Bay area are influenced by three forces; tides, wind and runoff. Tidal effects can be seen directly in the current measurements which are generally uniform in direction (predominantly north and south) with depth. The tidal currents are semi-diurnal and vary in strength on a fortnightly basis (stronger during spring tides and weaker during neap tides). Wind storms were generally from the south and increased the northerly current speeds and decreased the southerly current speeds. Increased currents during wind events were seen at all depths, although strongest near the surface and decreasing with depth. The predominant current direction for both tidal and wind influenced currents is toward the north throughout the water column.

The grain size distribution showed that the area has a high sand concentration (greater than 84% at all sites). Silt was the second most prominent sediment with 14% content furthest offshore and less than 6% progressing toward shore. The clay content was typically 1.5% throughout the area. Gravel was negligible except nearshore but still less than 2%. The potential for resuspension and scour occur in the study area (currents of 35 cm/s will resuspend sand). Current speeds measured near bottom exceeded this threshold 11% of the time. Based on this percentage scouring could occur around structures on the seabed. However, because two of the three bottom mounts were buried in the sediment, sediment deposition is also occurring in the study area.

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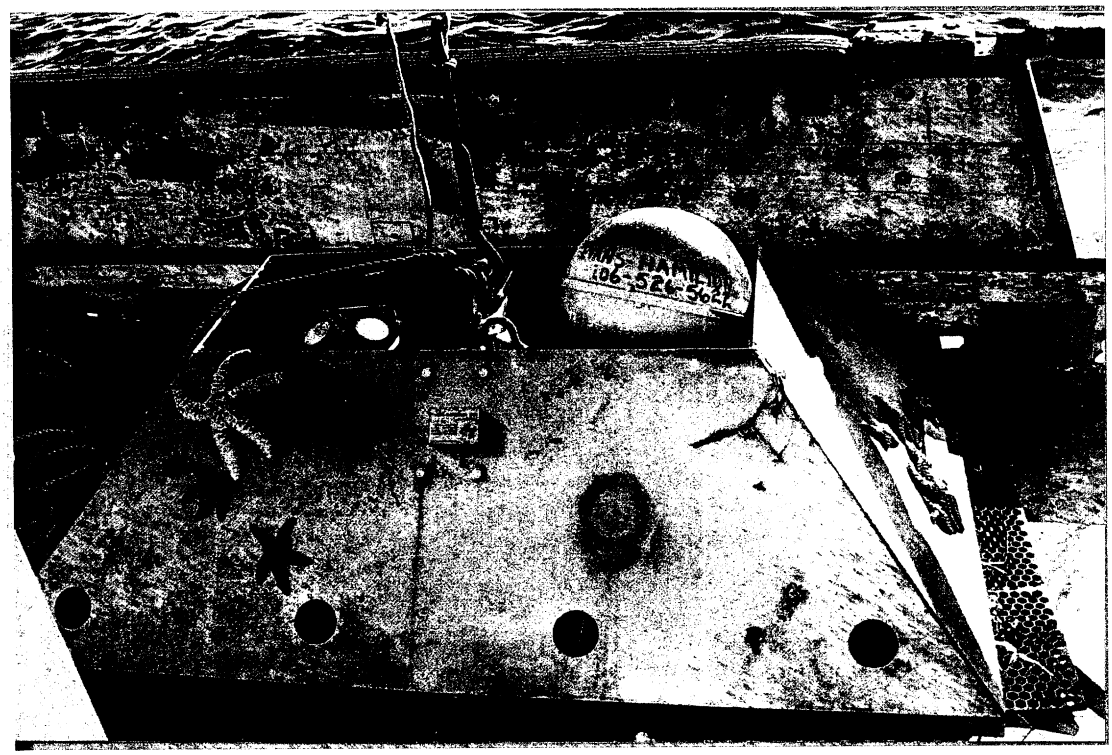
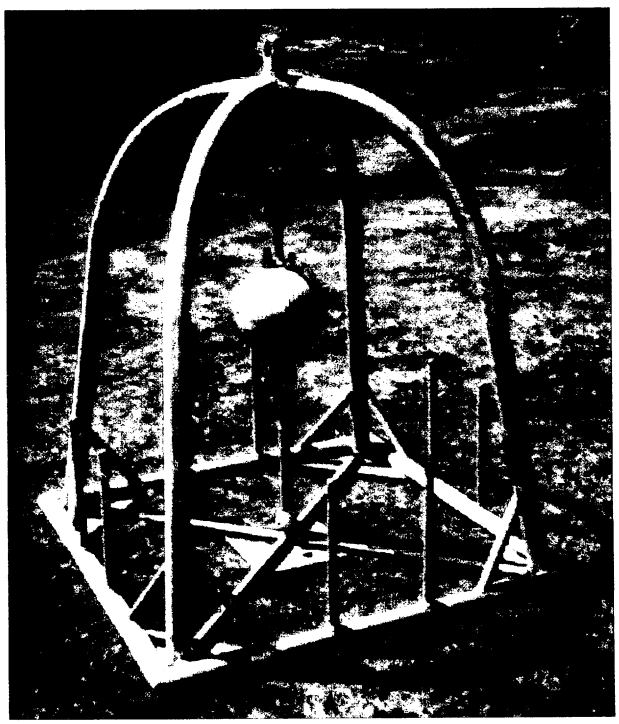
APPENDIX 1

INSTRUMENT AND BOTTOM MOUNT PHOTOGRAPHS

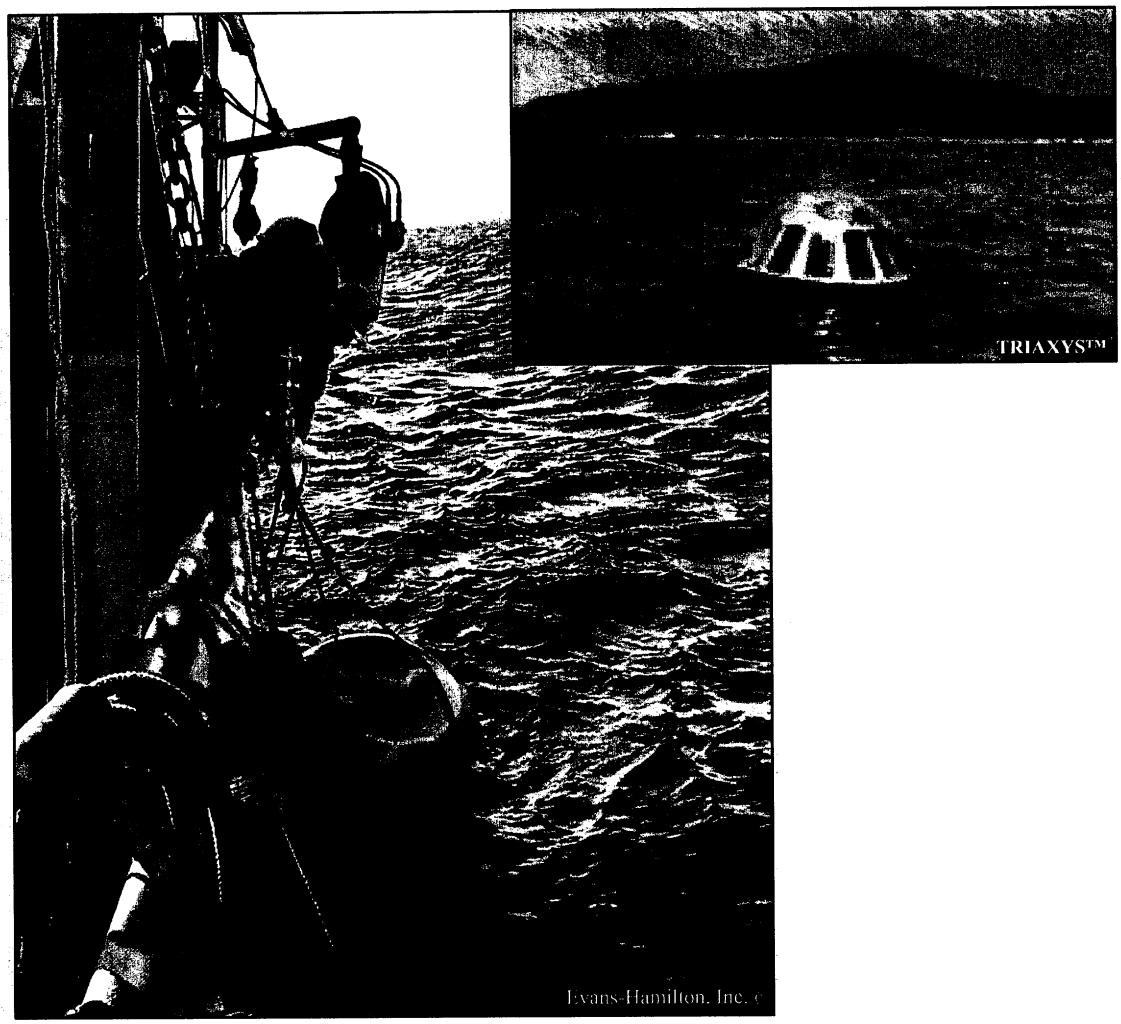
Appendix 1.1. SonTek 500 kHz ADP profiling current meter mounted in an upward-looking, anti-trawl, low relief bottom mount.



Appendix 1.2. InterOcean S4 current meter mounted at approximately 1 m above the bottom.



Appendix 1.3. AXYS TEchnologies Inc. (ATI) TRIAXYS™ Directional Wave Buoy.

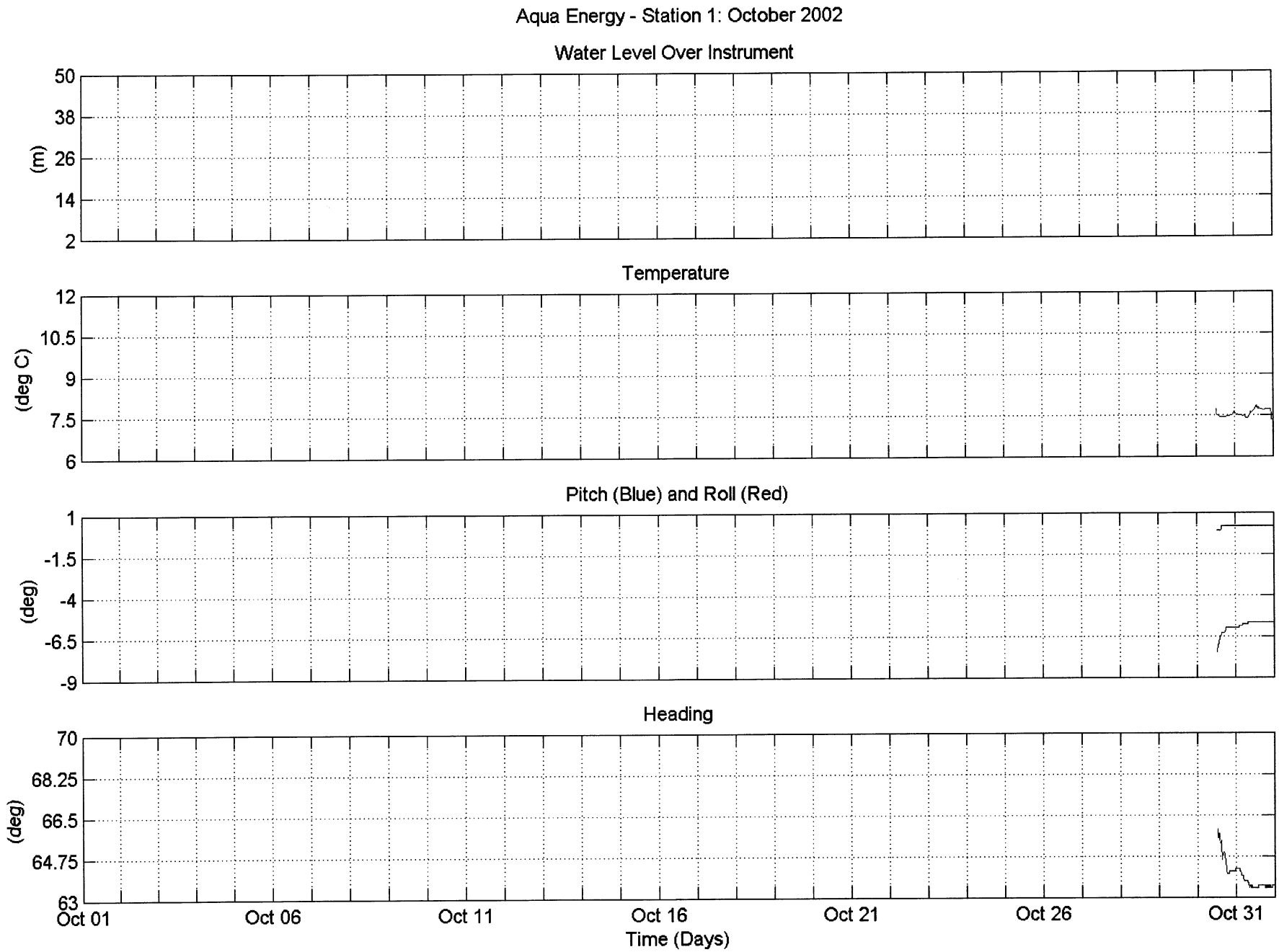


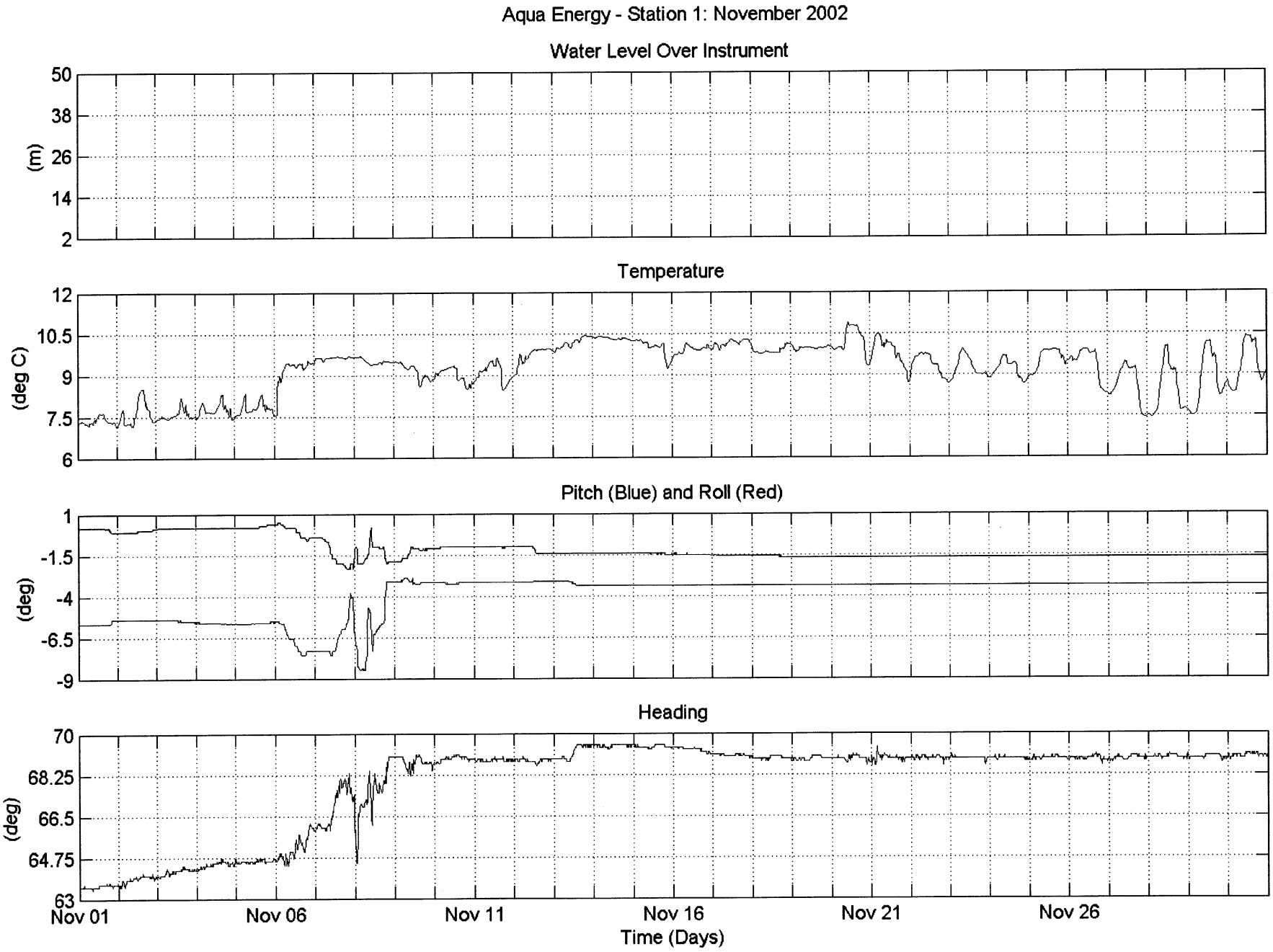
APPENDIX 2

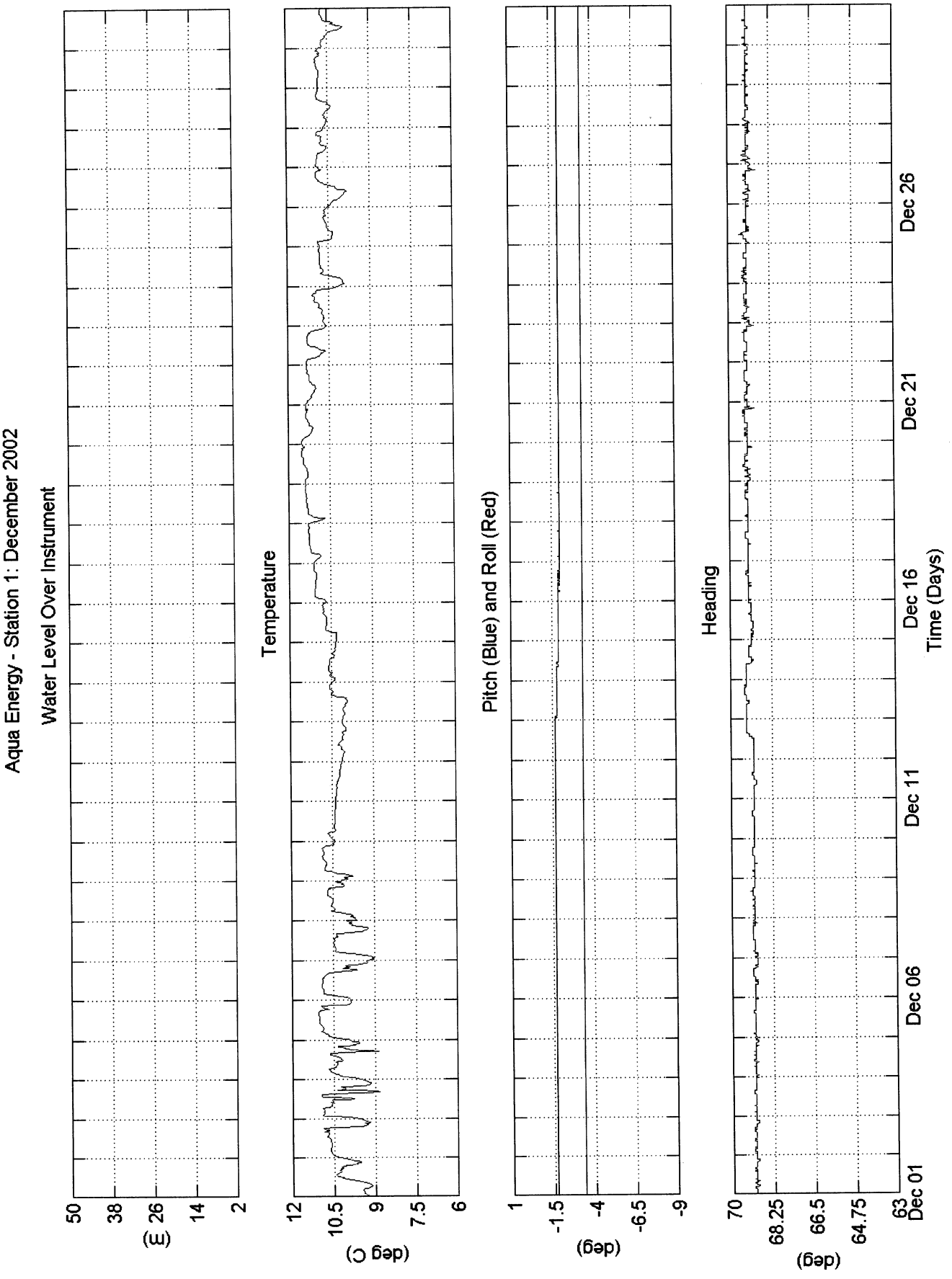
CURRENT MEASUREMENTS QA/QC PLOTS

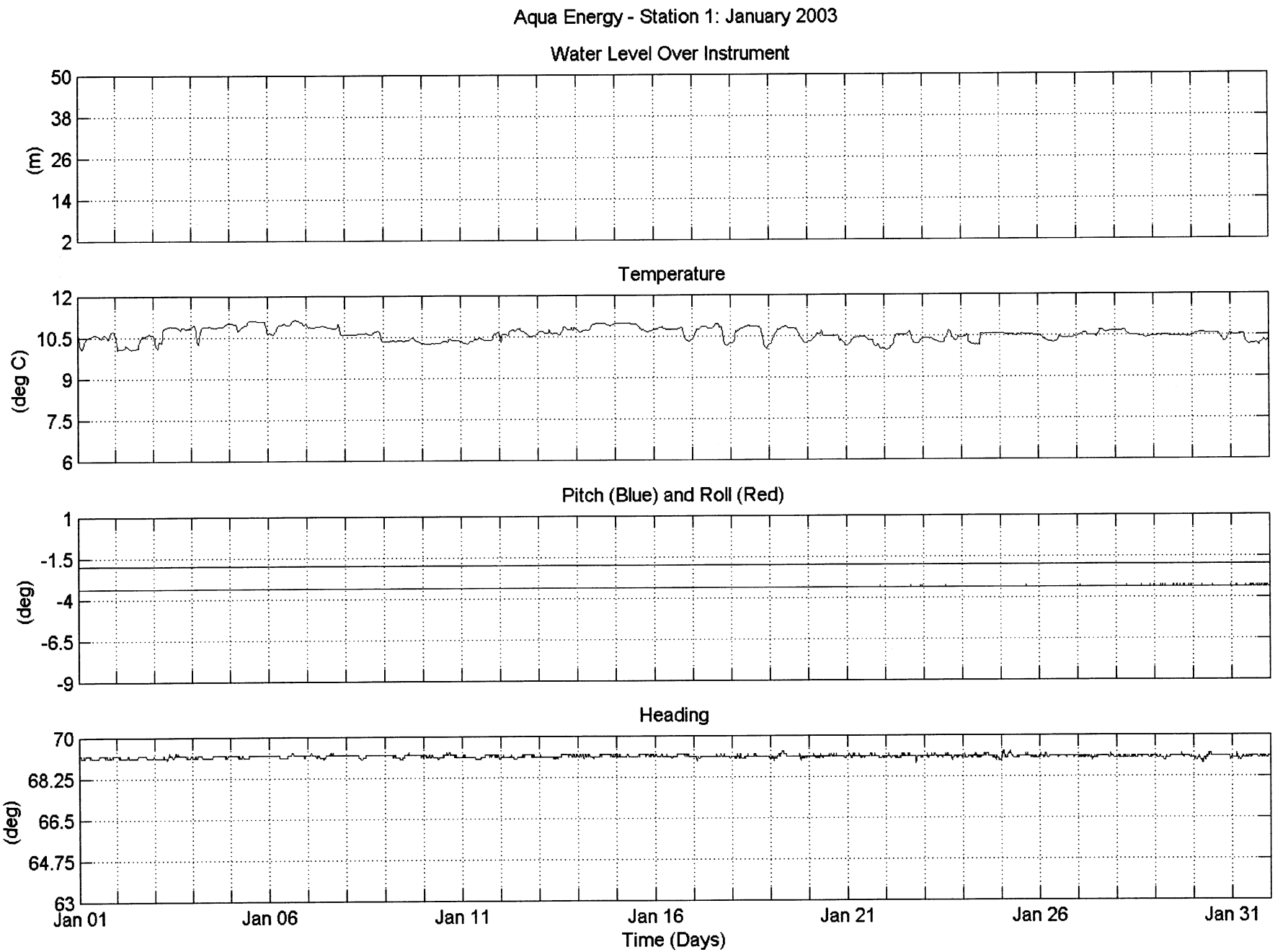
APPENDIX 2.1

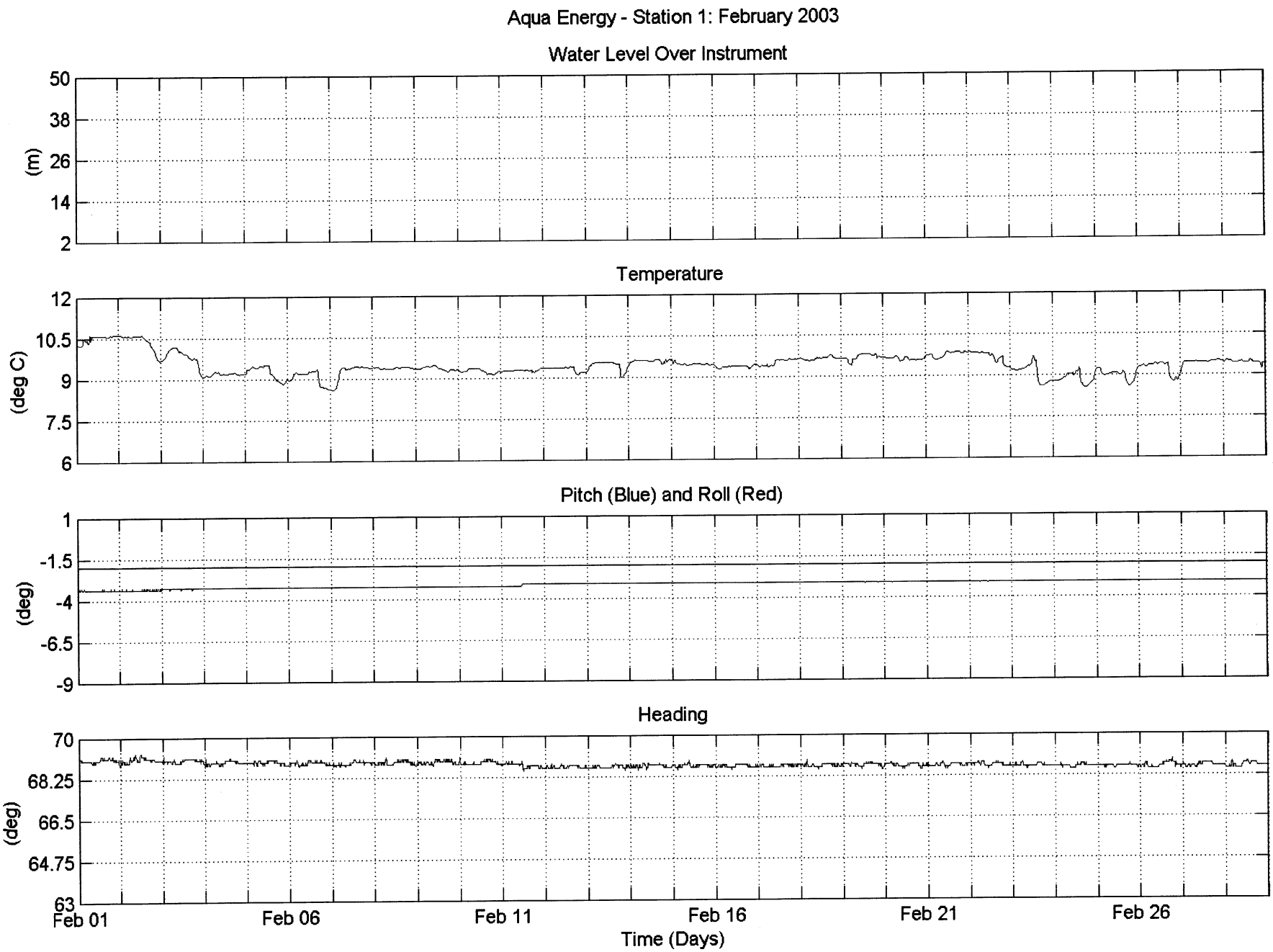
Current meter pitch, roll, compass heading, and temperature data

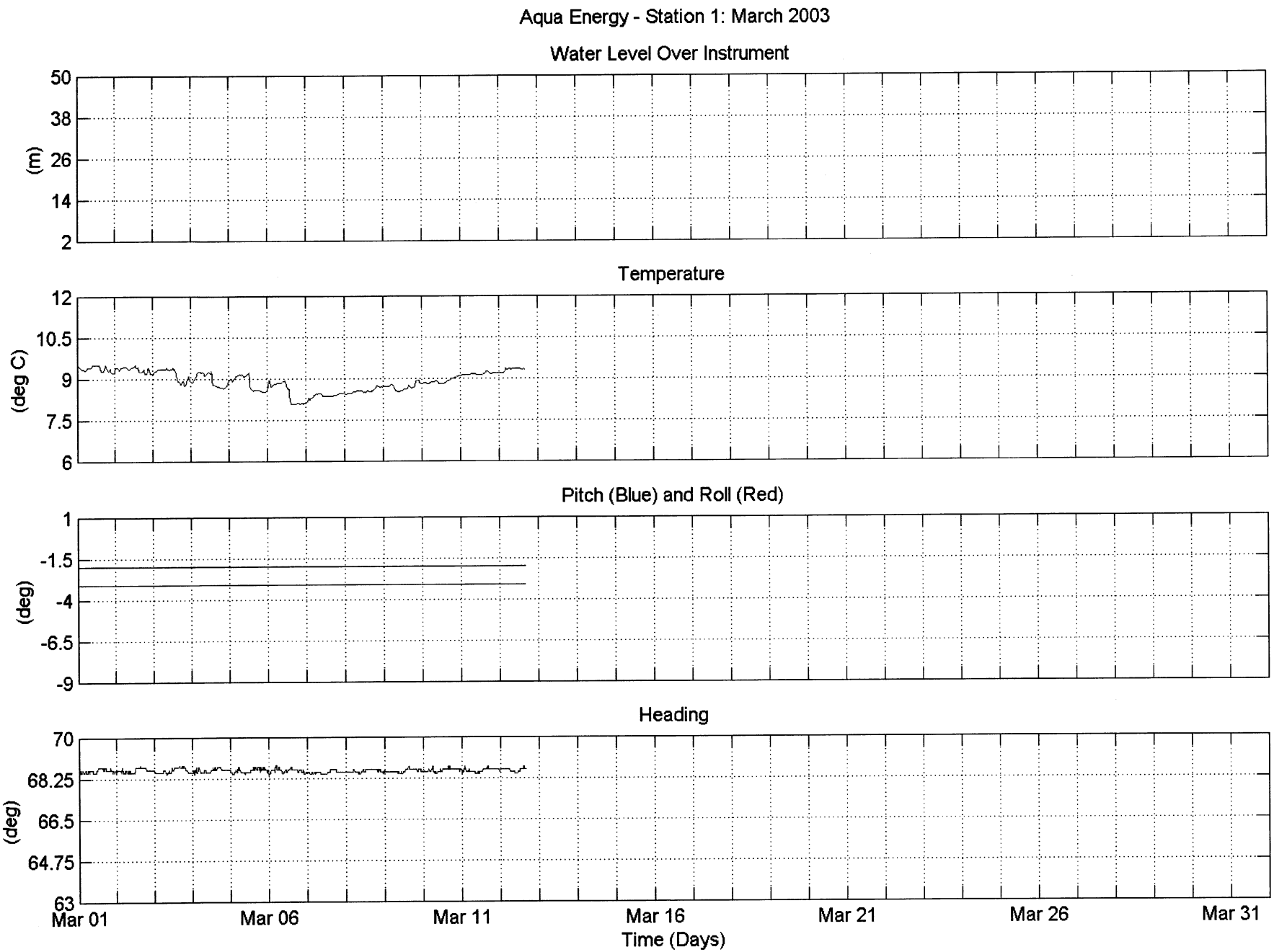






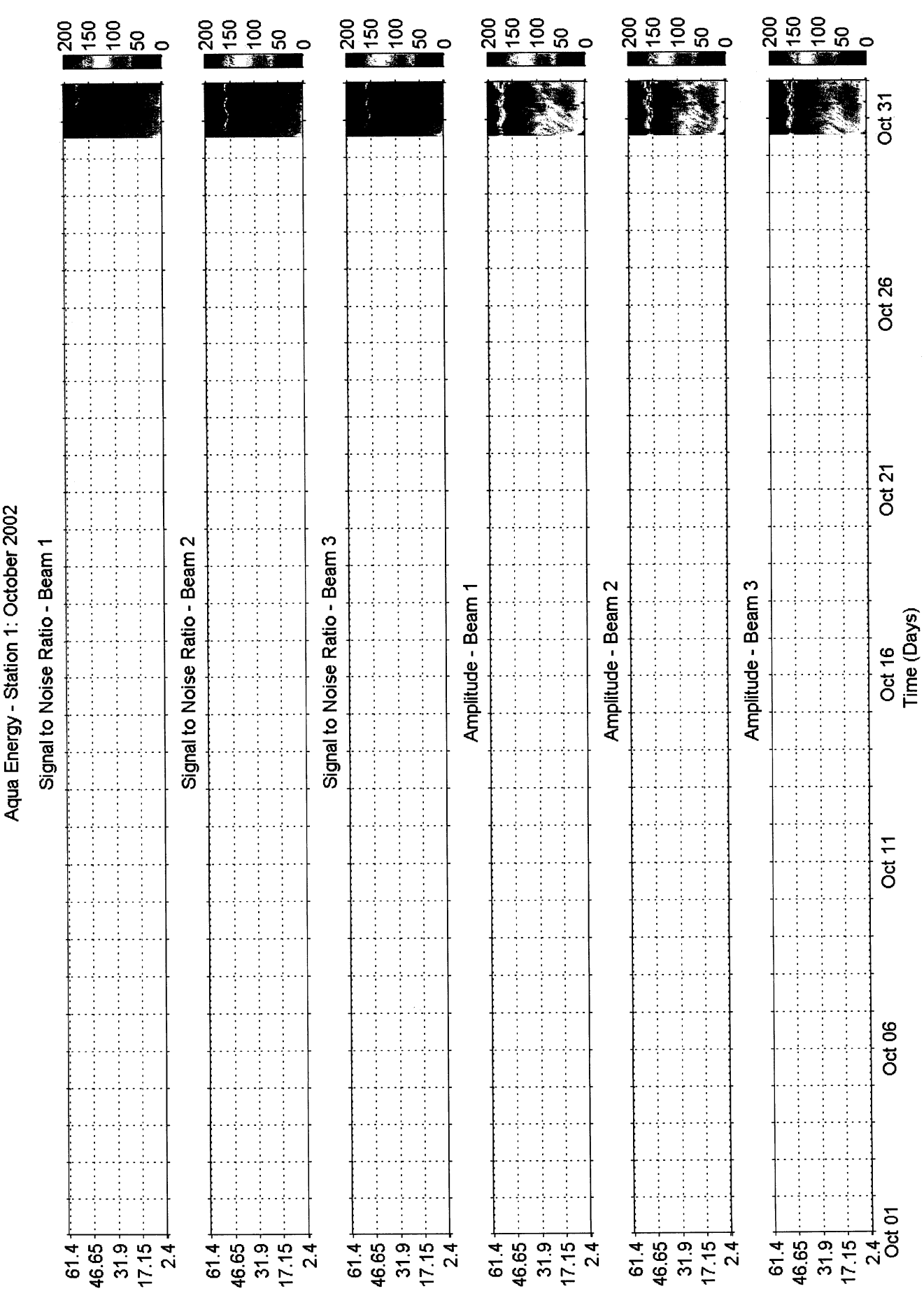


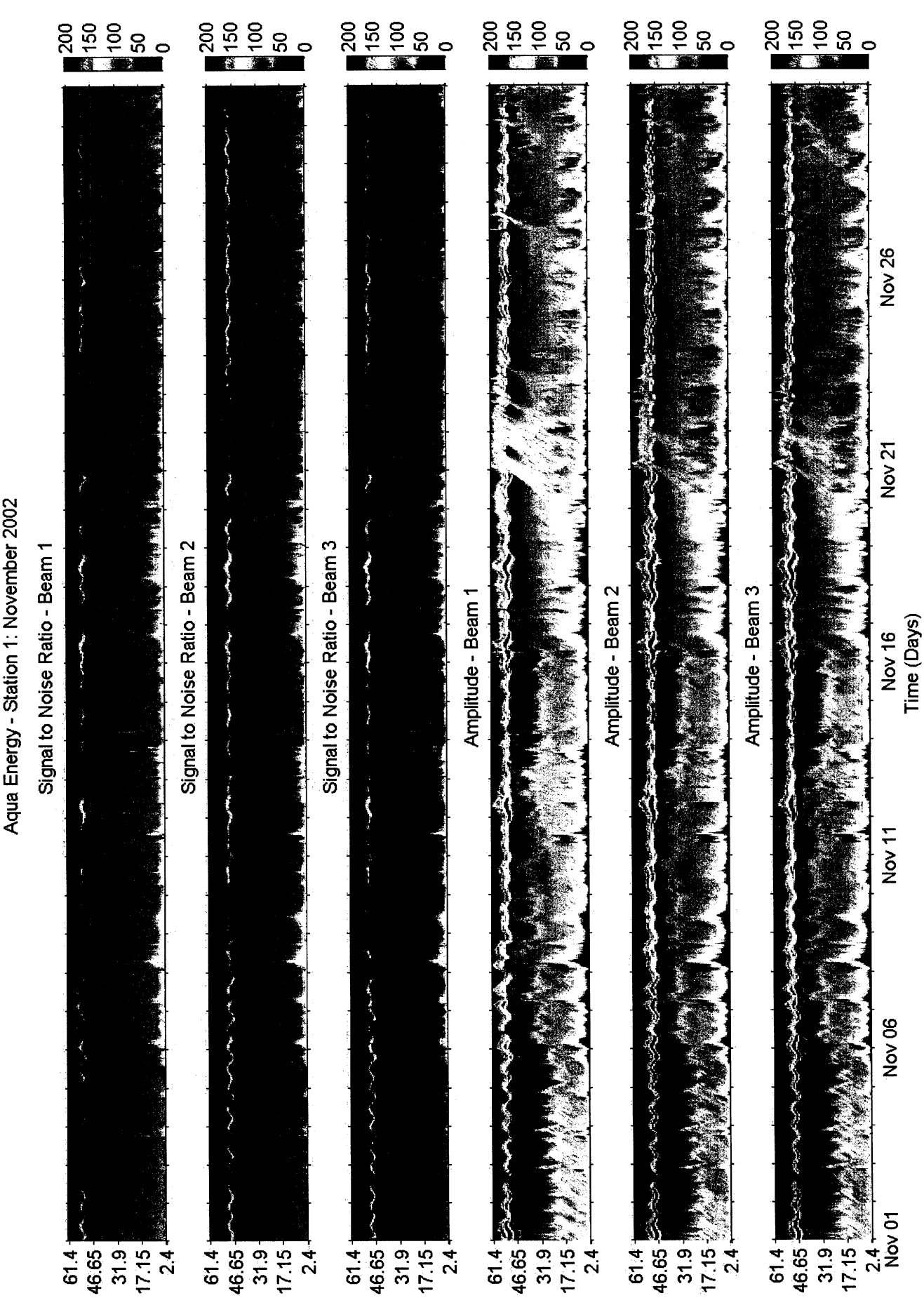


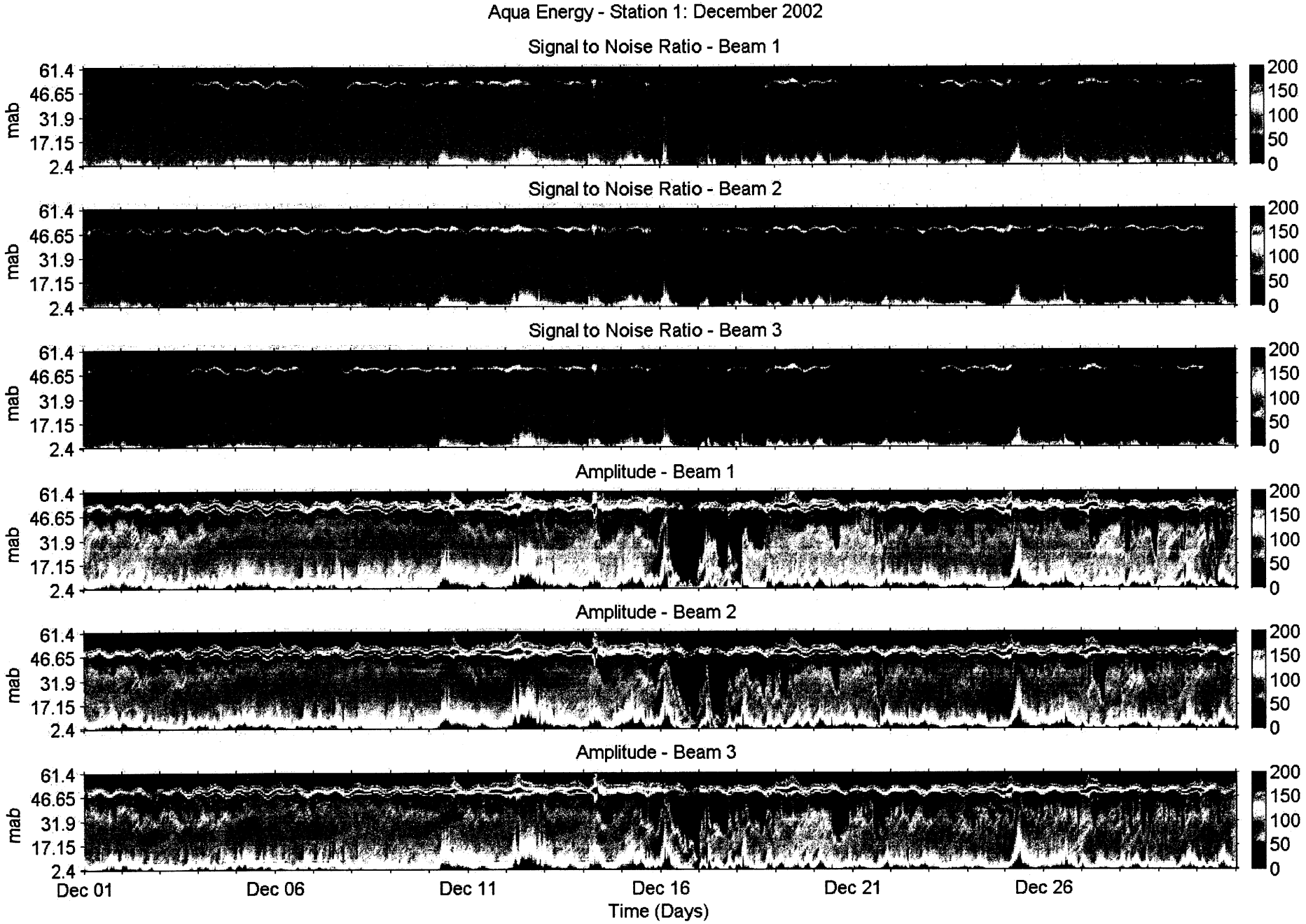


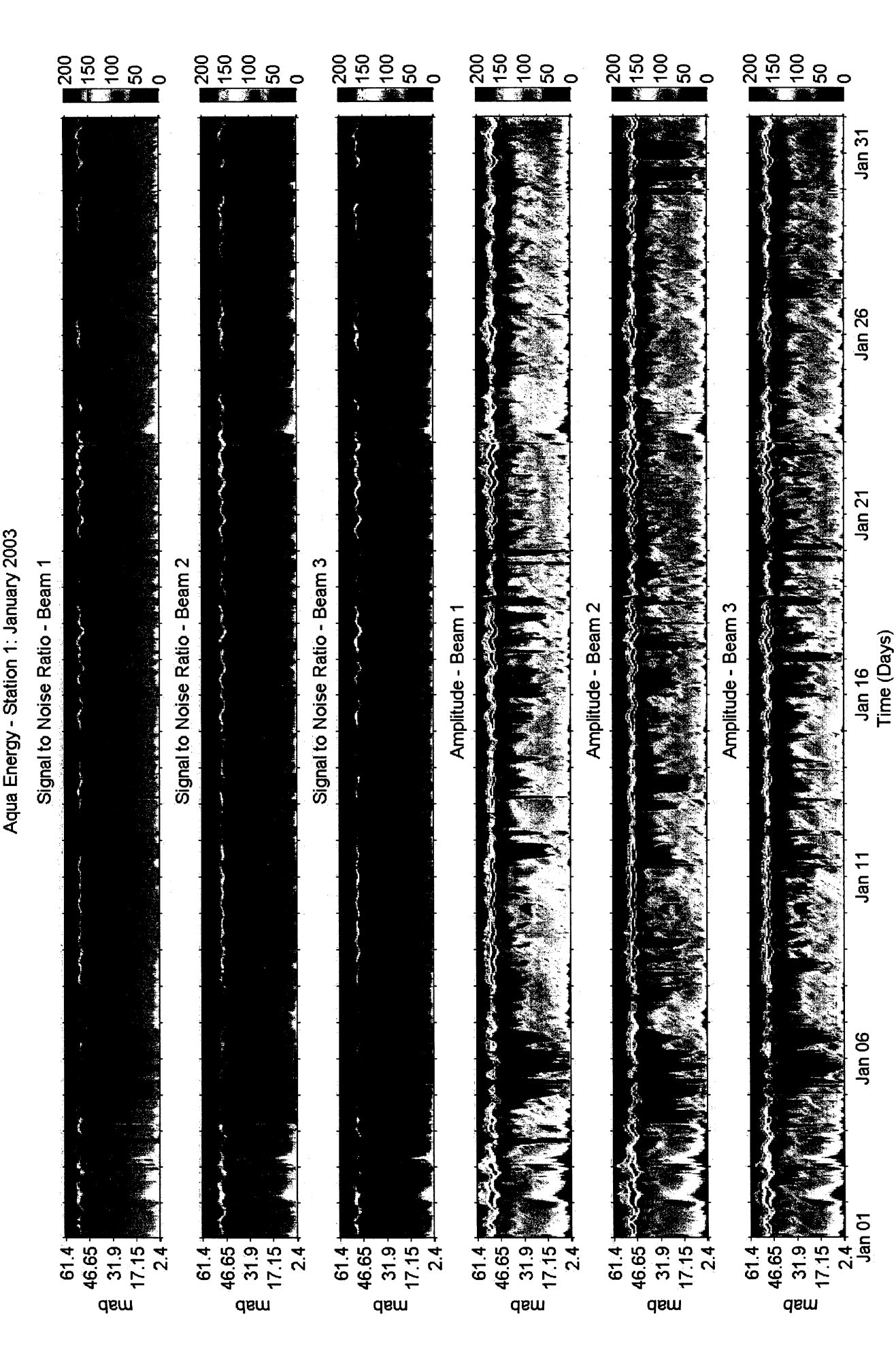
APPENDIX 2.2

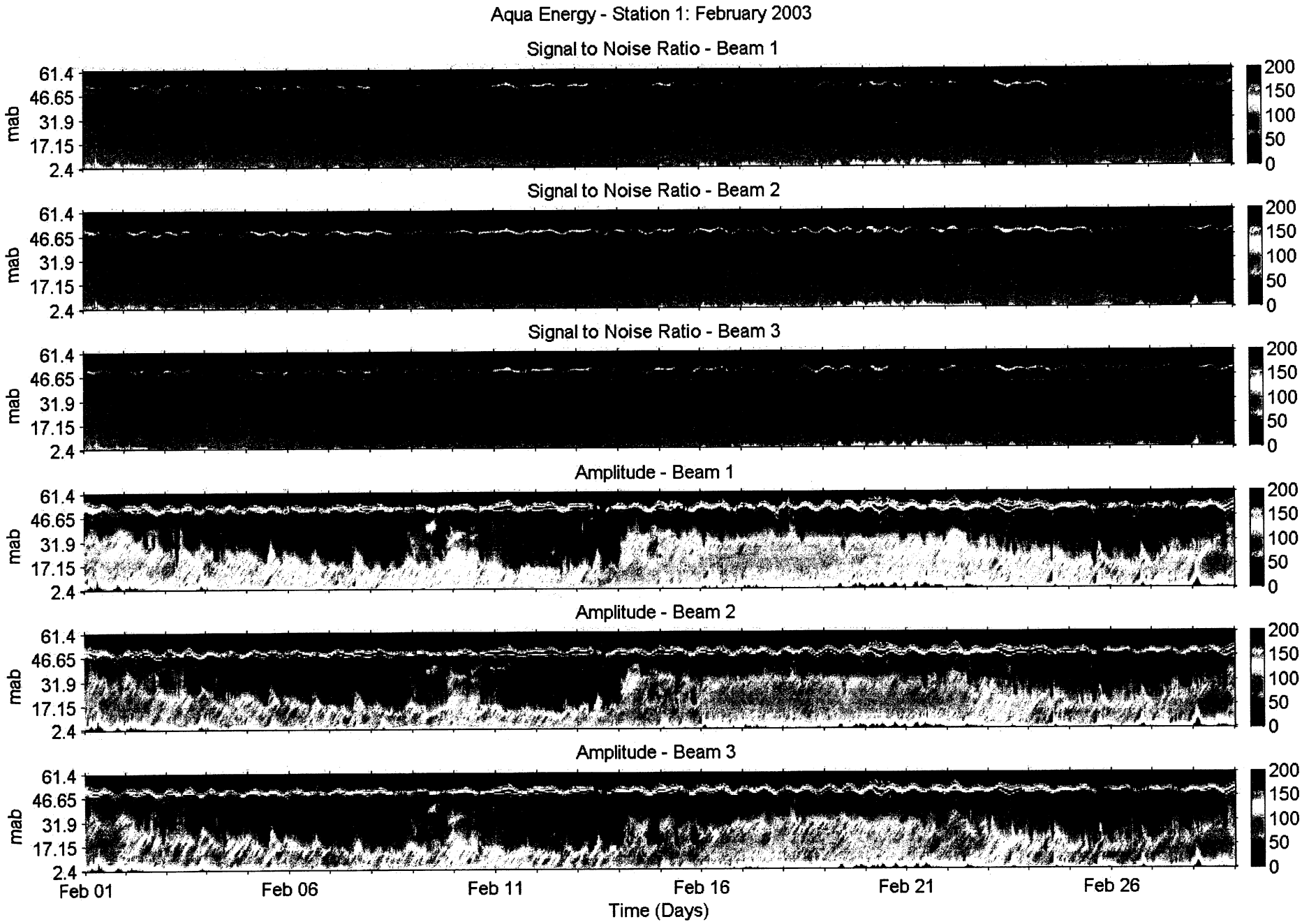
Current meter signal to noise ratio, and return signal amplitudes

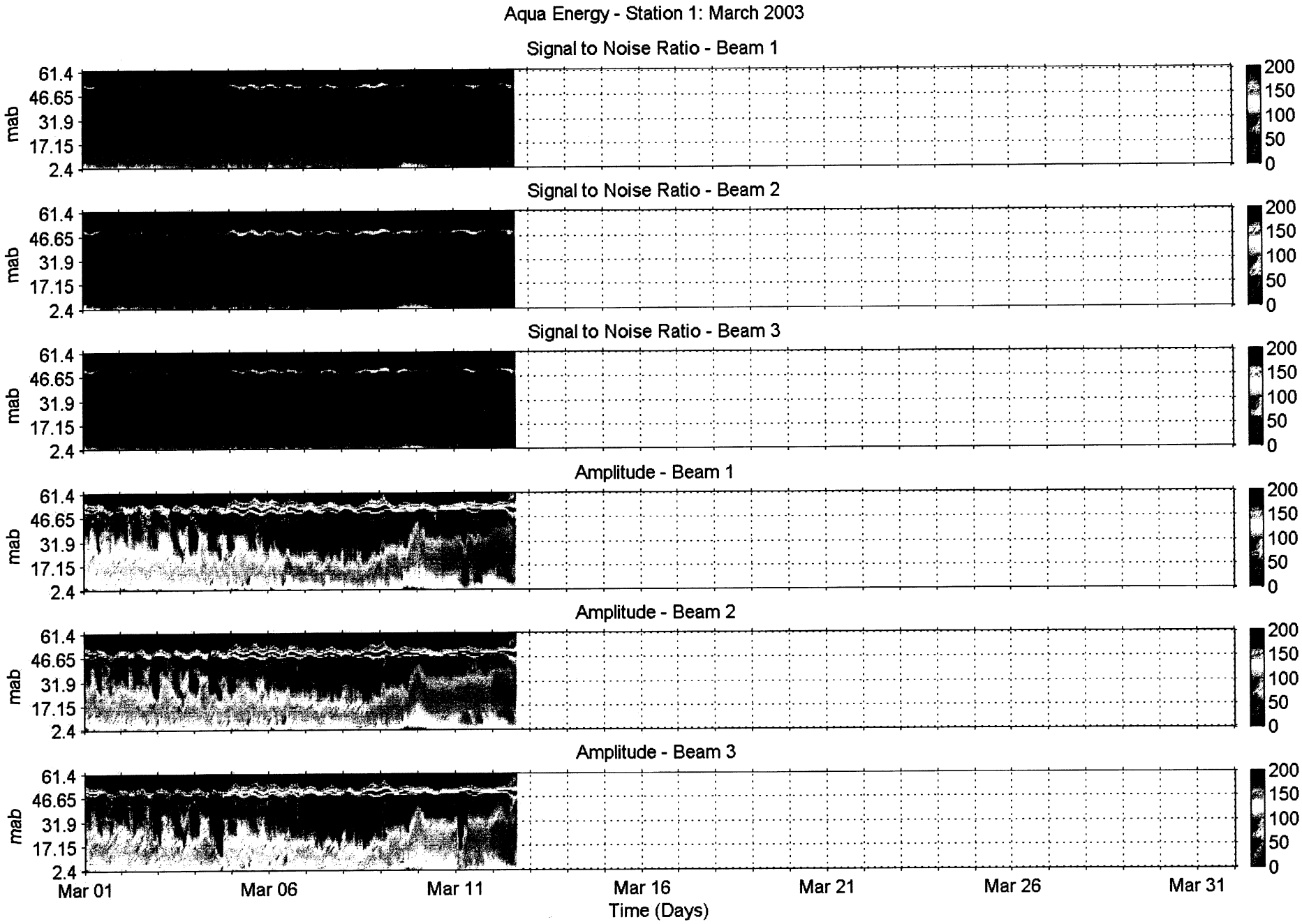






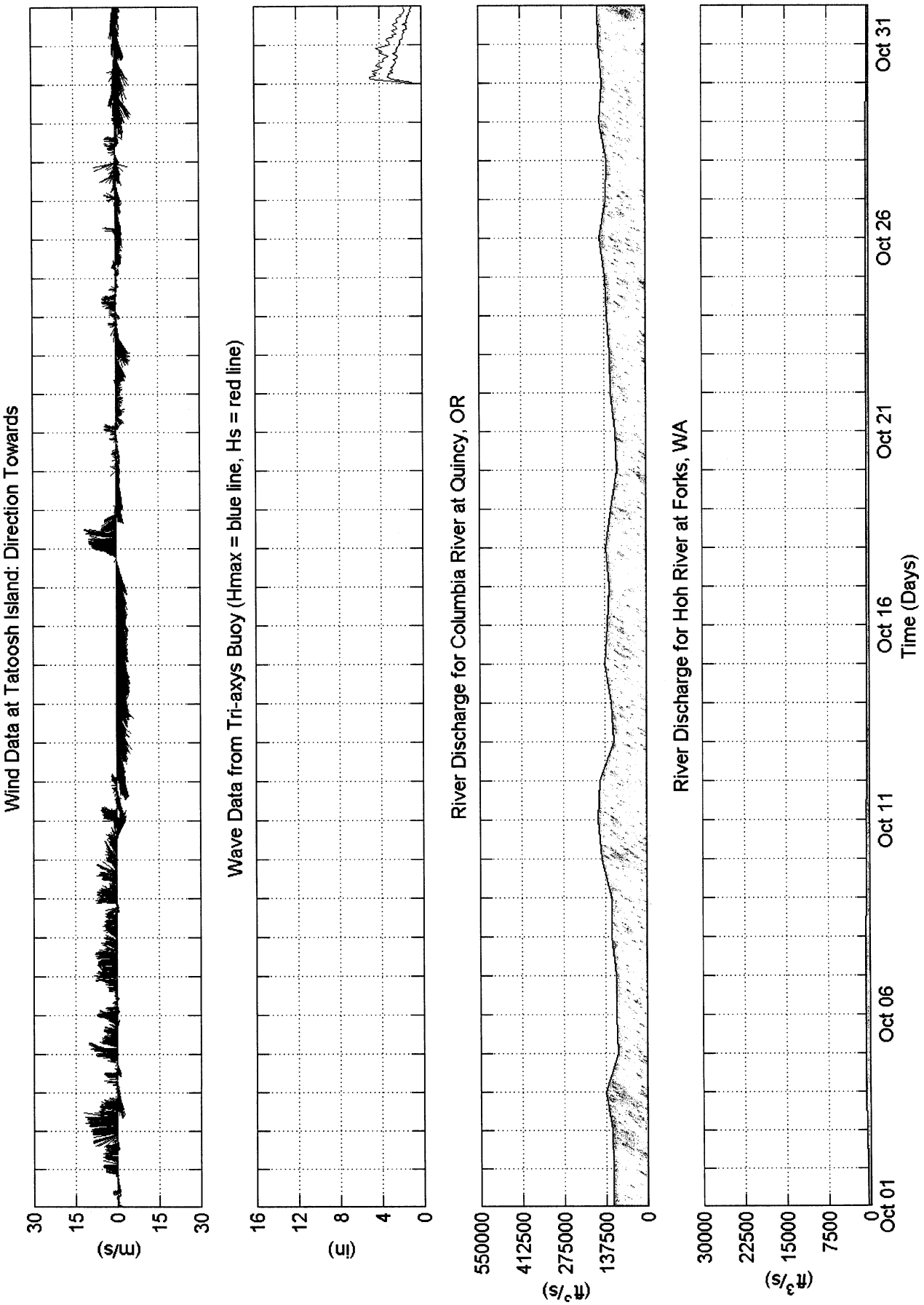




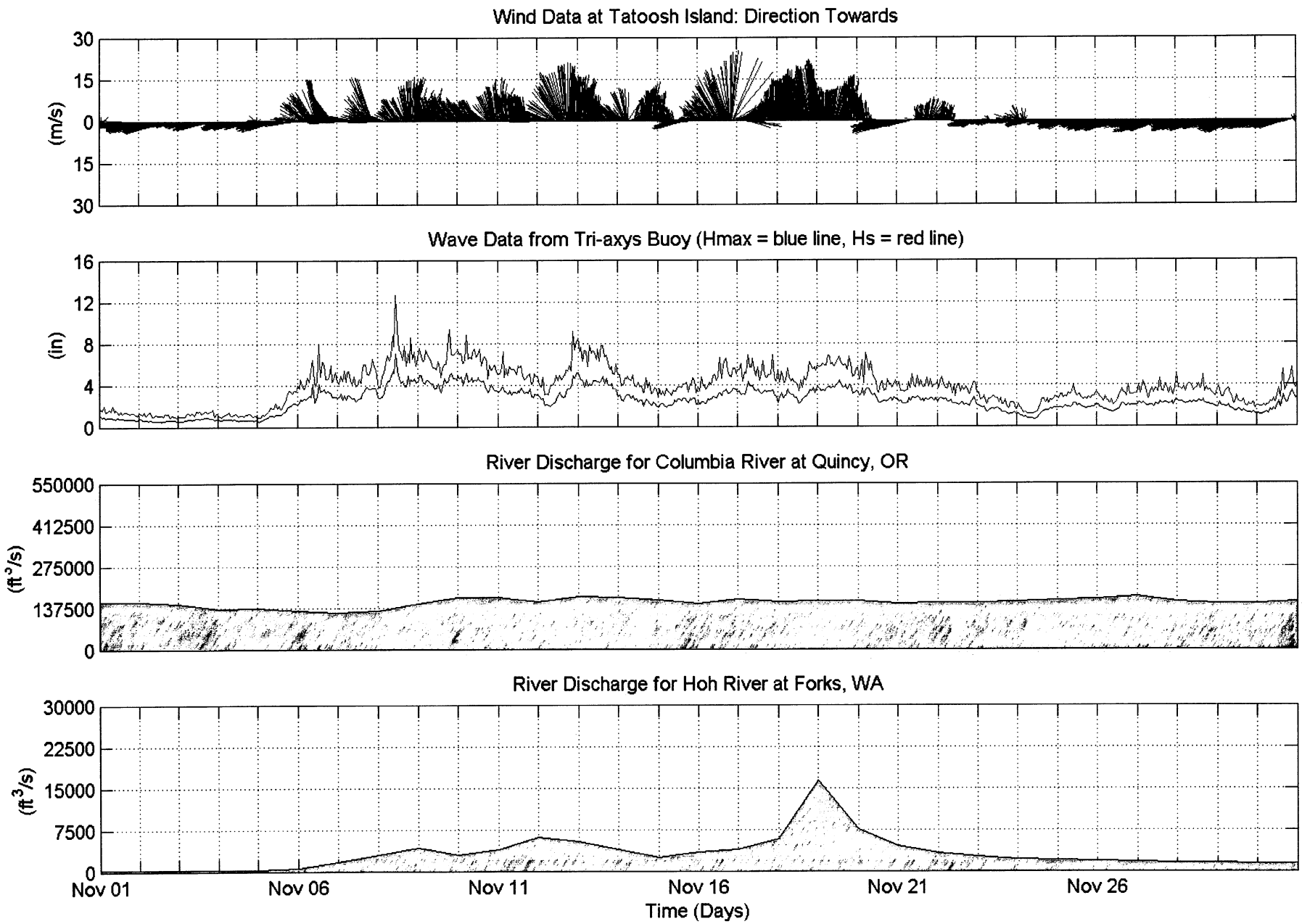


APPENDIX 3

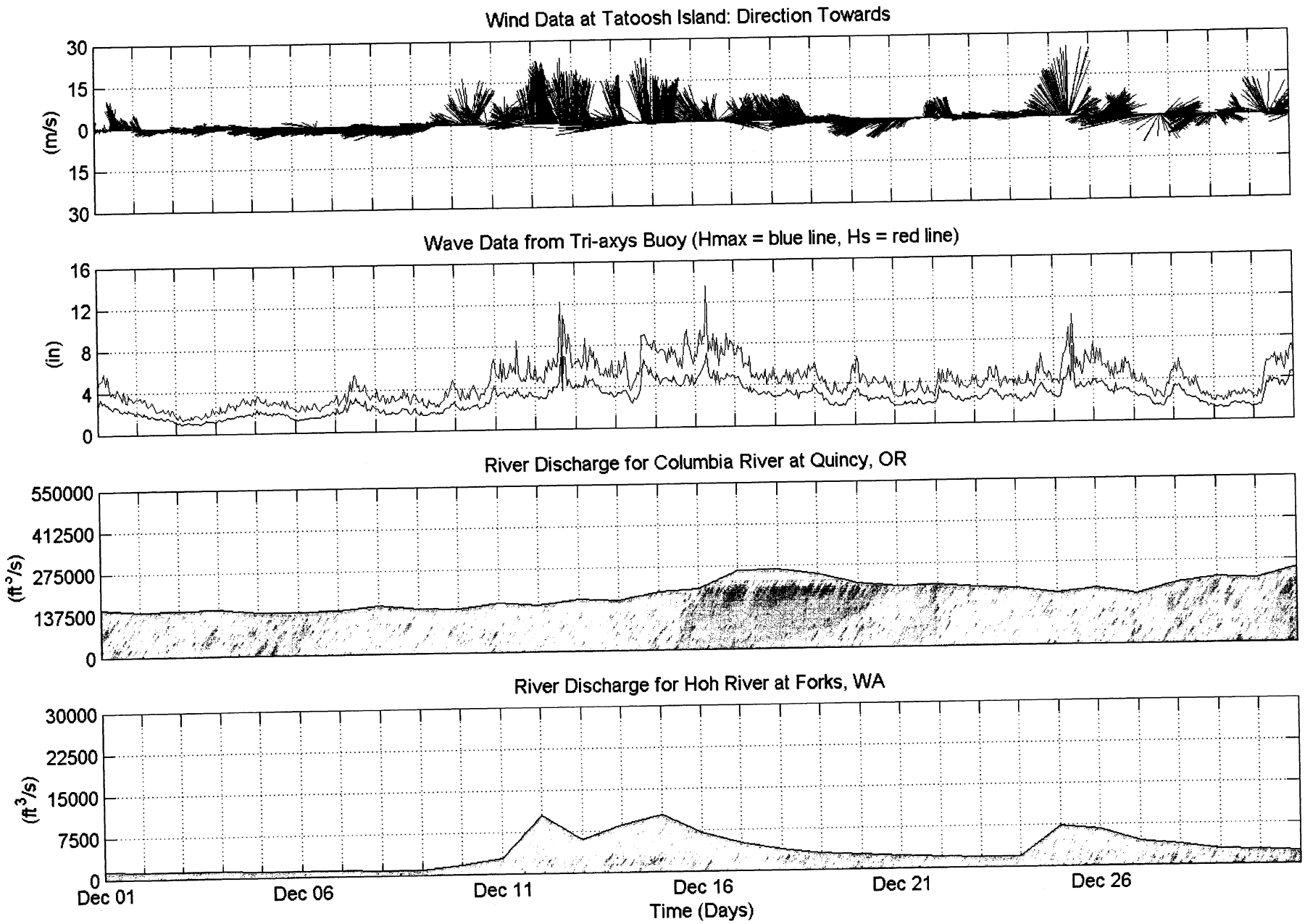
Coastal wind, wave, and river discharge during measurement period



Aqua Energy - Station 1: November 2002



Aqua Energy - Station 1: December 2002



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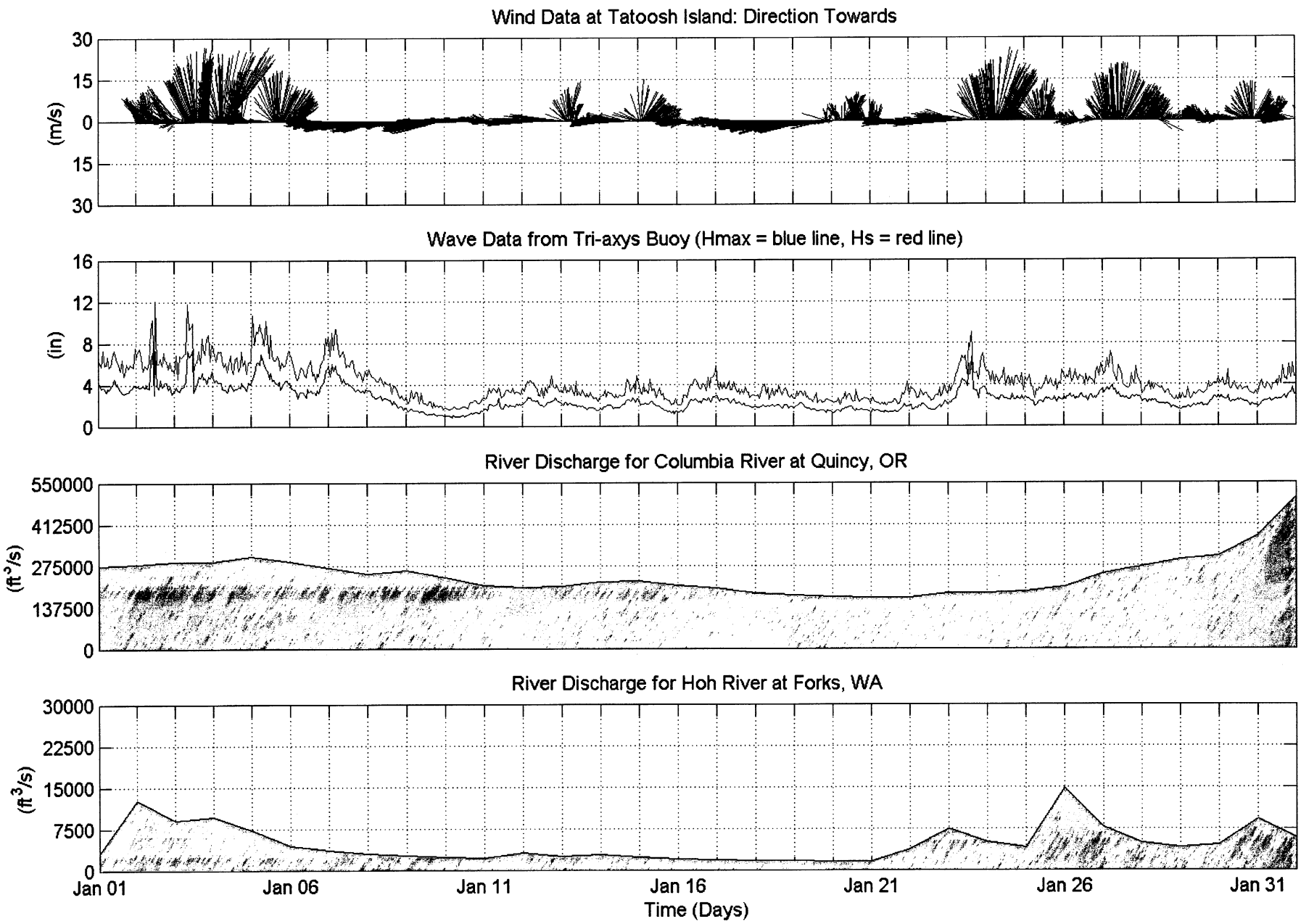

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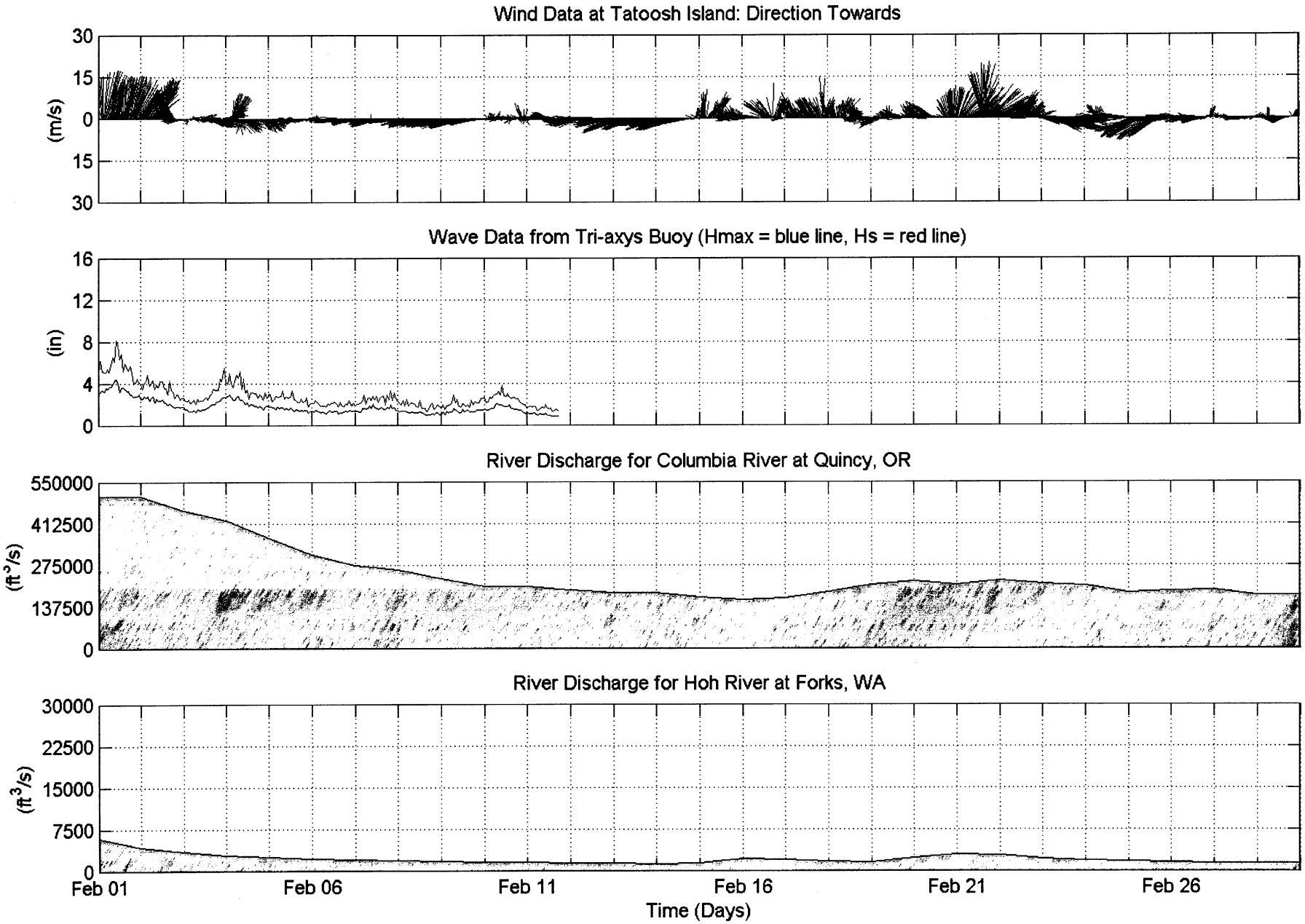
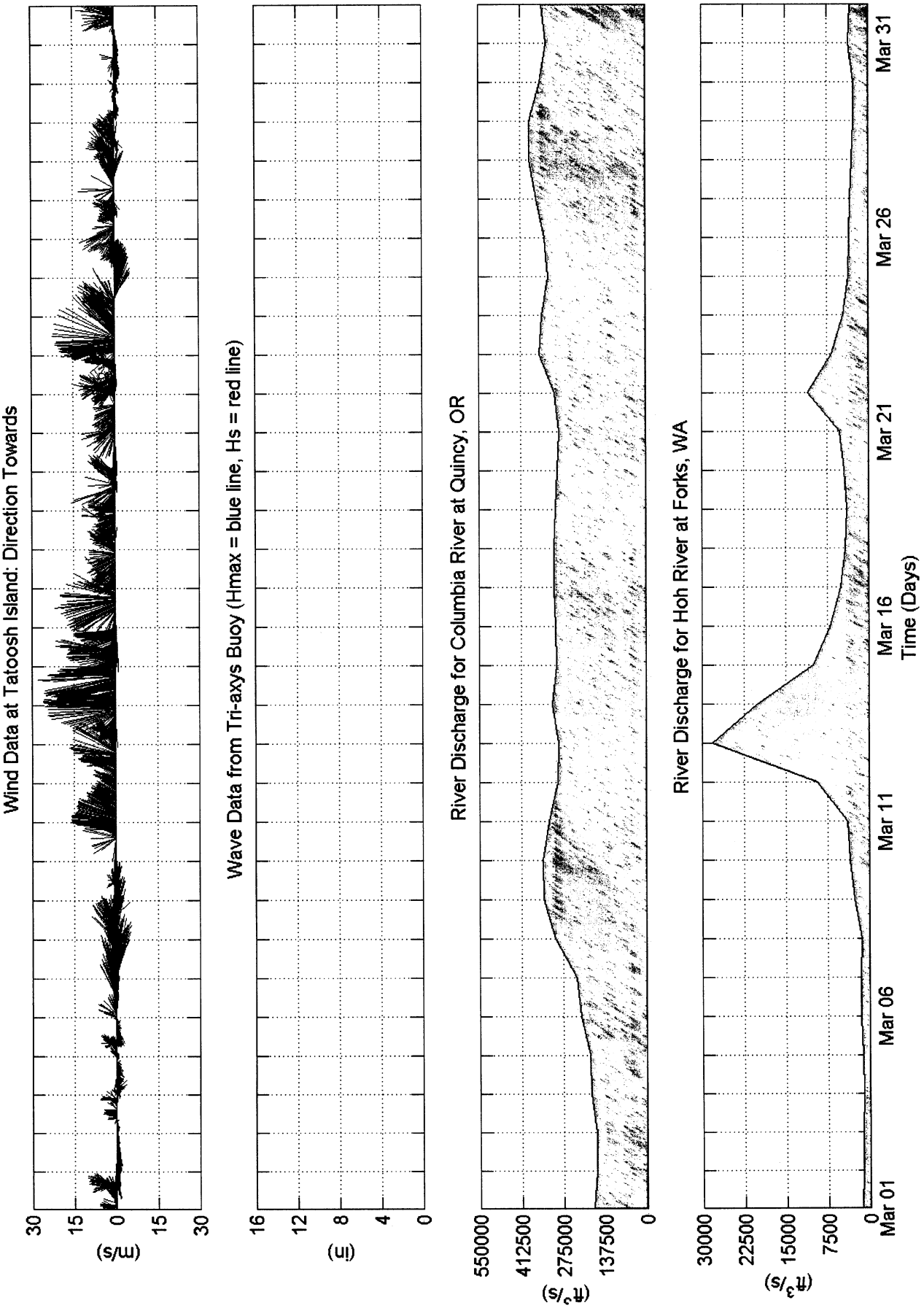
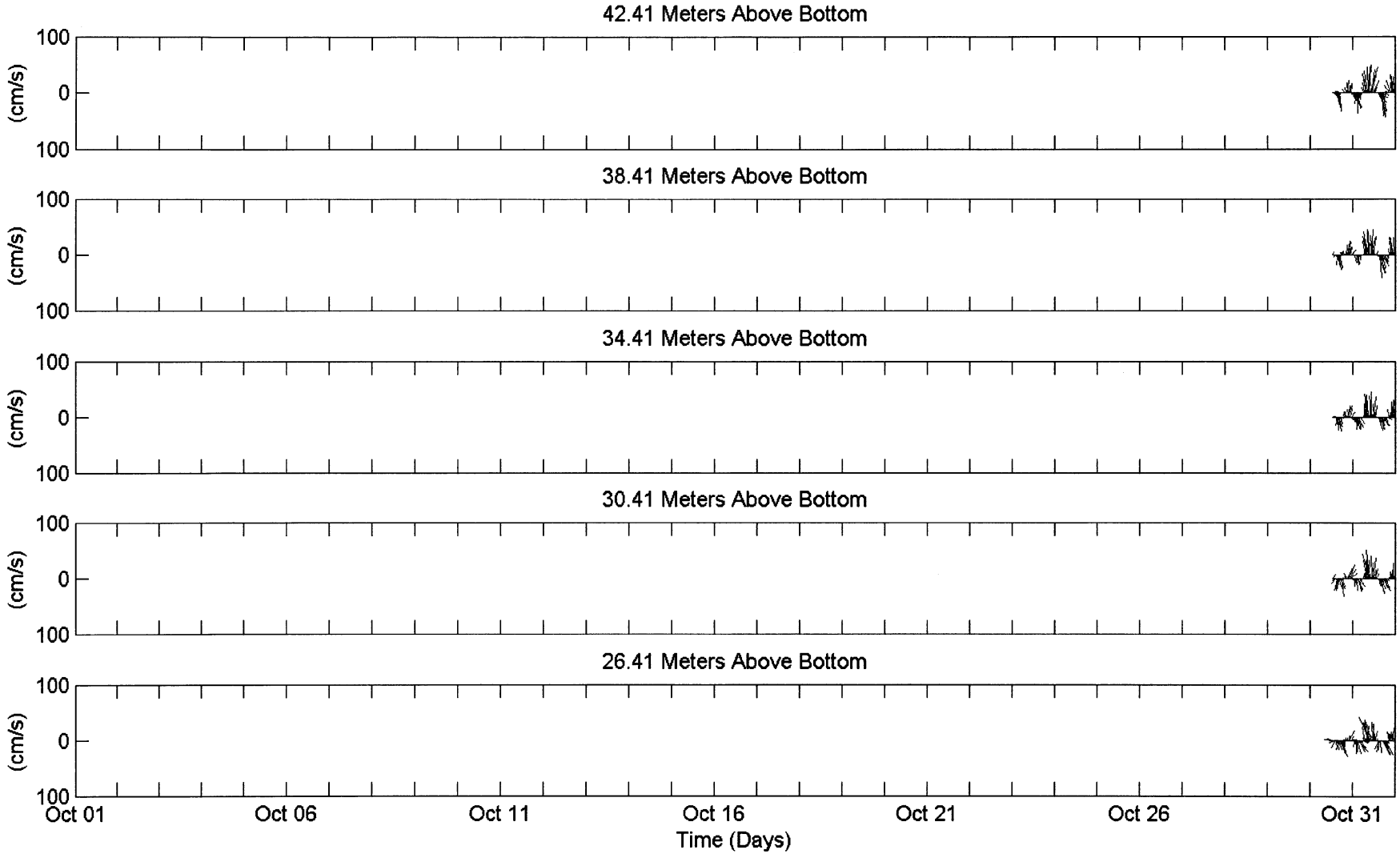


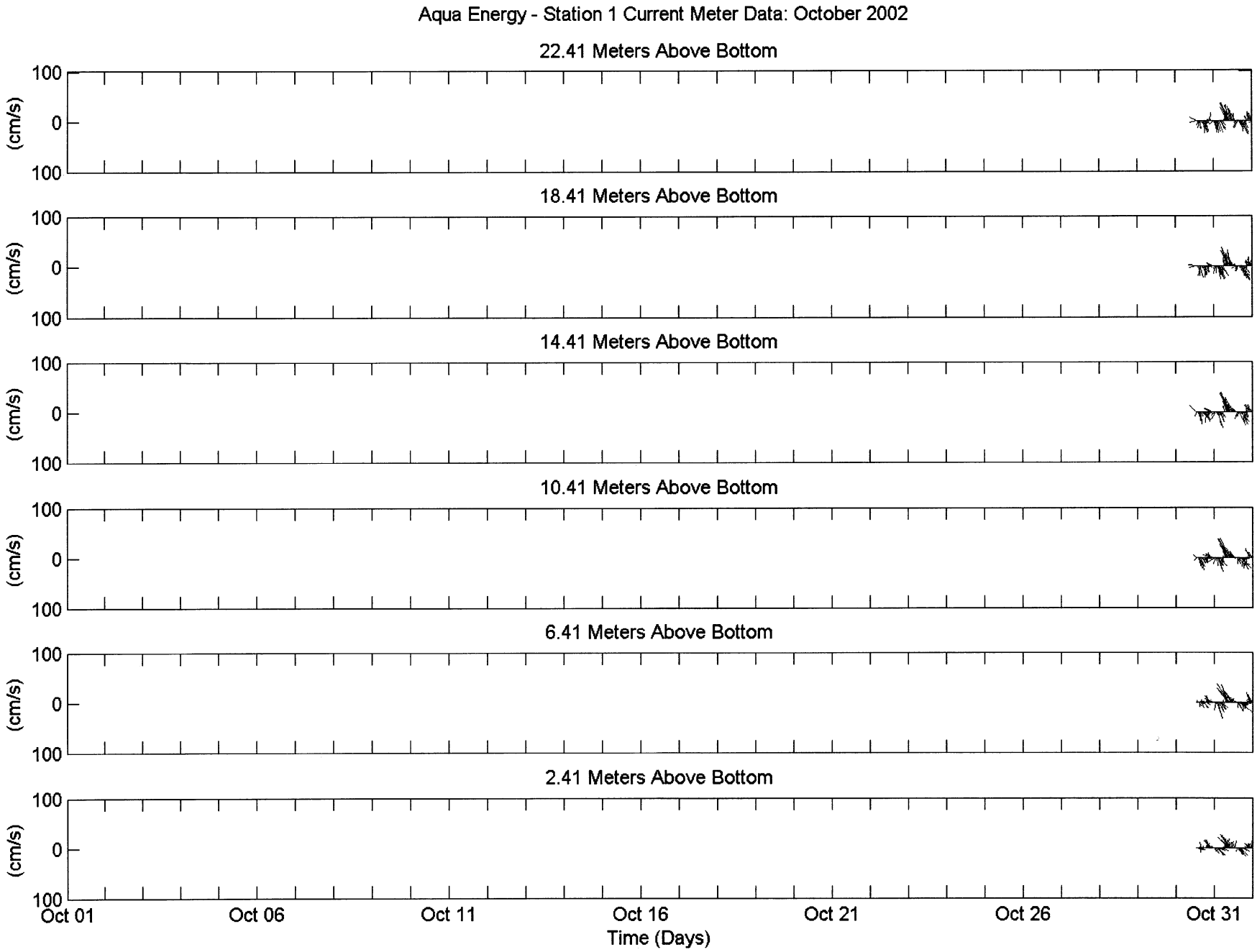


APPENDIX 4

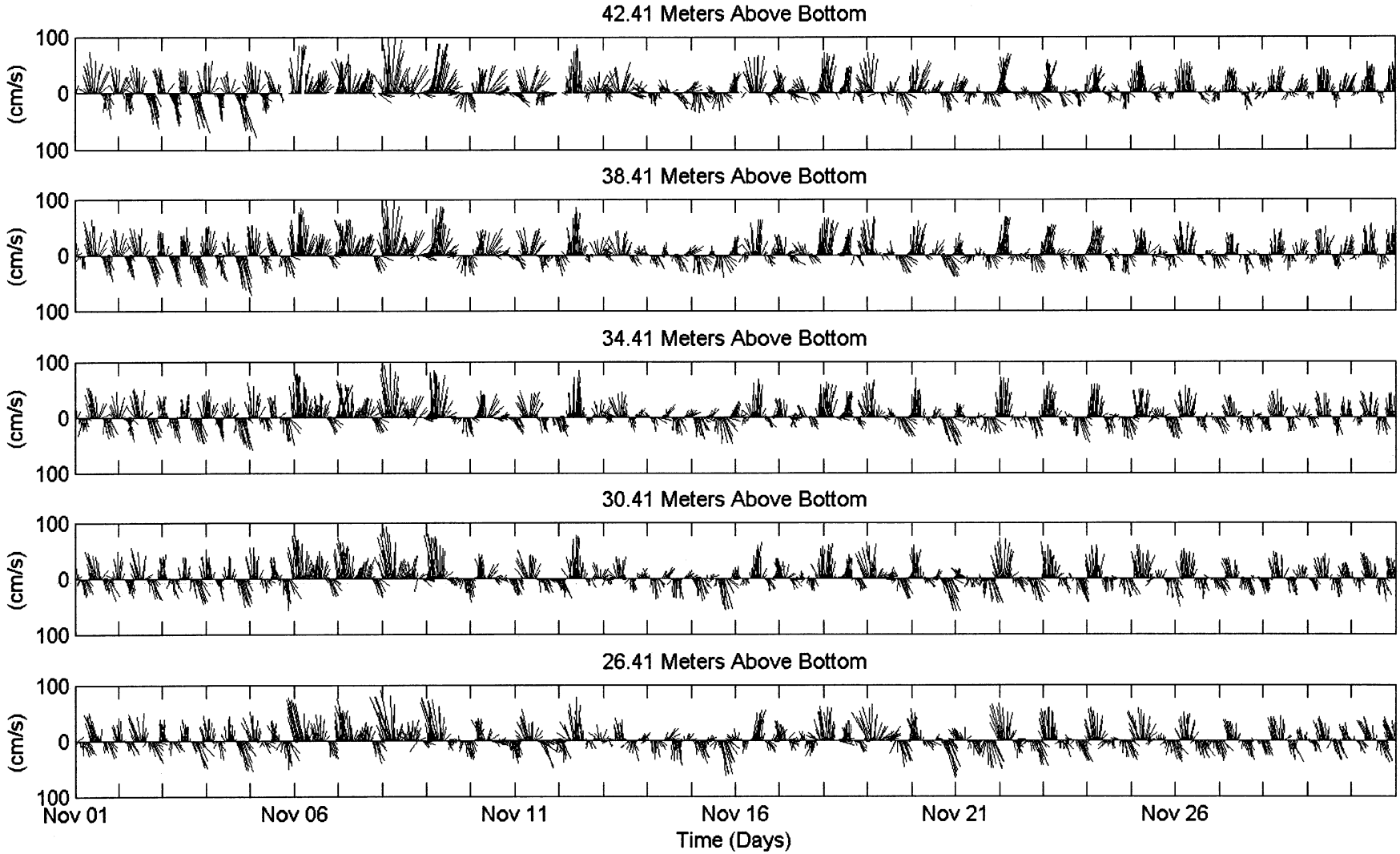
Vector plots of current at selected depths

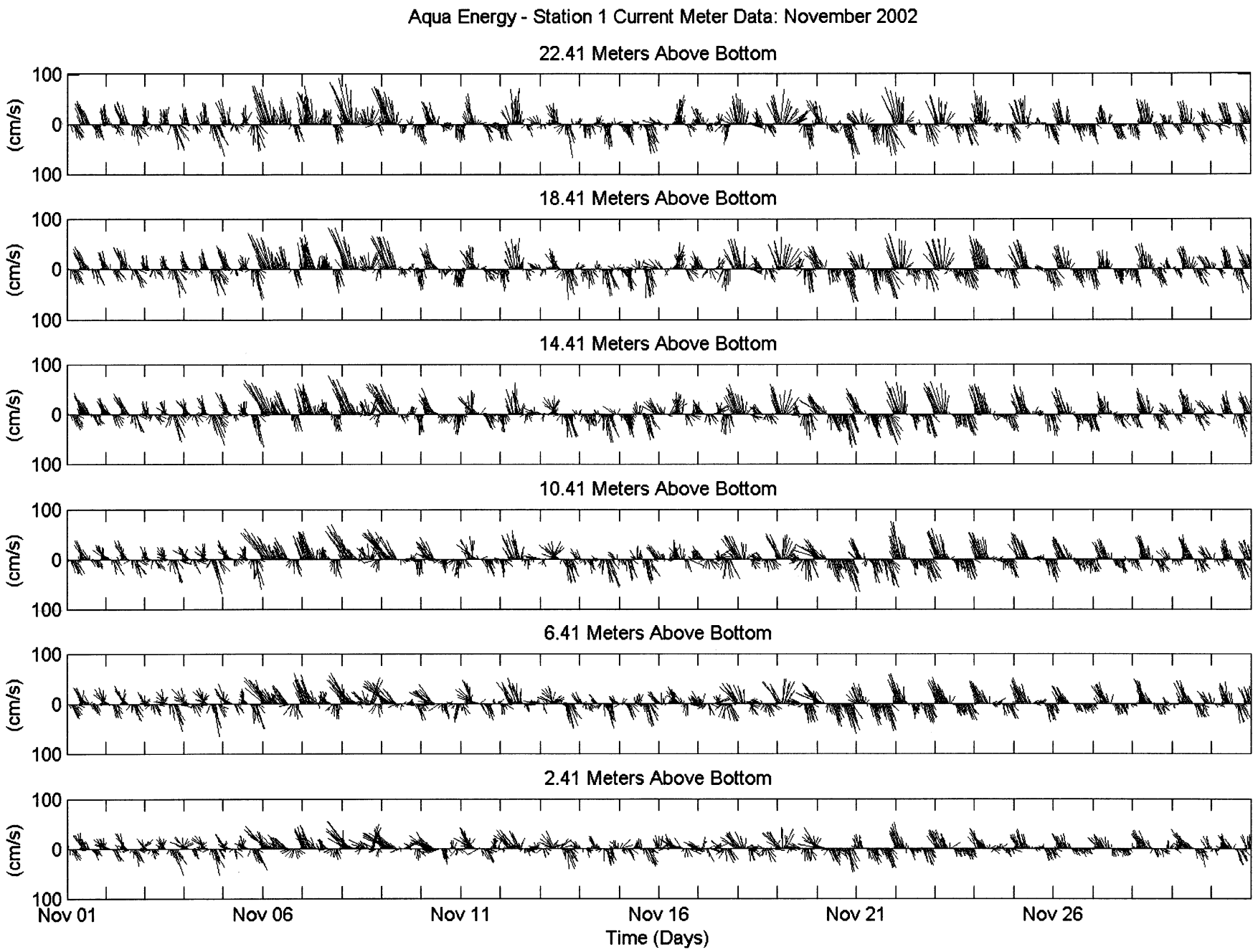
Aqua Energy - Station 1 Current Meter Data: October 2002





Aqua Energy - Station 1 Current Meter Data: November 2002





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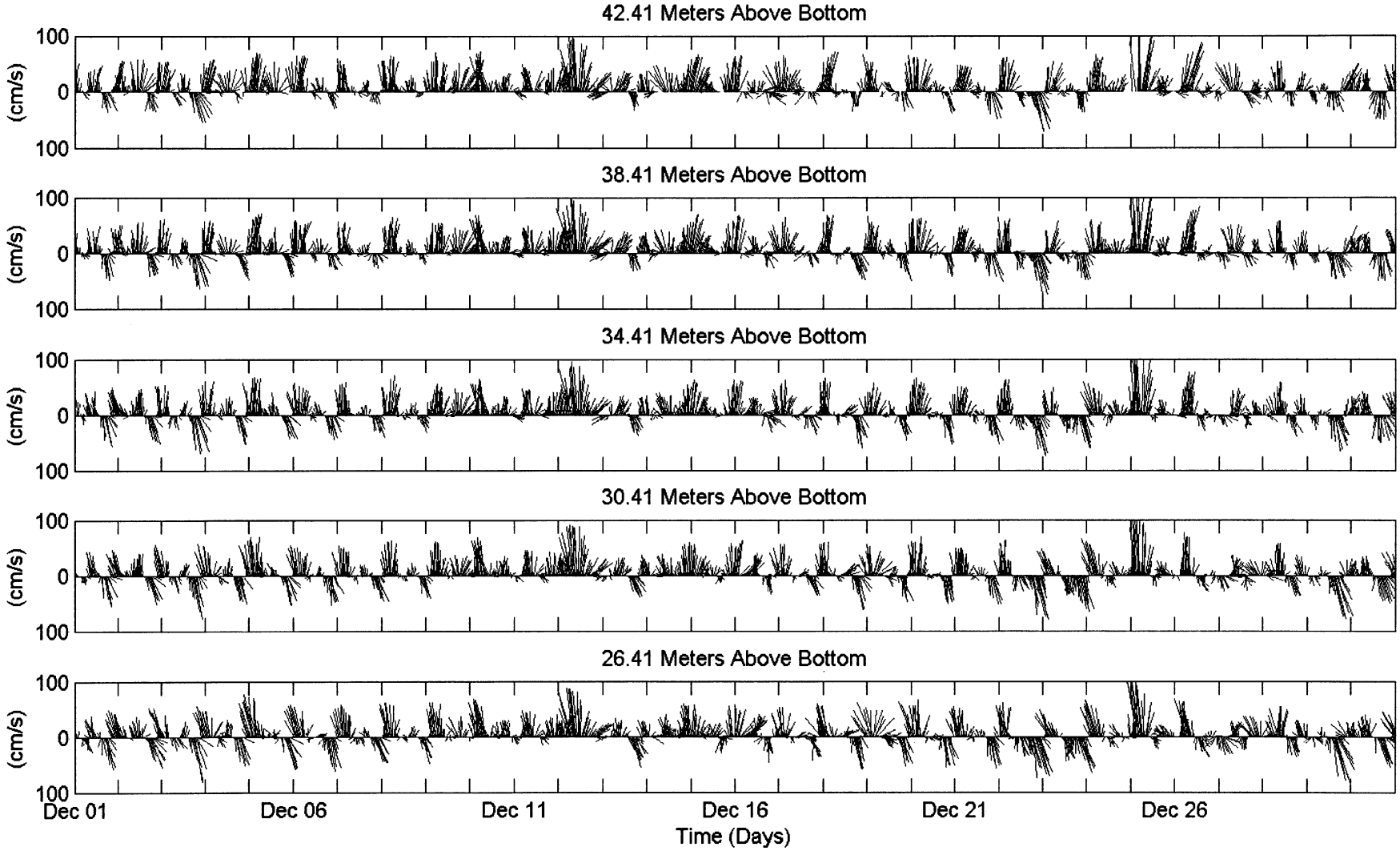

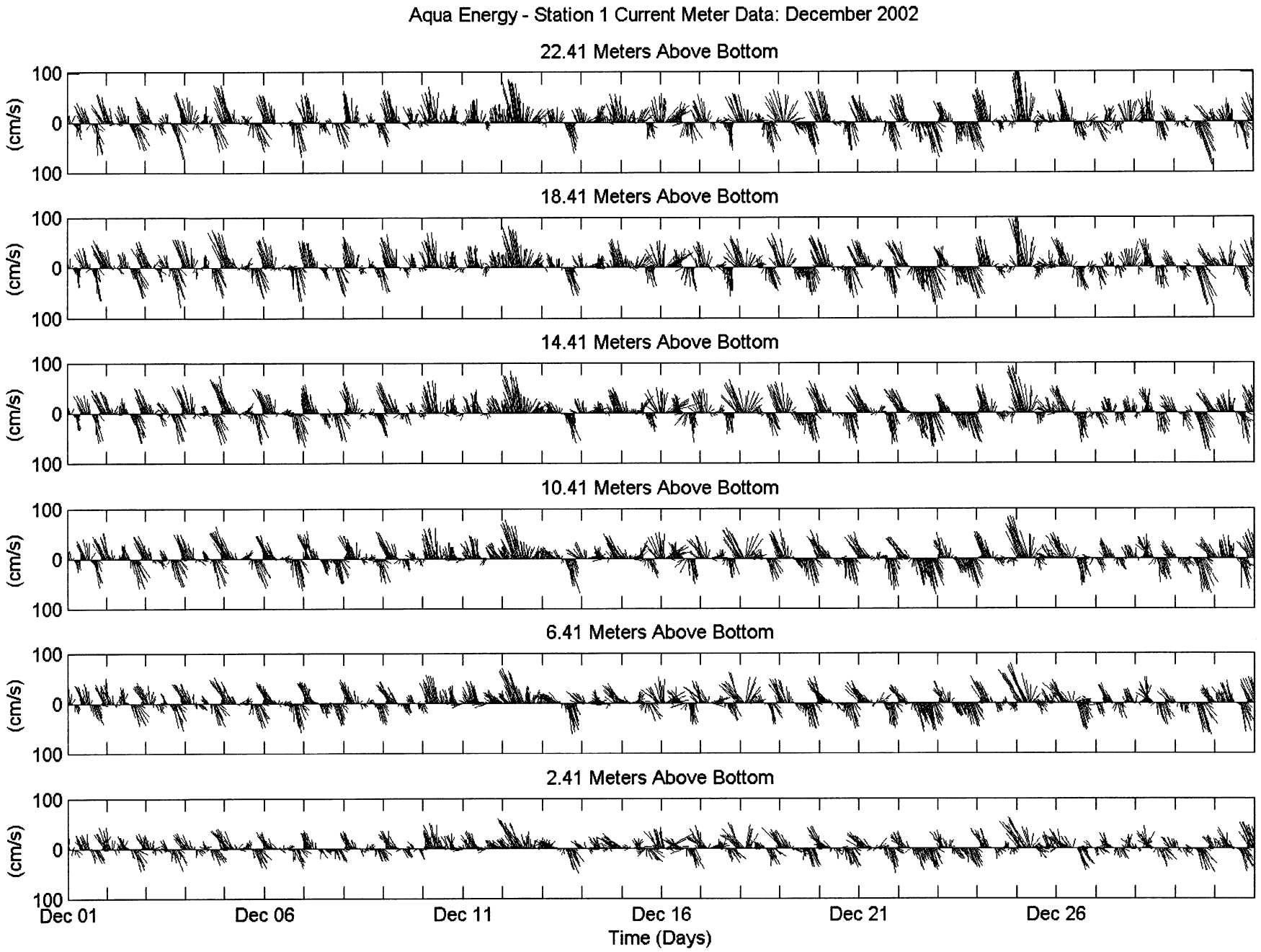

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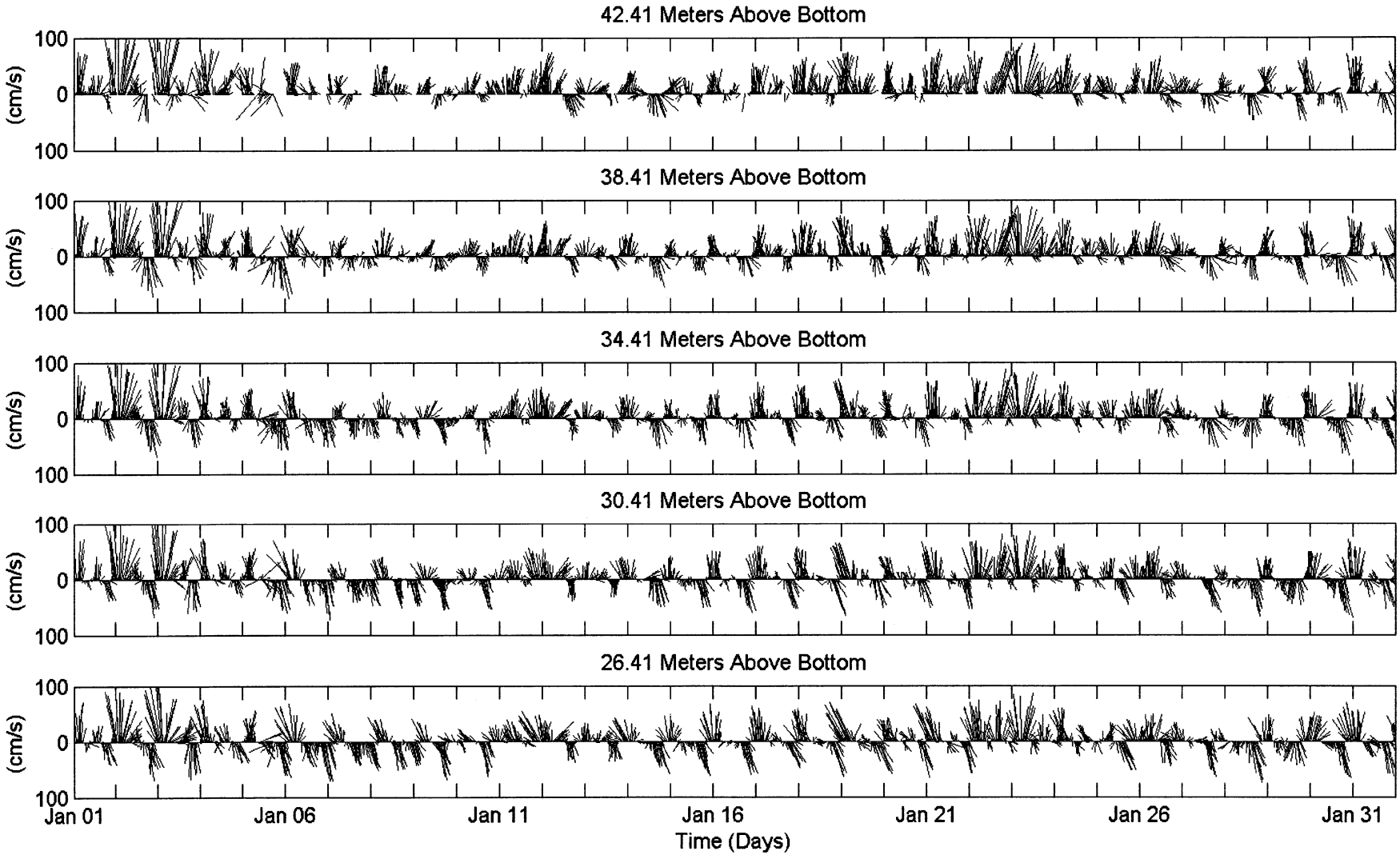

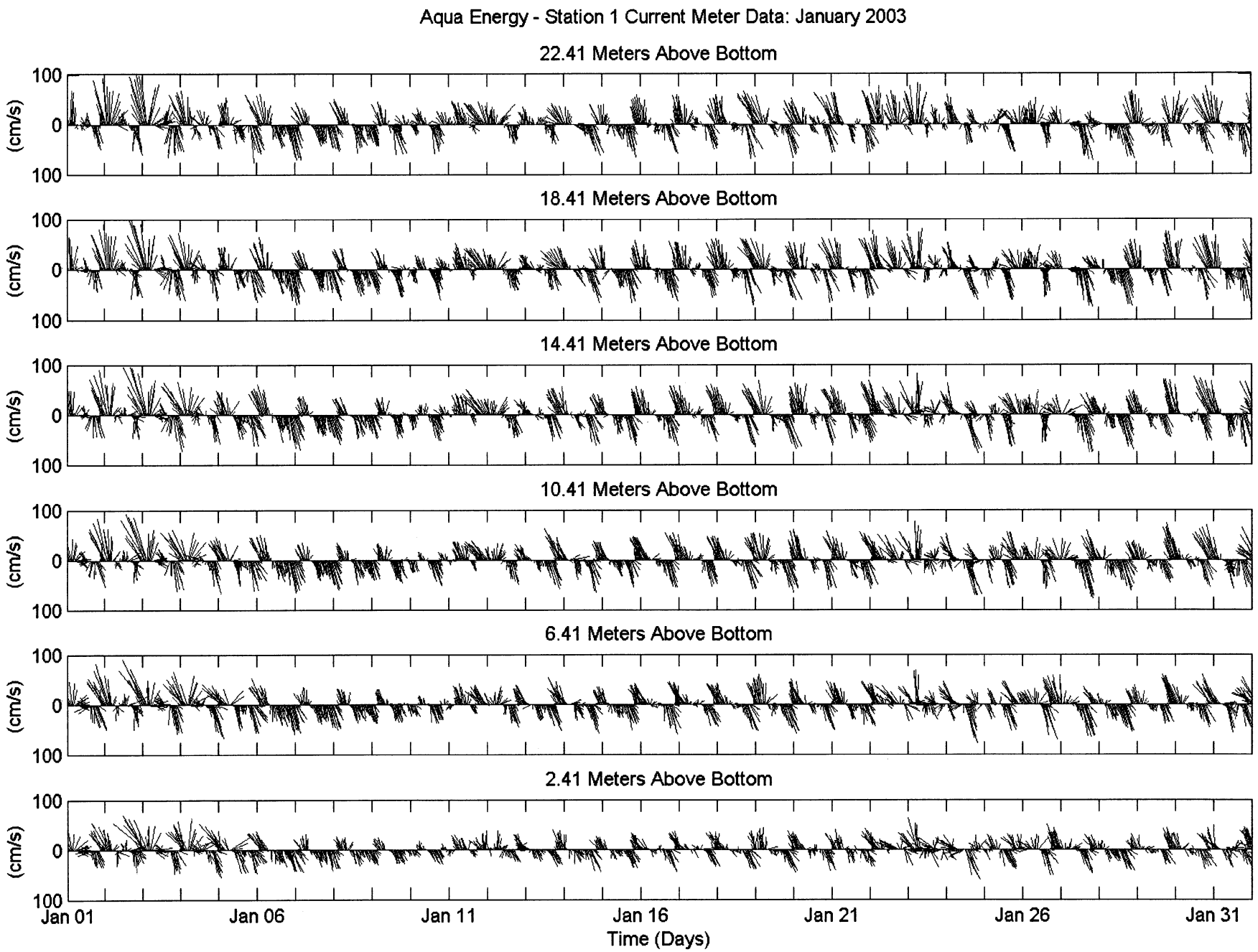

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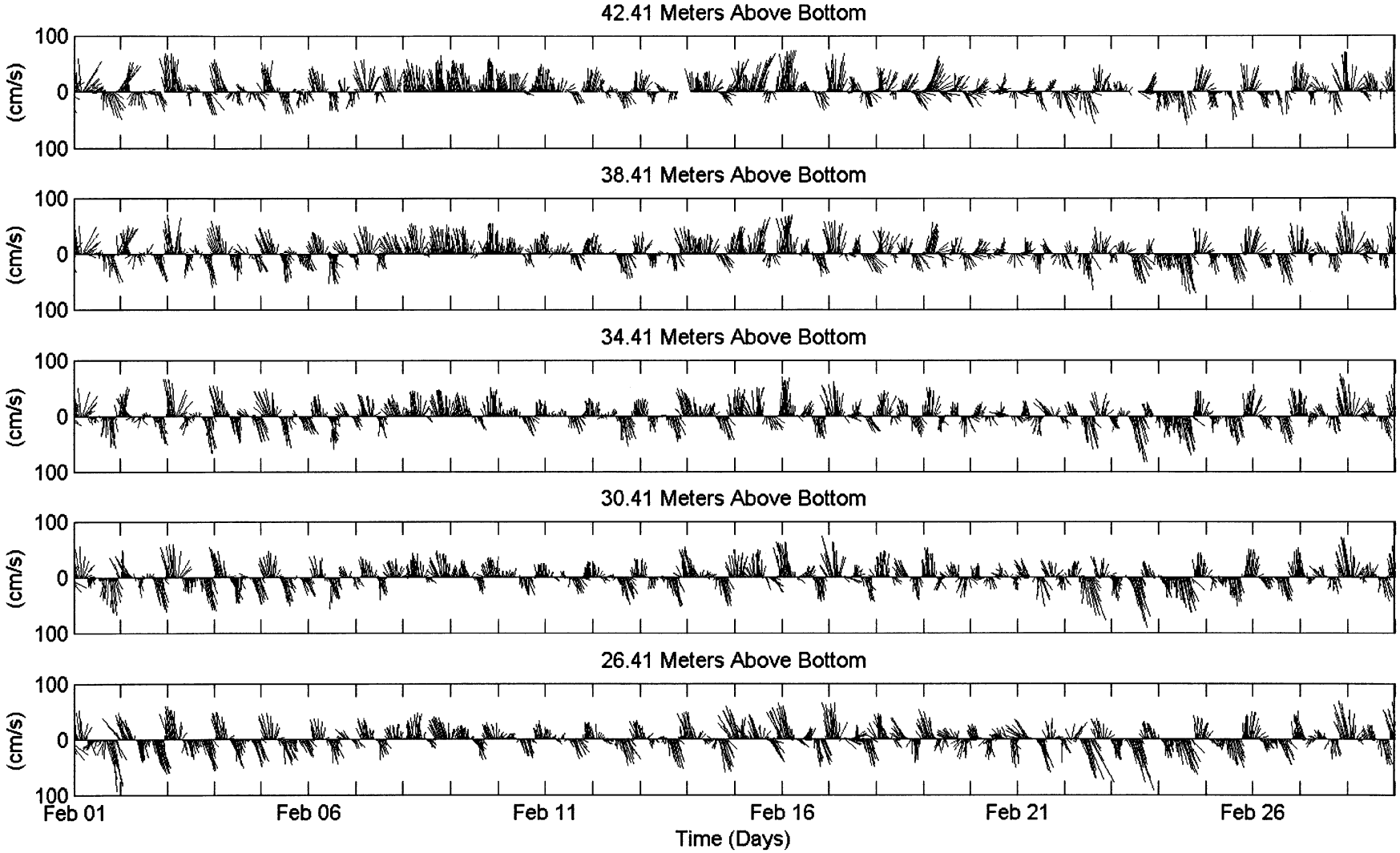
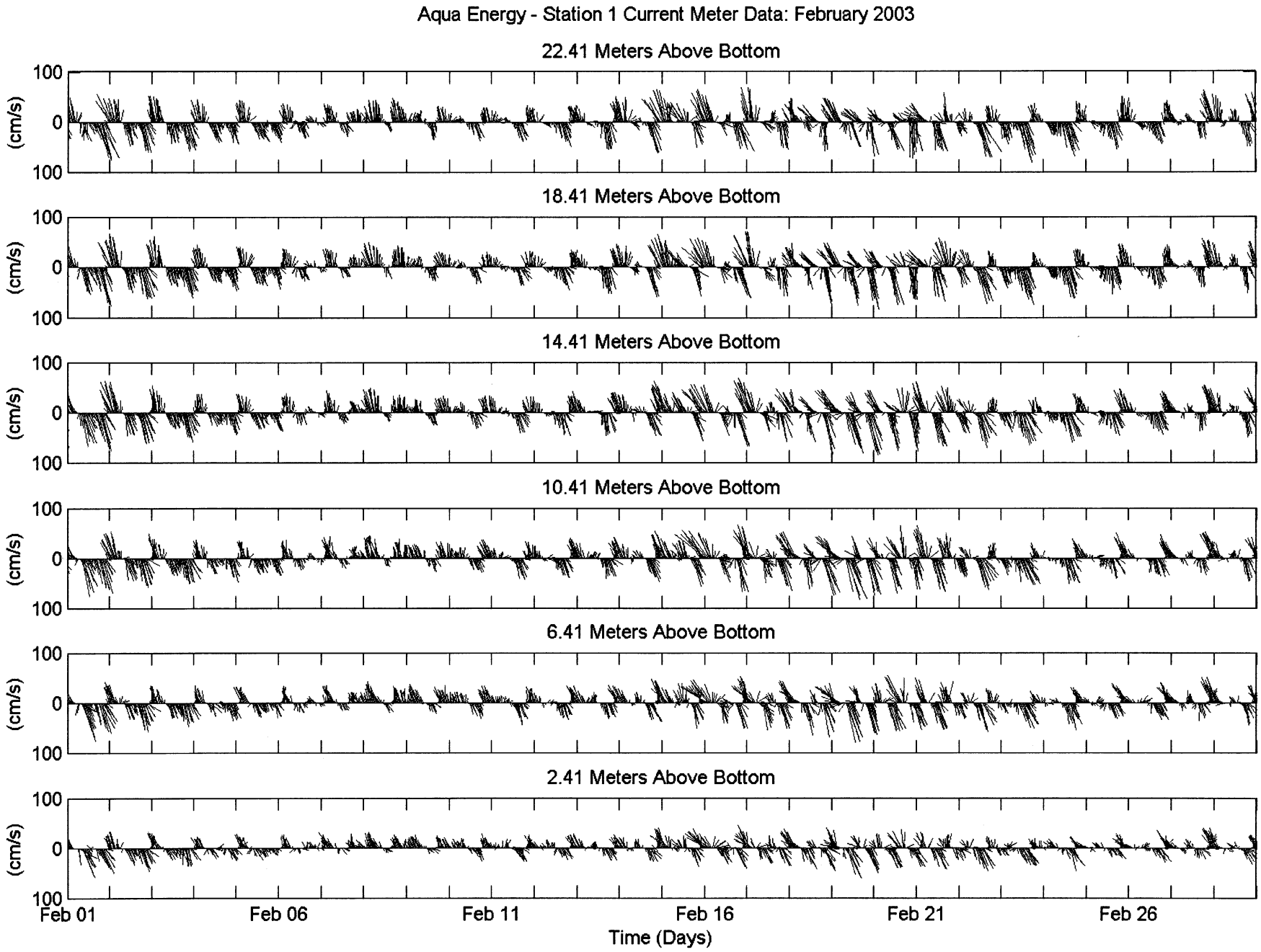
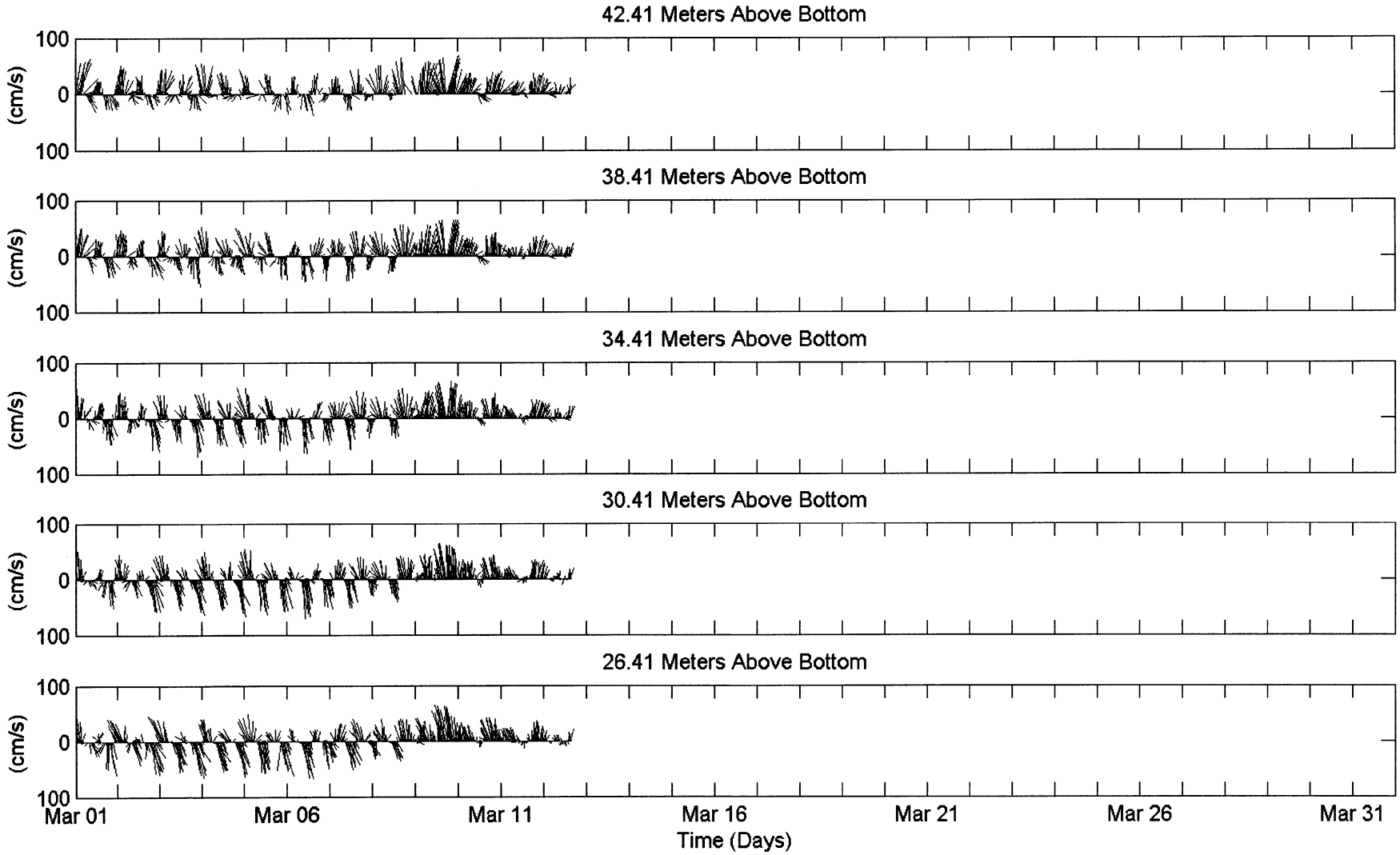
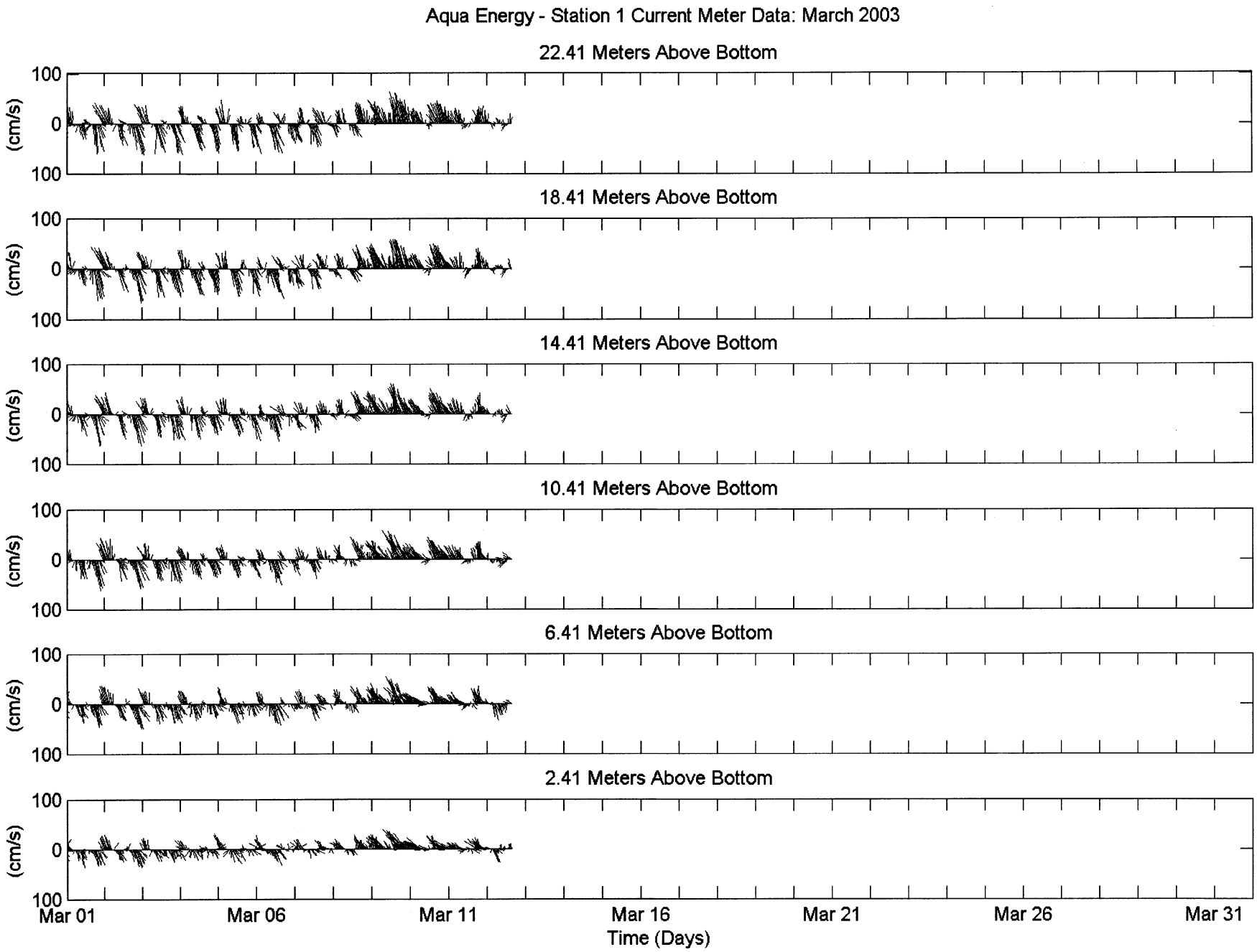




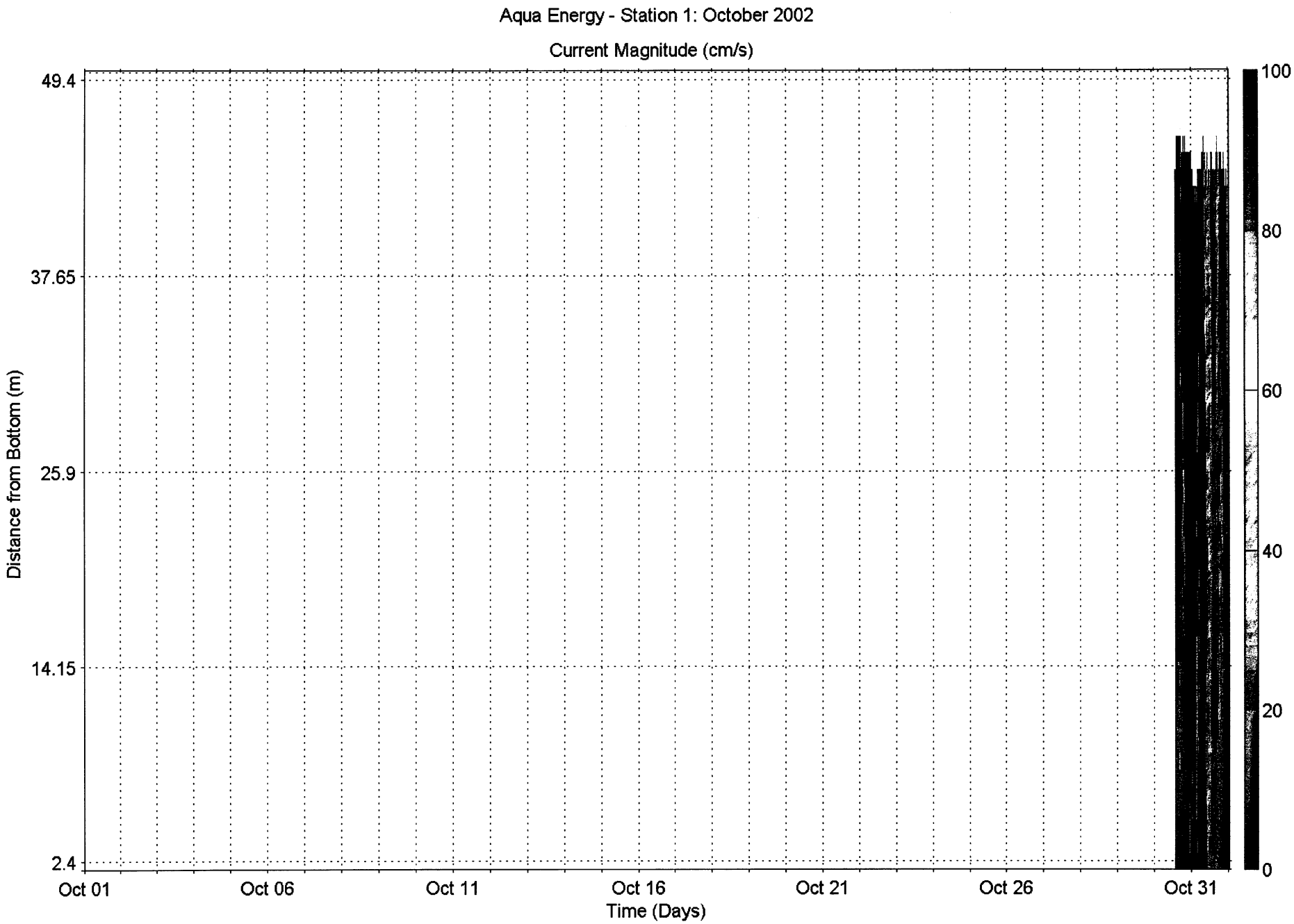
Aqua Energy - Station 1 Current Meter Data: March 2003

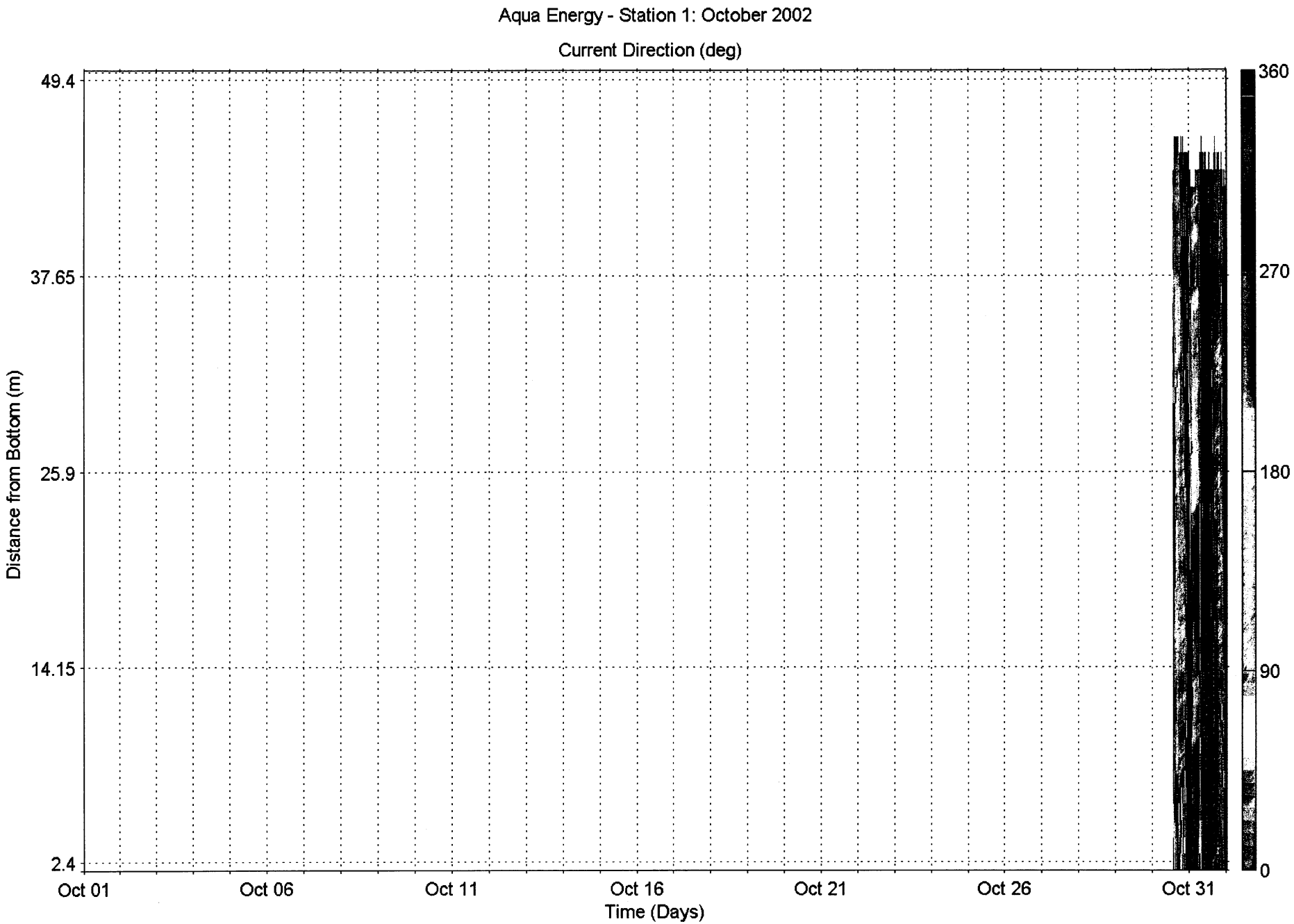


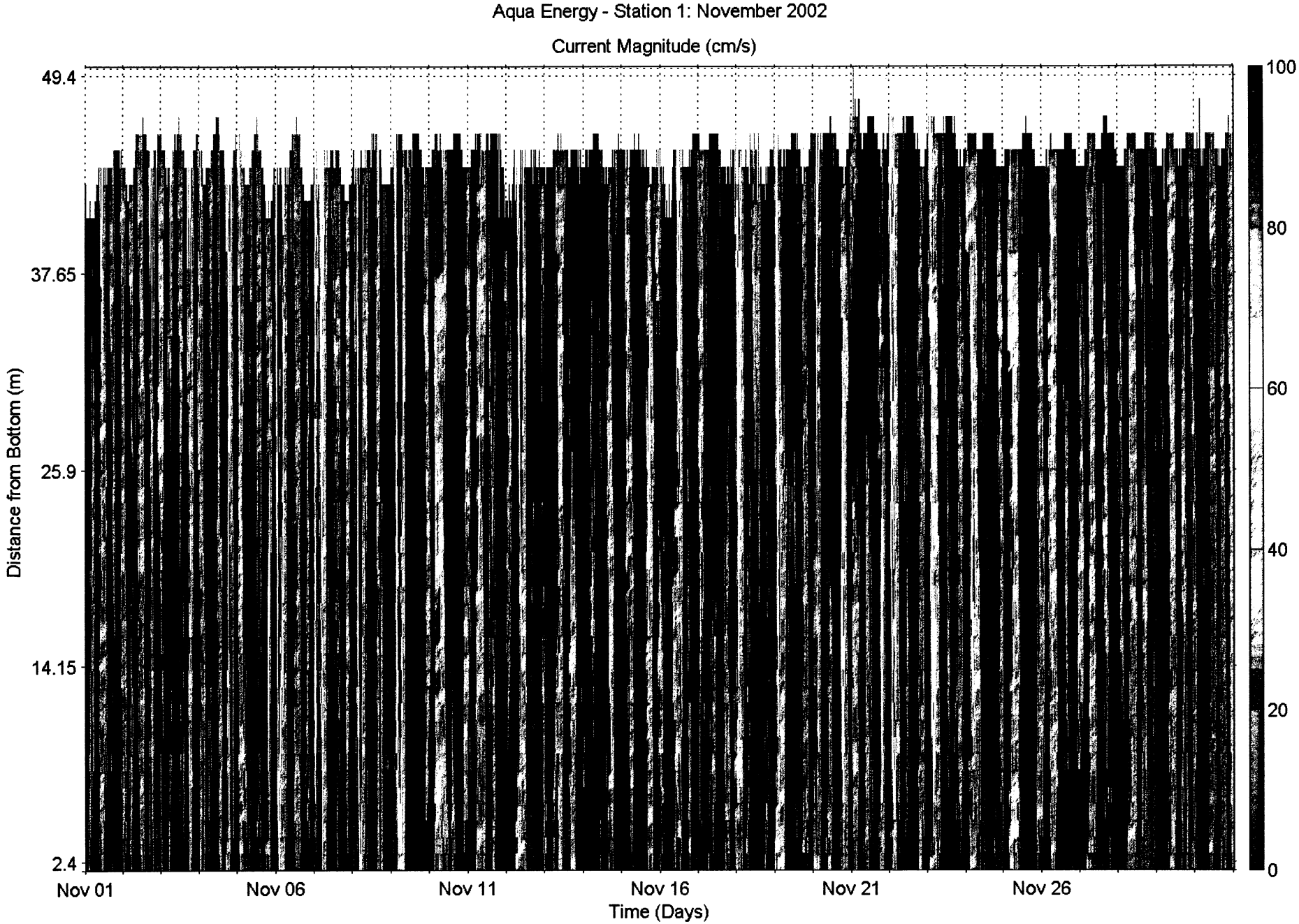


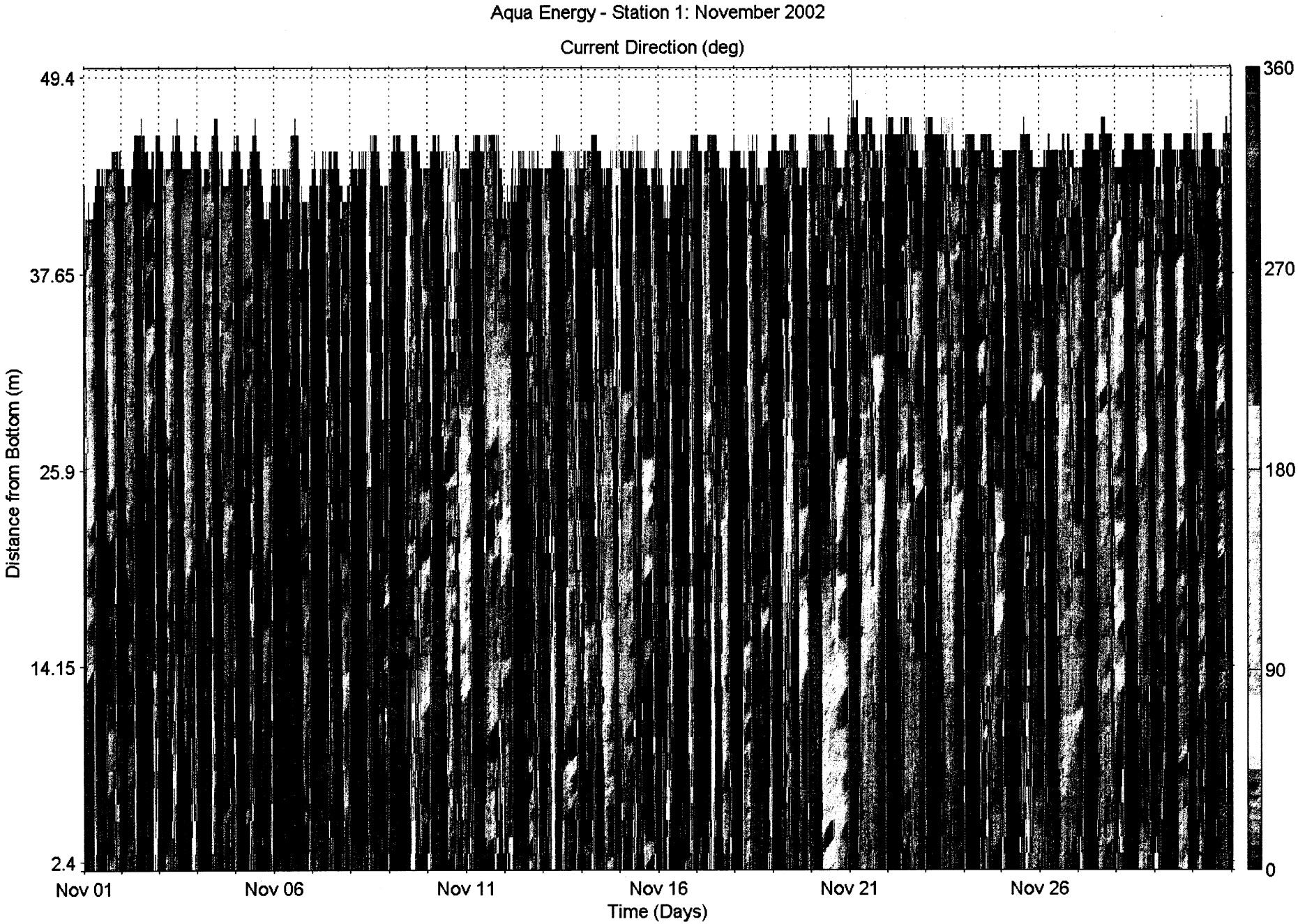
APPENDIX 5

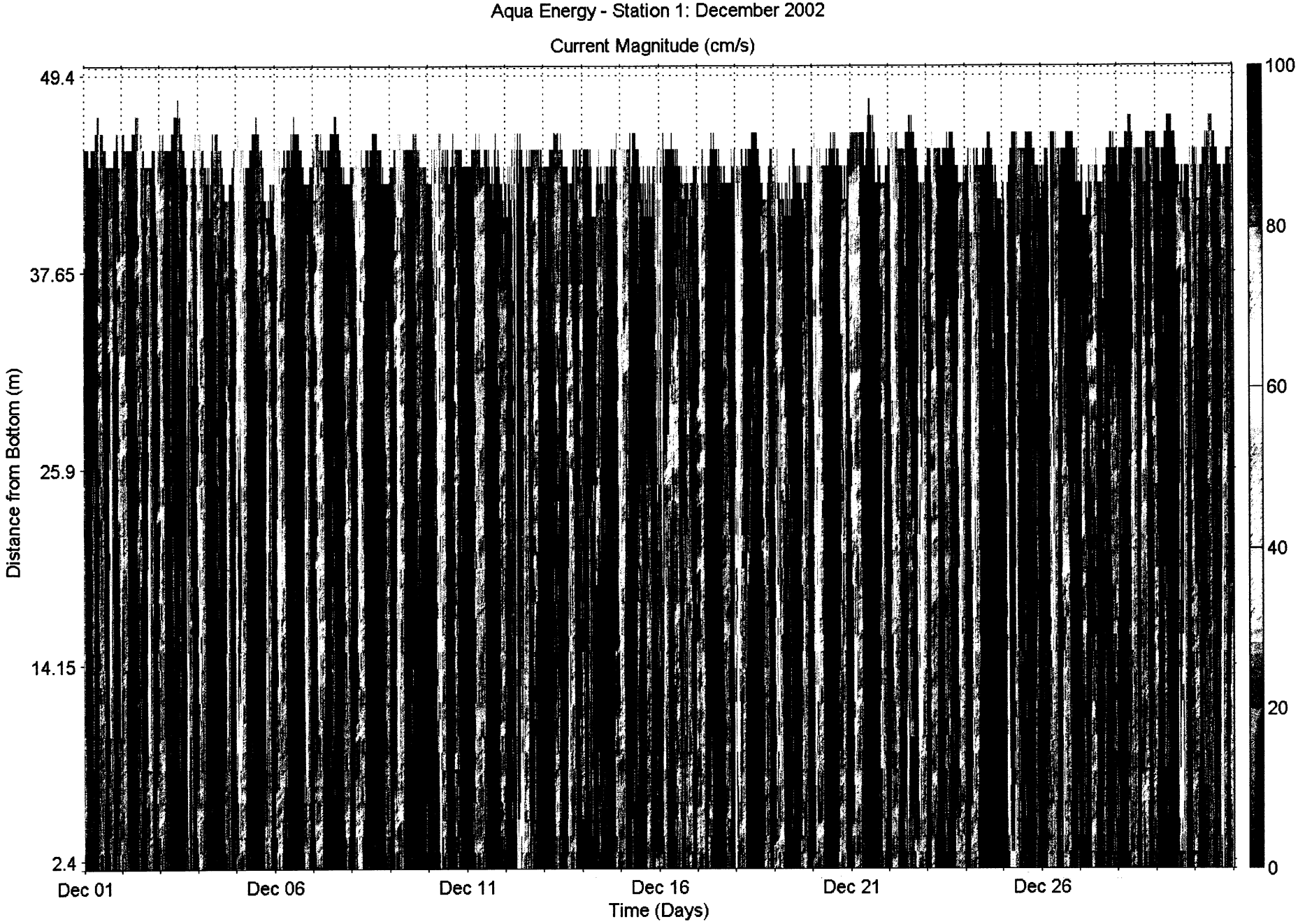
Contours of current speed and direction vs. depth and time

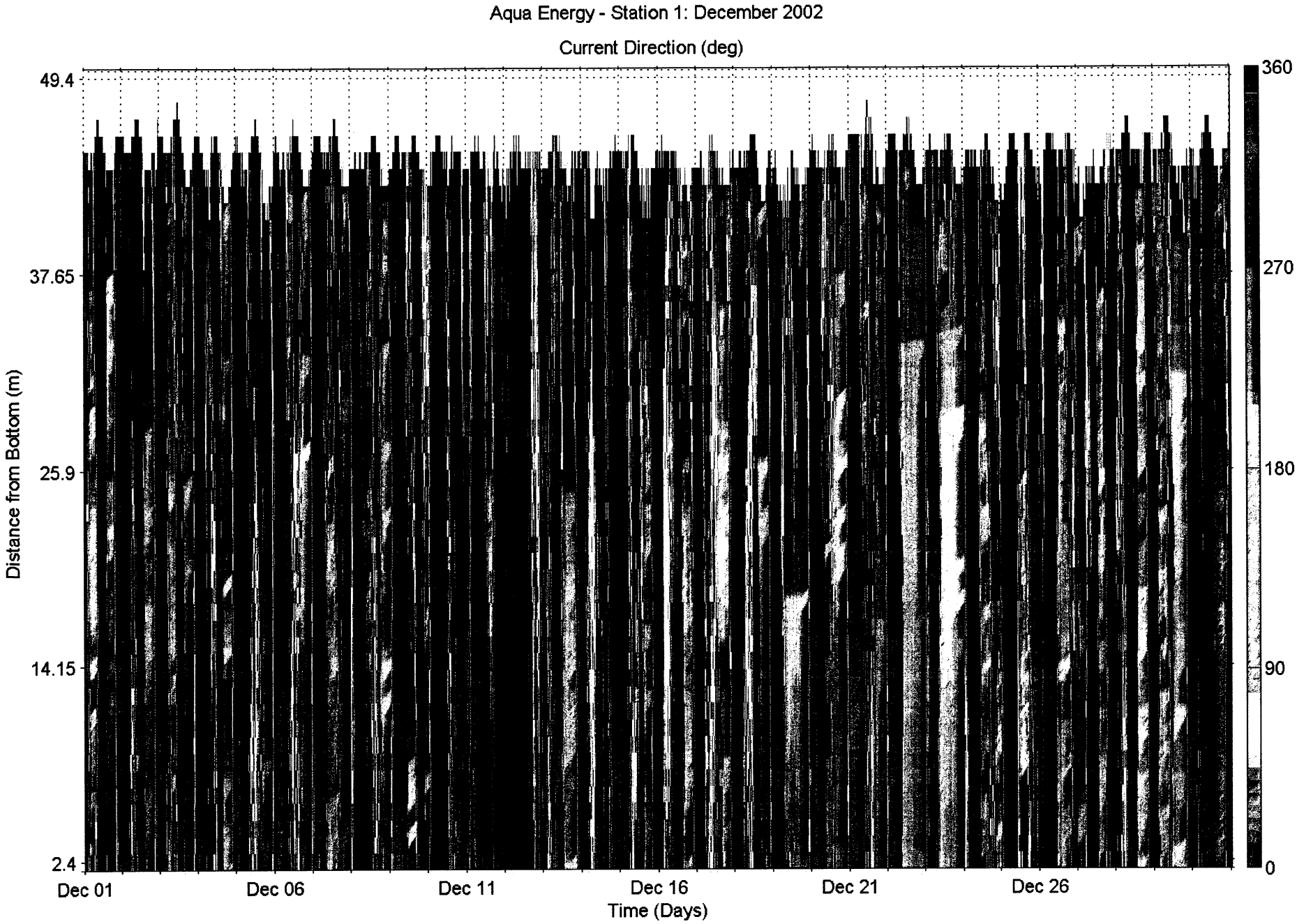


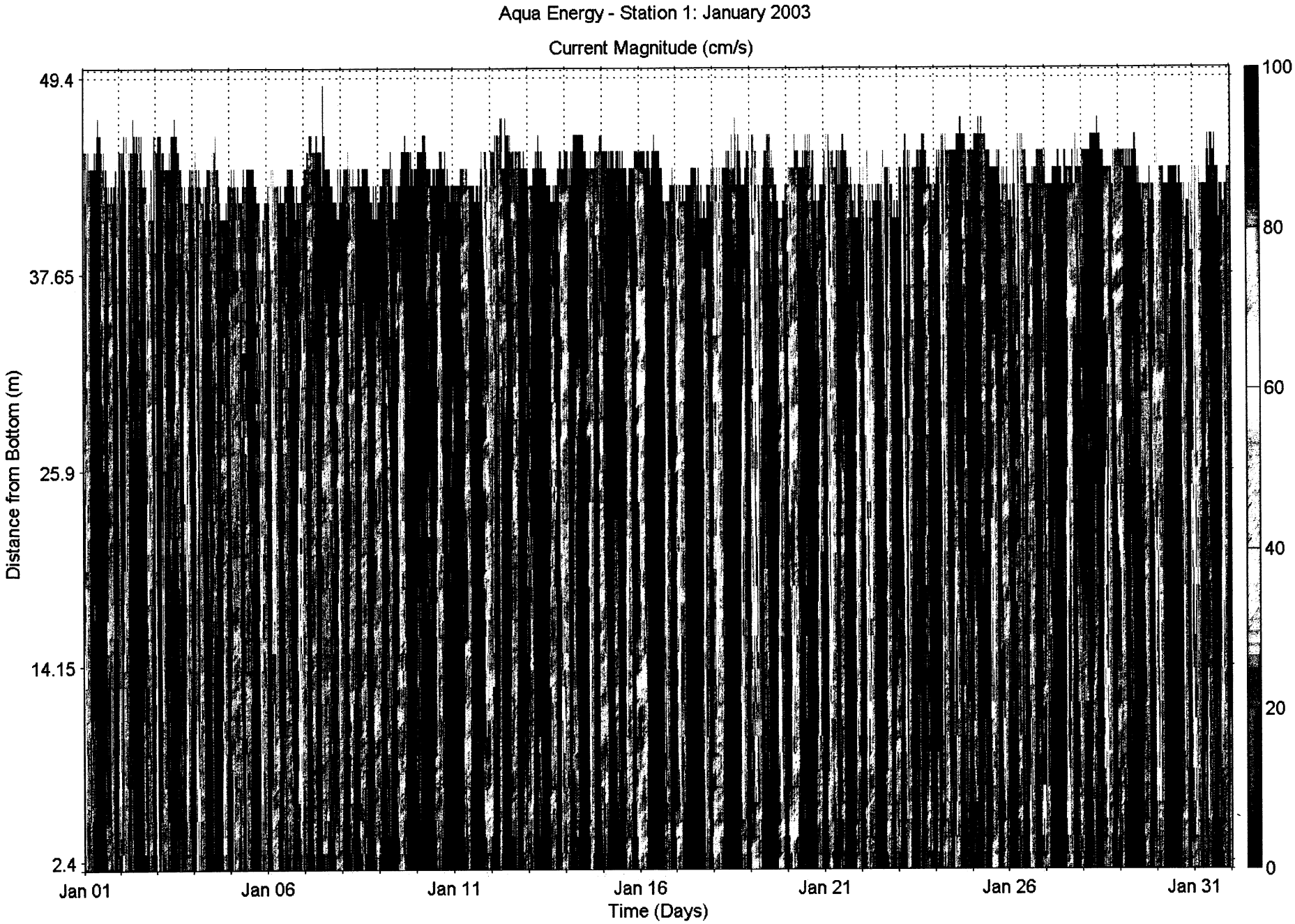


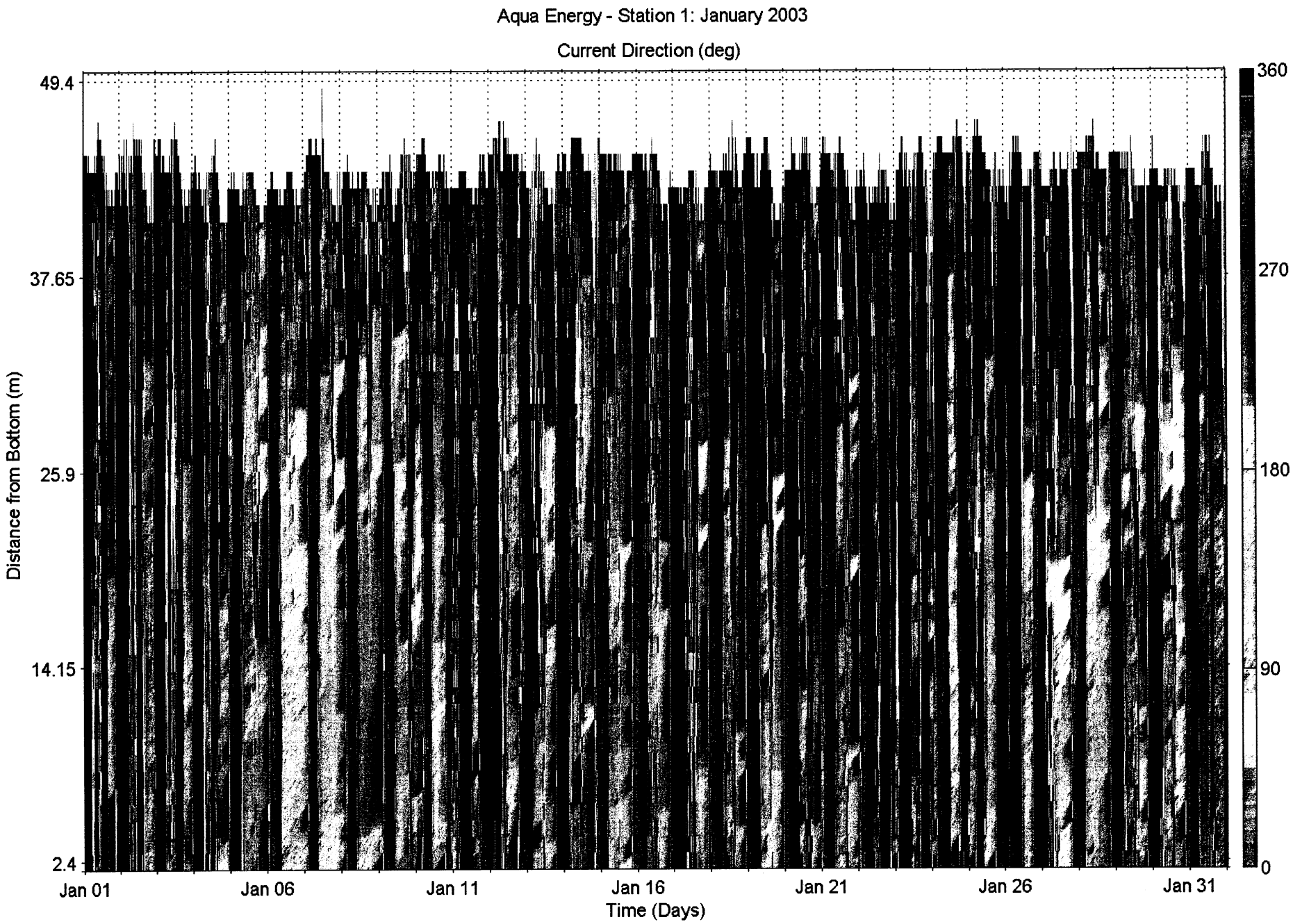


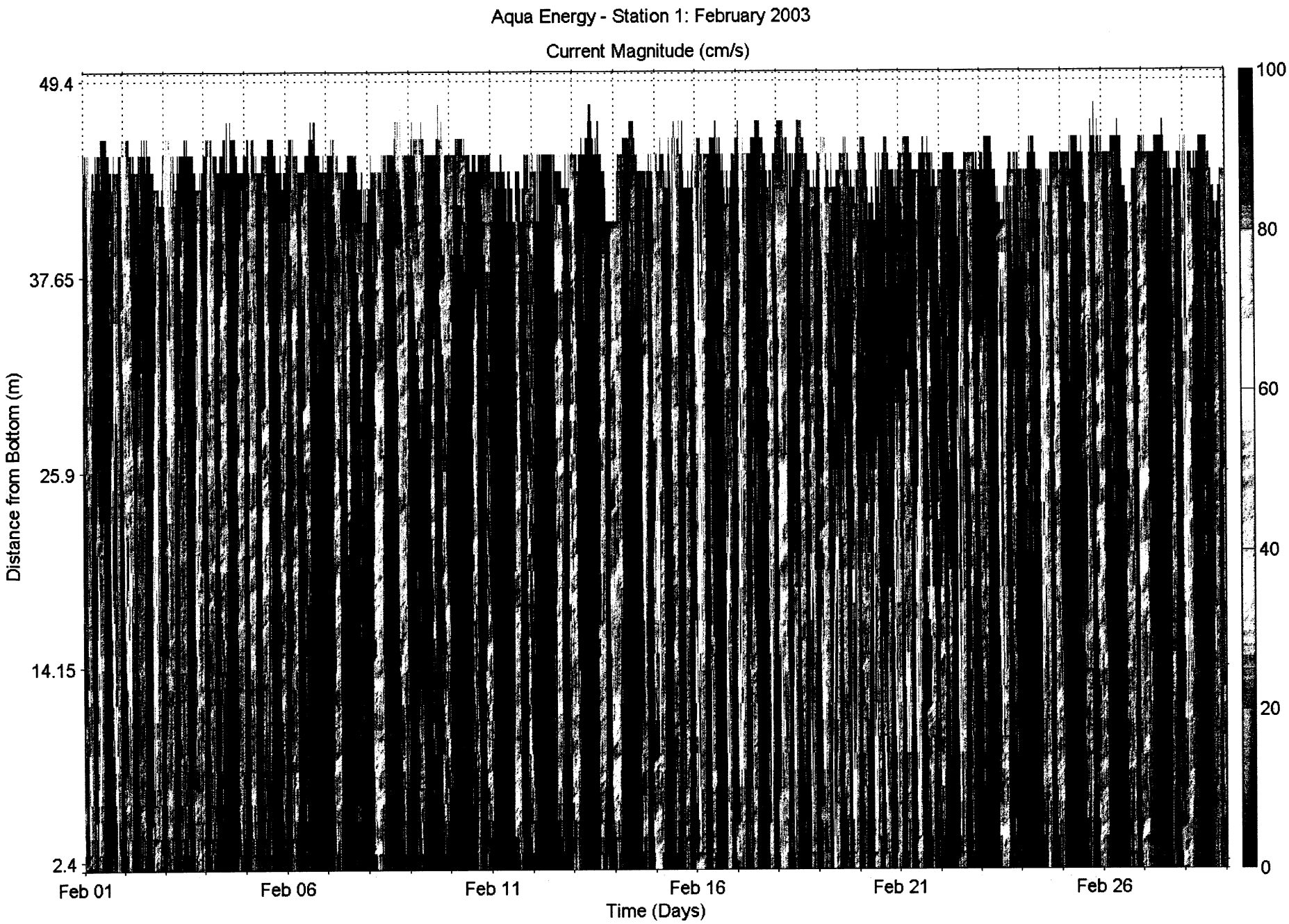


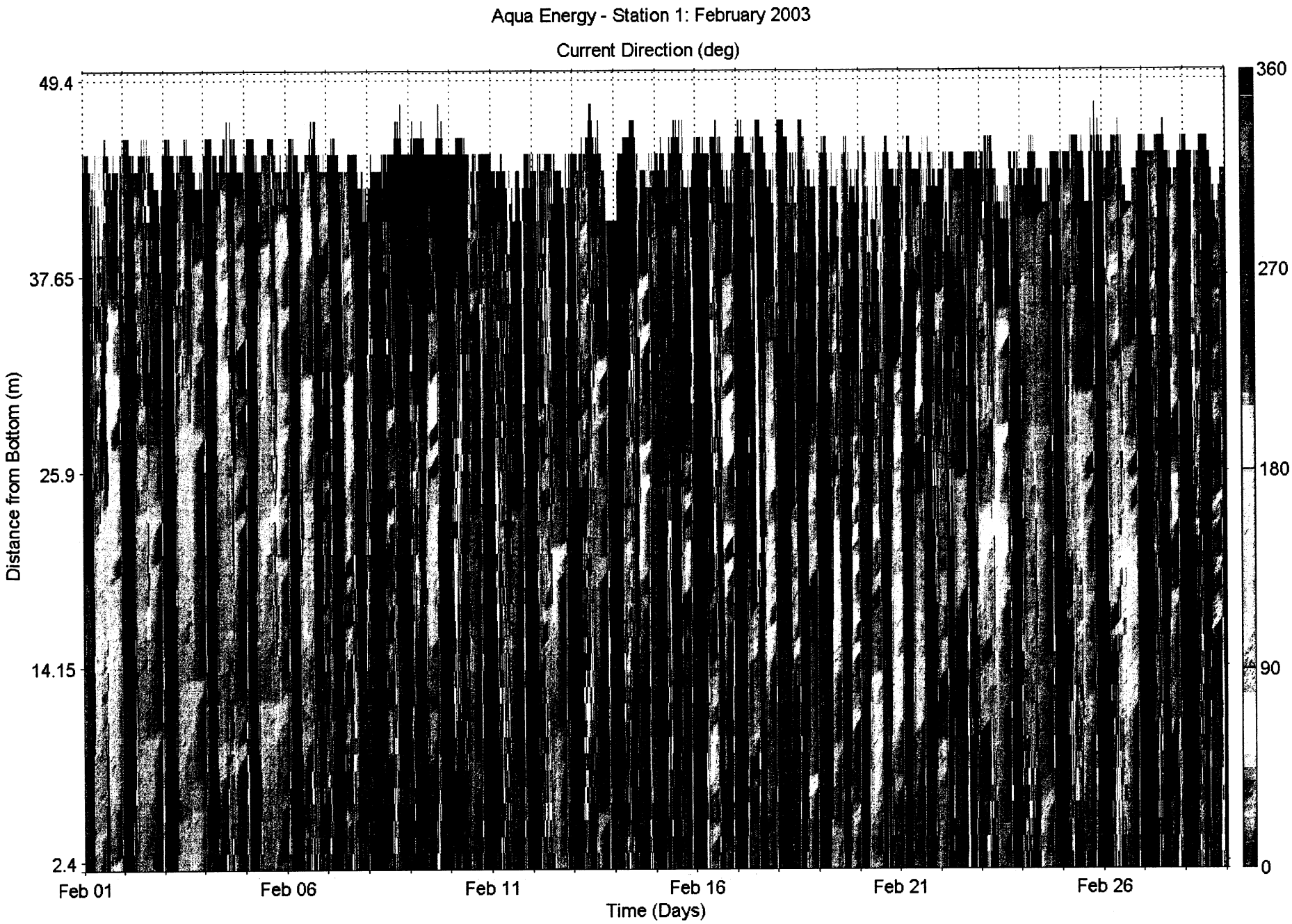


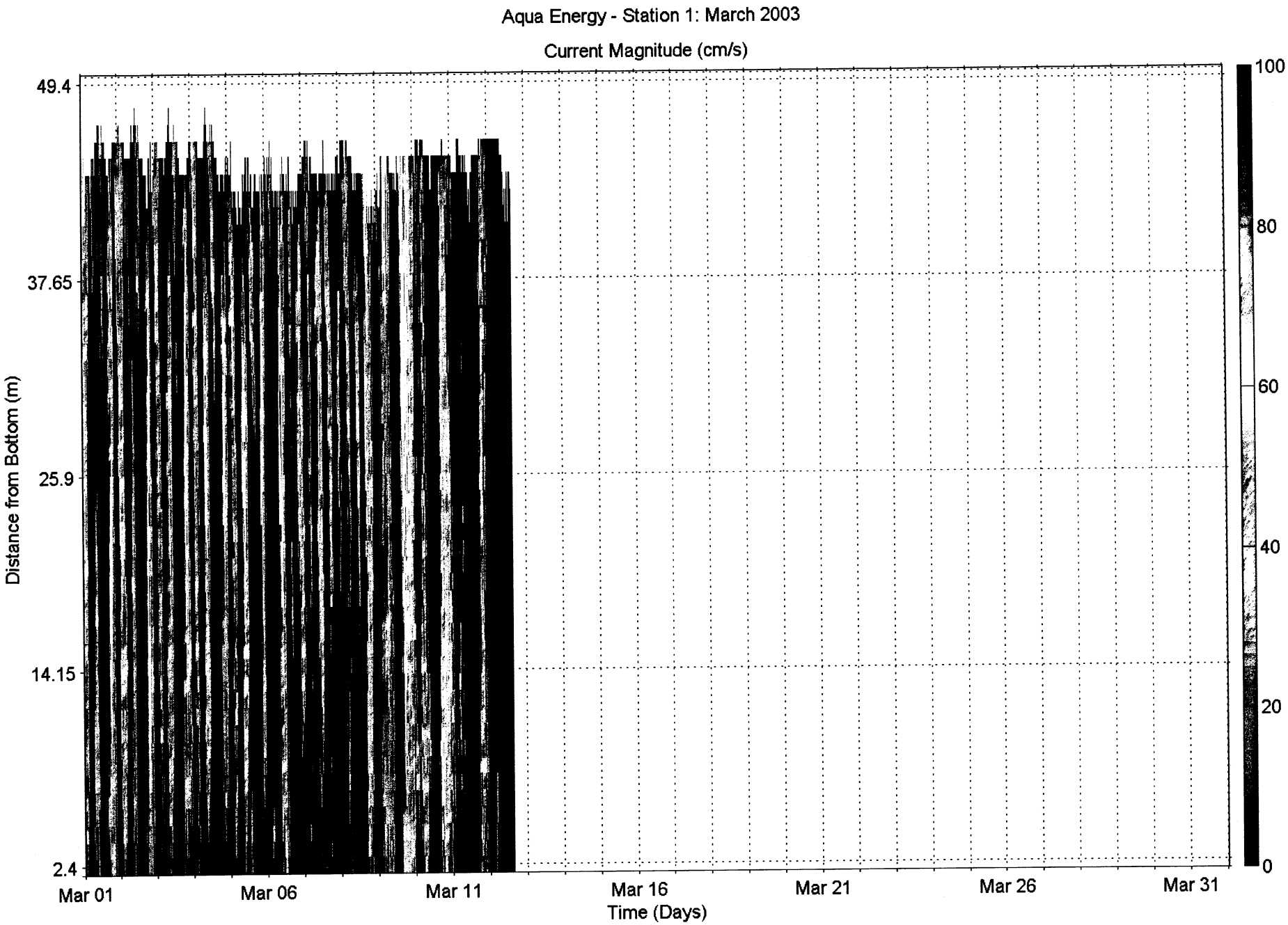


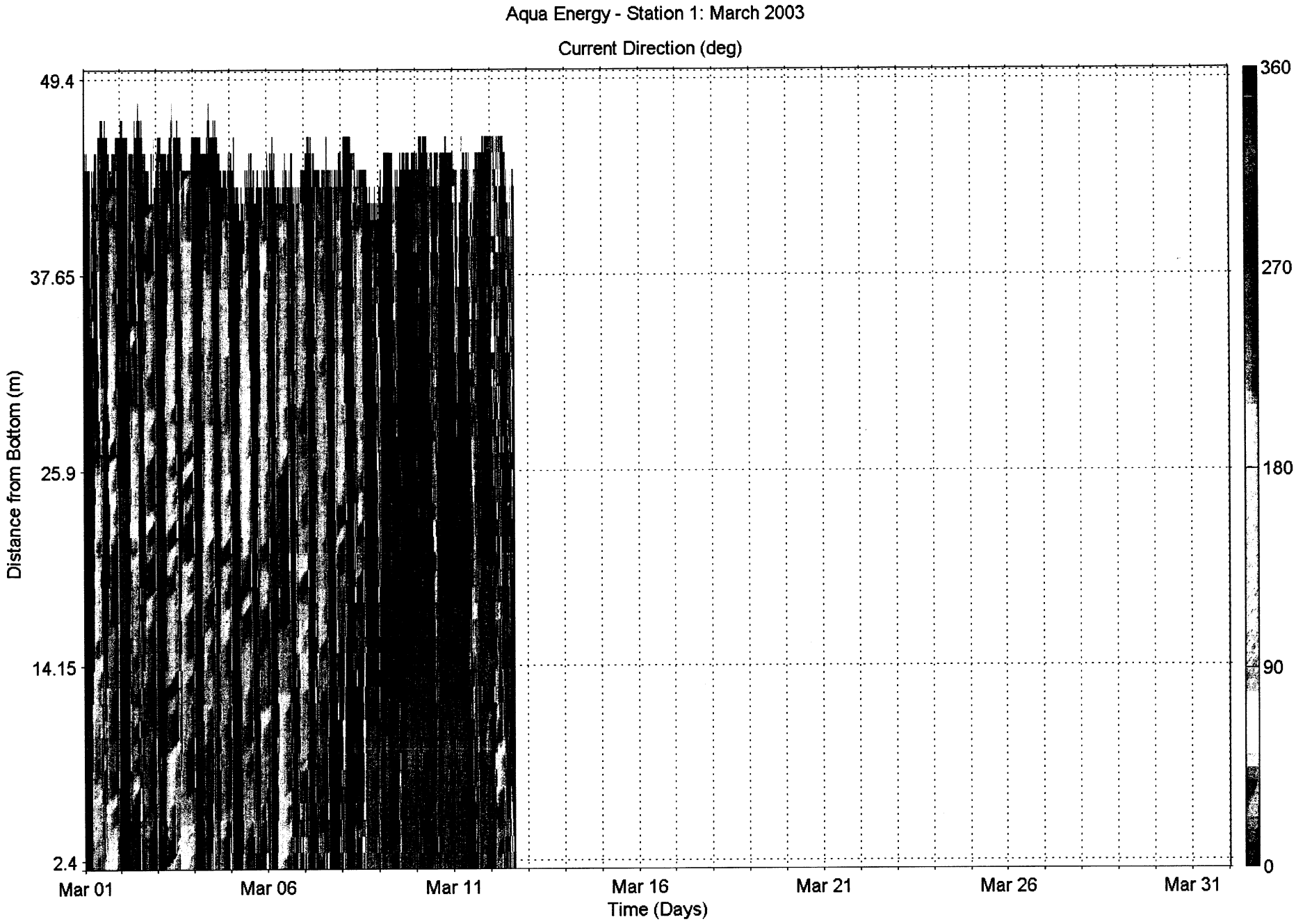












APPENDIX 6

Percent occurrence tables of current speed vs. direction

LOCATION: Washington State Outer Coast
DATE: October 30 2002 - March 12, 2003
DEPTH: 42 Meters
NUMBER OF OBSERVATIONS: 11876

DIRECTION (DEGREES TRUE)

SPEED CM/SEC	0-20	20-40	40-60	60-80	80-100	100-120	120-140	140-160	160-180	180-200	200-220	220-240	240-260	260-280	280-300	300-320	320-340	340-360	TOTAL
0.0 - 5.0	0.24	0.28	0.25	0.24	0.31	0.29	0.26	0.23	0.28	0.20	0.20	0.14	0.18	0.27	0.21	0.26	0.30	0.32	4.47
5.0 - 10.0	0.95	0.78	0.75	0.67	0.66	0.62	0.62	0.68	0.81	0.69	0.48	0.49	0.39	0.40	0.45	0.54	0.51	0.63	11.11
10.0 - 15.0	1.49	0.91	0.79	0.74	0.82	0.70	0.71	0.89	0.87	0.88	0.53	0.47	0.36	0.39	0.47	0.63	1.01	1.14	13.79
15.0 - 20.0	1.54	1.18	0.87	0.64	0.43	0.56	0.70	0.82	1.14	0.93	0.37	0.19	0.24	0.17	0.24	0.55	0.98	1.36	12.90
20.0 - 25.0	1.91	1.31	0.81	0.47	0.27	0.40	0.57	0.90	1.16	0.65	0.14	0.07	0.08	0.04	0.13	0.30	0.82	1.68	11.72
25.0 - 30.0	1.98	1.48	0.57	0.28	0.12	0.24	0.37	0.77	1.19	0.53	0.06	0.03	0.03	0.00	0.03	0.13	0.77	1.80	10.37
30.0 - 35.0	2.37	1.15	0.43	0.17	0.07	0.08	0.24	0.57	0.87	0.23	0.03	0.01	0.03	0.00	0.03	0.08	0.43	1.60	8.37
35.0 - 40.0	1.97	0.97	0.25	0.05	0.04	0.04	0.04	0.29	0.65	0.10	0.01	0.00	0.00	0.00	0.01	0.03	0.39	1.65	6.49
40.0 - 45.0	1.94	0.64	0.14	0.03	0.01	0.01	0.04	0.21	0.36	0.05	0.00	0.00	0.00	0.00	0.00	0.02	0.29	1.61	5.35
45.0 - 50.0	1.85	0.52	0.10	0.00	0.00	0.00	0.01	0.06	0.33	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.19	1.42	4.53
50.0 - 55.0	1.36	0.27	0.05	0.00	0.00	0.00	0.00	0.05	0.20	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.13	1.12	3.18
55.0 - 60.0	1.23	0.29	0.03	0.00	0.00	0.00	0.00	0.03	0.13	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.08	0.91	2.70
60.0 - 65.0	0.93	0.15	0.02	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.04	0.48	1.72
65.0 - 70.0	0.69	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.38	1.26
70.0 - 75.0	0.32	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.16	0.59
75.0 - 80.0	0.22	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.39
80.0 - 85.0	0.15	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.26
85.0 - 90.0	0.19	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.25
90.0 - 95.0	0.08	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.12
95.0 - 100.0	0.06	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.16
100.0 - >	0.17	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.26
TOTAL	21.64	10.17	5.06	3.29	2.72	2.94	3.56	5.52	8.18	4.32	1.82	1.41	1.31	1.26	1.57	2.54	5.99	16.70	100.00

LOCATION: Washington State Outer Coast
DATE: October 30 2002 - March 12, 2003
DEPTH: 38 Meters
NUMBER OF OBSERVATIONS: 12780

DIRECTION (DEGREES TRUE)

SPEED CM/SEC	0-20	20-40	40-60	60-80	80-100	100-120	120-140	140-160	160-180	180-200	200-220	220-240	240-260	260-280	280-300	300-320	320-340	340-360	TOTAL
0.0 - 5.0	0.42	0.31	0.35	0.36	0.28	0.38	0.27	0.25	0.21	0.31	0.31	0.18	0.20	0.22	0.19	0.32	0.26	0.33	5.16
5.0 - 10.0	0.84	0.76	0.94	0.70	0.72	0.74	0.84	0.80	0.74	0.76	0.39	0.55	0.35	0.45	0.49	0.49	0.67	0.67	11.88
10.0 - 15.0	1.20	1.10	0.78	0.84	0.67	0.67	0.91	1.15	1.17	0.94	0.59	0.33	0.29	0.21	0.34	0.52	0.81	1.14	13.65
15.0 - 20.0	1.67	1.30	0.85	0.59	0.35	0.61	0.85	1.35	1.35	0.88	0.43	0.13	0.15	0.16	0.34	0.36	0.91	1.60	13.88
20.0 - 25.0	1.85	1.16	0.55	0.32	0.20	0.23	0.54	1.19	1.78	0.70	0.19	0.05	0.04	0.05	0.12	0.23	0.79	1.61	11.60
25.0 - 30.0	2.24	1.03	0.53	0.15	0.09	0.15	0.27	1.04	1.64	0.74	0.07	0.02	0.02	0.02	0.03	0.06	0.64	1.88	10.60
30.0 - 35.0	1.92	0.76	0.19	0.02	0.02	0.03	0.14	0.74	1.53	0.42	0.02	0.01	0.00	0.00	0.02	0.07	0.48	1.62	7.98
35.0 - 40.0	1.68	0.57	0.10	0.02	0.02	0.02	0.07	0.59	0.95	0.15	0.02	0.01	0.00	0.01	0.00	0.02	0.34	1.38	5.93
40.0 - 45.0	1.71	0.40	0.09	0.00	0.01	0.00	0.02	0.35	0.88	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.25	1.79	5.61
45.0 - 50.0	1.72	0.30	0.05	0.00	0.00	0.01	0.01	0.15	0.74	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.19	1.24	4.45
50.0 - 55.0	1.38	0.16	0.02	0.00	0.00	0.00	0.00	0.05	0.55	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.92	3.15
55.0 - 60.0	1.04	0.08	0.00	0.00	0.00	0.00	0.00	0.02	0.33	0.02	0.01	0.00	0.01	0.00	0.00	0.00	0.04	0.53	2.07
60.0 - 65.0	0.81	0.05	0.00	0.00	0.00	0.00	0.00	0.02	0.12	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.37	1.36
65.0 - 70.0	0.49	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.05	0.27	0.94
70.0 - 75.0	0.26	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.20	0.52
75.0 - 80.0	0.19	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.34
80.0 - 85.0	0.12	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.23
85.0 - 90.0	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.18
90.0 - 95.0	0.06	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.13
95.0 - 100.0	0.05	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.12
100.0 - >	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.21
TOTAL	19.90	8.08	4.45	3.00	2.35	2.84	3.91	7.69	12.14	5.11	2.02	1.26	1.06	1.12	1.53	2.07	5.50	15.99	100.00

LOCATION: Washington State Outer Coast
DATE: October 30 2002 - March 12, 2003
DEPTH: 34 Meters
NUMBER OF OBSERVATIONS: 12780

DIRECTION (DEGREES TRUE)

SPEED CM/SEC	0-20	20-40	40-60	60-80	80-100	100-120	120-140	140-160	160-180	180-200	200-220	220-240	240-260	260-280	280-300	300-320	320-340	340-360	TOTAL
0.0 - 5.0	0.33	0.32	0.34	0.42	0.38	0.36	0.29	0.32	0.23	0.31	0.25	0.20	0.22	0.22	0.21	0.27	0.31	0.38	5.36
5.0 - 10.0	0.95	0.71	0.70	0.83	0.74	0.70	0.83	1.04	0.87	0.84	0.61	0.34	0.44	0.27	0.46	0.54	0.73	0.81	12.39
10.0 - 15.0	1.39	1.13	1.03	0.81	0.57	0.83	0.99	1.20	1.25	0.97	0.46	0.29	0.18	0.31	0.33	0.49	0.89	1.33	14.46
15.0 - 20.0	1.60	1.12	0.67	0.50	0.43	0.51	0.74	1.34	1.62	0.77	0.23	0.12	0.11	0.14	0.19	0.45	0.93	1.48	12.93
20.0 - 25.0	1.92	0.99	0.52	0.21	0.16	0.23	0.52	1.26	1.71	0.88	0.14	0.05	0.08	0.08	0.09	0.21	0.96	1.71	11.74
25.0 - 30.0	1.78	0.83	0.24	0.09	0.04	0.09	0.20	1.24	1.88	0.66	0.05	0.02	0.00	0.01	0.03	0.11	0.63	1.90	9.81
30.0 - 35.0	1.65	0.52	0.15	0.03	0.01	0.00	0.07	0.87	1.74	0.52	0.03	0.01	0.00	0.00	0.01	0.06	0.58	1.62	7.88
35.0 - 40.0	1.59	0.34	0.13	0.02	0.00	0.00	0.06	0.55	1.52	0.20	0.02	0.00	0.00	0.00	0.00	0.02	0.32	1.81	6.57
40.0 - 45.0	1.51	0.21	0.06	0.00	0.00	0.00	0.01	0.38	1.30	0.11	0.00	0.01	0.00	0.00	0.00	0.01	0.29	1.72	5.60
45.0 - 50.0	1.32	0.09	0.02	0.00	0.00	0.00	0.00	0.20	1.24	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.19	1.40	4.50
50.0 - 55.0	0.99	0.04	0.00	0.00	0.00	0.00	0.00	0.11	0.81	0.03	0.02	0.00	0.00	0.00	0.00	0.00	0.04	0.90	2.94
55.0 - 60.0	0.72	0.04	0.00	0.00	0.00	0.00	0.00	0.09	0.41	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.64	1.96
60.0 - 65.0	0.62	0.01	0.00	0.00	0.00	0.01	0.00	0.02	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.51	1.48
65.0 - 70.0	0.31	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.27	0.83
70.0 - 75.0	0.18	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.17	0.44
75.0 - 80.0	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.34
80.0 - 85.0	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.26
85.0 - 90.0	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.13
90.0 - 95.0	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.09
95.0 - 100.0	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.10
100.0 - >	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.16
TOTAL	17.32	6.38	3.87	2.91	2.32	2.73	3.72	8.62	15.22	5.36	1.81	1.04	1.03	1.02	1.32	2.16	5.99	17.19	100.00

LOCATION: Washington State Outer Coast
DATE: October 30 2002 - March 12, 2003
DEPTH: 30 Meters
NUMBER OF OBSERVATIONS: 12780

DIRECTION (DEGREES TRUE)

SPEED CM/SEC	0-20	20-40	40-60	60-80	80-100	100-120	120-140	140-160	160-180	180-200	200-220	220-240	240-260	260-280	280-300	300-320	320-340	340-360	TOTAL
0.0 - 5.0	0.38	0.24	0.33	0.26	0.38	0.38	0.38	0.34	0.24	0.36	0.38	0.22	0.25	0.21	0.20	0.27	0.31	0.33	5.47
5.0 - 10.0	0.84	0.81	0.72	0.82	0.76	0.77	0.75	0.84	0.87	0.82	0.63	0.41	0.33	0.41	0.59	0.58	0.65	0.84	12.43
10.0 - 15.0	1.22	1.04	0.73	0.60	0.56	0.65	0.97	1.41	1.39	1.12	0.47	0.39	0.28	0.27	0.41	0.55	1.06	1.09	14.21
15.0 - 20.0	1.59	0.99	0.59	0.41	0.32	0.44	0.59	1.44	1.78	0.96	0.35	0.13	0.16	0.12	0.16	0.53	1.03	1.44	13.04
20.0 - 25.0	1.67	0.71	0.38	0.24	0.17	0.18	0.49	1.44	2.04	0.57	0.10	0.07	0.06	0.06	0.09	0.26	0.90	1.78	11.21
25.0 - 30.0	1.61	0.45	0.27	0.09	0.09	0.06	0.25	1.15	2.11	0.52	0.04	0.00	0.01	0.02	0.04	0.20	0.81	2.18	9.90
30.0 - 35.0	1.68	0.34	0.13	0.05	0.03	0.01	0.08	0.94	1.72	0.41	0.02	0.01	0.00	0.01	0.02	0.04	0.68	1.93	8.10
35.0 - 40.0	1.21	0.21	0.09	0.01	0.01	0.01	0.05	0.74	1.54	0.23	0.02	0.00	0.00	0.01	0.00	0.05	0.51	1.99	6.67
40.0 - 45.0	1.05	0.09	0.04	0.00	0.00	0.00	0.01	0.36	1.56	0.10	0.00	0.00	0.00	0.01	0.00	0.00	0.44	1.66	5.32
45.0 - 50.0	0.85	0.05	0.01	0.00	0.00	0.00	0.00	0.34	1.42	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.20	1.24	4.18
50.0 - 55.0	0.66	0.02	0.00	0.00	0.00	0.00	0.00	0.13	1.26	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.08	1.11	3.27
55.0 - 60.0	0.56	0.01	0.00	0.00	0.00	0.00	0.00	0.05	0.76	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.02	1.01	2.42
60.0 - 65.0	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.60	1.49
65.0 - 70.0	0.16	0.01	0.00	0.00	0.00	0.00	0.00	0.02	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.33	0.73
70.0 - 75.0	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.27	0.54
75.0 - 80.0	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.20	0.41
80.0 - 85.0	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.19
85.0 - 90.0	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.14
90.0 - 95.0	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.10
95.0 - 100.0	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.05
100.0 - >	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.13
TOTAL	14.11	4.98	3.28	2.48	2.32	2.50	3.58	9.26	17.69	5.20	2.01	1.22	1.10	1.11	1.51	2.48	6.79	18.37	100.00

LOCATION: Washington State Outer Coast
DATE: October 30 2002 - March 12, 2003
DEPTH: 26 Meters
NUMBER OF OBSERVATIONS: 12780

DIRECTION (DEGREES TRUE)

SPEED CM/SEC	0-20	20-40	40-60	60-80	80-100	100-120	120-140	140-160	160-180	180-200	200-220	220-240	240-260	260-280	280-300	300-320	320-340	340-360	TOTAL
0.0 - 5.0	0.31	0.41	0.41	0.22	0.26	0.32	0.36	0.28	0.35	0.36	0.32	0.27	0.25	0.28	0.34	0.26	0.31	0.28	5.59
5.0 - 10.0	0.80	0.65	0.71	0.70	0.63	0.74	0.67	0.97	1.04	0.76	0.64	0.57	0.63	0.40	0.48	0.51	0.75	0.91	12.55
10.0 - 15.0	1.17	0.90	0.65	0.47	0.65	0.58	0.99	1.36	1.36	0.98	0.68	0.34	0.33	0.31	0.33	0.70	1.03	1.14	13.97
15.0 - 20.0	1.40	0.78	0.41	0.20	0.35	0.35	0.68	1.59	1.80	0.98	0.42	0.13	0.08	0.10	0.22	0.47	1.10	1.64	12.71
20.0 - 25.0	1.41	0.54	0.27	0.20	0.14	0.16	0.47	1.36	1.94	0.85	0.23	0.05	0.02	0.04	0.12	0.34	1.22	2.14	11.49
25.0 - 30.0	1.34	0.35	0.21	0.09	0.09	0.07	0.25	1.03	1.94	0.41	0.05	0.02	0.01	0.01	0.05	0.16	0.95	2.22	9.26
30.0 - 35.0	1.11	0.19	0.16	0.04	0.02	0.03	0.03	1.03	2.28	0.26	0.03	0.00	0.00	0.00	0.02	0.09	1.03	2.03	8.33
35.0 - 40.0	0.83	0.14	0.09	0.03	0.01	0.01	0.02	0.82	1.66	0.23	0.02	0.00	0.01	0.00	0.00	0.07	0.66	2.05	6.64
40.0 - 45.0	0.67	0.07	0.06	0.01	0.00	0.00	0.02	0.70	1.49	0.08	0.00	0.00	0.01	0.00	0.00	0.00	0.53	1.71	5.34
45.0 - 50.0	0.56	0.04	0.01	0.00	0.00	0.00	0.00	0.34	1.37	0.05	0.00	0.00	0.00	0.00	0.00	0.02	0.37	1.36	4.10
50.0 - 55.0	0.38	0.00	0.00	0.00	0.00	0.00	0.00	0.22	1.18	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.31	1.24	3.37
55.0 - 60.0	0.28	0.02	0.00	0.00	0.00	0.00	0.00	0.13	1.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.99	2.55
60.0 - 65.0	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.59	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.73	1.63
65.0 - 70.0	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.36	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.43	0.95
70.0 - 75.0	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.28	0.57
75.0 - 80.0	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.13	0.31
80.0 - 85.0	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.16	0.25
85.0 - 90.0	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.13
90.0 - 95.0	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.09
95.0 - 100.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.10
100.0 - >	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.06
TOTAL	10.67	4.08	2.98	1.95	2.15	2.25	3.50	9.92	18.72	5.02	2.39	1.39	1.33	1.14	1.55	2.61	8.59	19.74	100.00

LOCATION: Washington State Outer Coast
DATE: October 30 2002 - March 12, 2003
DEPTH: 22 Meters
NUMBER OF OBSERVATIONS: 12780

DIRECTION (DEGREES TRUE)

SPEED CM/SEC	0-20	20-40	40-60	60-80	80-100	100-120	120-140	140-160	160-180	180-200	200-220	220-240	240-260	260-280	280-300	300-320	320-340	340-360	TOTAL
0.0 - 5.0	0.40	0.27	0.28	0.38	0.27	0.38	0.40	0.28	0.30	0.39	0.21	0.33	0.23	0.24	0.32	0.40	0.27	0.33	5.69
5.0 - 10.0	0.81	0.65	0.70	0.58	0.70	0.68	0.95	0.92	0.81	0.68	0.64	0.50	0.50	0.42	0.59	0.58	0.70	0.95	12.36
10.0 - 15.0	1.03	0.80	0.49	0.52	0.45	0.61	0.88	1.47	1.45	1.07	0.67	0.32	0.32	0.34	0.41	0.59	0.95	1.22	13.58
15.0 - 20.0	1.20	0.51	0.42	0.17	0.34	0.27	0.69	1.66	1.83	0.79	0.39	0.13	0.09	0.23	0.16	0.47	1.24	1.74	12.33
20.0 - 25.0	1.25	0.44	0.23	0.18	0.20	0.15	0.44	1.61	2.07	0.56	0.18	0.08	0.01	0.04	0.13	0.40	1.32	1.93	11.21
25.0 - 30.0	0.99	0.21	0.20	0.11	0.09	0.08	0.14	1.42	1.89	0.42	0.04	0.01	0.02	0.02	0.10	0.25	1.17	2.14	9.28
30.0 - 35.0	0.73	0.21	0.11	0.05	0.04	0.03	0.10	1.31	1.85	0.31	0.01	0.00	0.00	0.02	0.03	0.26	0.92	2.12	8.11
35.0 - 40.0	0.56	0.09	0.09	0.04	0.00	0.00	0.02	0.80	1.94	0.13	0.00	0.00	0.00	0.01	0.02	0.17	0.88	1.97	6.73
40.0 - 45.0	0.33	0.03	0.06	0.00	0.00	0.01	0.01	0.63	1.71	0.06	0.00	0.00	0.00	0.00	0.01	0.09	1.00	1.60	5.53
45.0 - 50.0	0.29	0.03	0.01	0.02	0.00	0.00	0.00	0.41	1.30	0.05	0.00	0.00	0.00	0.00	0.00	0.03	0.69	1.44	4.27
50.0 - 55.0	0.23	0.01	0.02	0.00	0.00	0.00	0.00	0.24	1.26	0.05	0.00	0.00	0.00	0.00	0.00	0.05	0.42	1.27	3.54
55.0 - 60.0	0.15	0.01	0.00	0.00	0.00	0.00	0.00	0.17	1.15	0.02	0.00	0.00	0.00	0.00	0.00	0.01	0.30	1.10	2.90
60.0 - 65.0	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.74	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.70	1.83
65.0 - 70.0	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.37	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.34	1.06
70.0 - 75.0	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.23	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.19	0.63
75.0 - 80.0	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.18	0.39
80.0 - 85.0	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.13	0.24
85.0 - 90.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.09	0.11
90.0 - 95.0	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.05	0.08
95.0 - 100.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04
100.0 - >	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.08
TOTAL	8.19	3.26	2.62	2.04	2.10	2.21	3.63	11.21	19.08	4.59	2.14	1.36	1.16	1.32	1.76	3.29	10.44	19.61	100.00

LOCATION: Washington State Outer Coast
DATE: October 30 2002 - March 12, 2003
DEPTH: 18 Meters
NUMBER OF OBSERVATIONS: 12780

DIRECTION (DEGREES TRUE)

SPEED CM/SEC	0-20	20-40	40-60	60-80	80-100	100-120	120-140	140-160	160-180	180-200	200-220	220-240	240-260	260-280	280-300	300-320	320-340	340-360	TOTAL
0.0 - 5.0	0.37	0.38	0.26	0.27	0.28	0.35	0.29	0.39	0.25	0.42	0.27	0.24	0.28	0.30	0.20	0.32	0.29	0.22	5.38
5.0 - 10.0	0.90	0.61	0.77	0.49	0.72	0.84	1.00	0.89	1.05	0.65	0.67	0.50	0.54	0.42	0.56	0.59	0.70	0.63	12.53
10.0 - 15.0	0.97	0.81	0.50	0.41	0.46	0.64	1.05	1.37	1.42	0.90	0.67	0.31	0.27	0.27	0.36	0.65	1.04	1.27	13.36
15.0 - 20.0	1.12	0.52	0.23	0.24	0.31	0.32	0.74	1.42	1.67	0.81	0.28	0.24	0.16	0.15	0.25	0.62	1.24	1.62	11.96
20.0 - 25.0	0.97	0.34	0.17	0.09	0.14	0.20	0.44	1.42	2.03	0.77	0.13	0.03	0.03	0.11	0.15	0.45	1.35	2.00	10.81
25.0 - 30.0	0.63	0.27	0.10	0.11	0.09	0.07	0.26	1.42	1.79	0.50	0.04	0.00	0.00	0.02	0.15	0.35	1.59	1.97	9.37
30.0 - 35.0	0.54	0.05	0.04	0.01	0.05	0.03	0.13	1.24	1.93	0.36	0.02	0.00	0.00	0.00	0.08	0.31	1.40	1.81	8.00
35.0 - 40.0	0.34	0.11	0.07	0.03	0.01	0.02	0.05	1.20	1.89	0.12	0.00	0.00	0.00	0.00	0.04	0.25	1.28	1.60	7.02
40.0 - 45.0	0.28	0.06	0.02	0.02	0.00	0.00	0.01	0.70	1.72	0.10	0.01	0.00	0.00	0.00	0.01	0.23	1.02	1.49	5.66
45.0 - 50.0	0.21	0.02	0.01	0.01	0.00	0.01	0.00	0.56	1.36	0.05	0.00	0.00	0.00	0.00	0.00	0.14	1.01	1.22	4.59
50.0 - 55.0	0.13	0.00	0.01	0.01	0.00	0.00	0.01	0.30	1.06	0.03	0.00	0.00	0.00	0.00	0.00	0.02	0.77	1.26	3.59
55.0 - 60.0	0.08	0.00	0.00	0.02	0.00	0.00	0.00	0.20	0.99	0.02	0.00	0.00	0.00	0.00	0.00	0.02	0.52	1.07	2.91
60.0 - 65.0	0.06	0.00	0.00	0.01	0.00	0.00	0.00	0.12	0.94	0.01	0.00	0.00	0.00	0.00	0.00	0.03	0.34	0.51	2.02
65.0 - 70.0	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.52	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.25	0.36	1.25
70.0 - 75.0	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.15	0.19	0.59
75.0 - 80.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.16	0.56
80.0 - 85.0	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.07	0.13
85.0 - 90.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.03	0.09
90.0 - 95.0	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.08	0.10
95.0 - 100.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.04	0.05
100.0 - >	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03
TOTAL	6.69	3.18	2.18	1.72	2.05	2.48	3.97	11.32	19.13	4.75	2.08	1.32	1.28	1.28	1.78	3.99	13.15	17.64	100.00

LOCATION: Washington State Outer Coast
DATE: October 30 2002 - March 12, 2003
DEPTH: 14 Meters
NUMBER OF OBSERVATIONS: 12780

DIRECTION (DEGREES TRUE)

SPEED CM/SEC	0-20	20-40	40-60	60-80	80-100	100-120	120-140	140-160	160-180	180-200	200-220	220-240	240-260	260-280	280-300	300-320	320-340	340-360	TOTAL
0.0 - 5.0	0.25	0.29	0.27	0.23	0.23	0.38	0.38	0.34	0.31	0.34	0.25	0.26	0.27	0.25	0.28	0.24	0.30	0.32	5.18
5.0 - 10.0	0.78	0.70	0.60	0.64	0.58	0.82	1.15	1.14	1.02	0.76	0.56	0.42	0.36	0.41	0.38	0.57	0.67	0.76	12.32
10.0 - 15.0	0.94	0.67	0.56	0.49	0.52	0.72	1.03	1.31	1.36	1.03	0.49	0.23	0.33	0.27	0.45	0.61	1.01	1.06	13.08
15.0 - 20.0	0.93	0.43	0.34	0.23	0.33	0.39	0.86	1.54	1.80	0.74	0.36	0.12	0.12	0.15	0.36	0.77	1.25	1.50	12.22
20.0 - 25.0	0.82	0.26	0.06	0.08	0.16	0.27	0.55	1.54	2.08	0.55	0.13	0.10	0.09	0.16	0.20	0.71	1.55	1.95	11.26
25.0 - 30.0	0.56	0.12	0.14	0.06	0.09	0.11	0.27	1.51	1.82	0.31	0.05	0.02	0.03	0.05	0.16	0.59	1.60	1.68	9.16
30.0 - 35.0	0.26	0.13	0.05	0.05	0.05	0.02	0.15	1.57	1.85	0.23	0.02	0.02	0.01	0.01	0.12	0.43	1.75	1.78	8.47
35.0 - 40.0	0.27	0.09	0.05	0.03	0.01	0.02	0.06	1.13	1.71	0.17	0.01	0.00	0.00	0.00	0.05	0.27	1.49	1.37	6.74
40.0 - 45.0	0.23	0.08	0.02	0.04	0.01	0.00	0.02	0.83	1.57	0.10	0.01	0.00	0.00	0.00	0.00	0.33	1.41	1.22	5.86
45.0 - 50.0	0.10	0.01	0.02	0.00	0.00	0.01	0.02	0.52	1.41	0.02	0.00	0.00	0.00	0.00	0.00	0.17	1.41	1.07	4.76
50.0 - 55.0	0.05	0.01	0.00	0.02	0.00	0.00	0.00	0.39	1.06	0.03	0.00	0.00	0.00	0.00	0.01	0.16	1.19	0.81	3.72
55.0 - 60.0	0.06	0.00	0.01	0.01	0.00	0.00	0.00	0.17	1.00	0.01	0.00	0.00	0.00	0.00	0.00	0.07	0.81	0.62	2.76
60.0 - 65.0	0.04	0.00	0.00	0.01	0.00	0.00	0.00	0.13	0.81	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.50	0.38	1.88
65.0 - 70.0	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.48	0.01	0.00	0.00	0.00	0.00	0.00	0.02	0.34	0.20	1.09
70.0 - 75.0	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.19	0.14	0.68
75.0 - 80.0	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.12	0.06	0.41
80.0 - 85.0	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.04	0.17
85.0 - 90.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.05	0.14
90.0 - 95.0	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.05
95.0 - 100.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.03
100.0 - >	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02
TOTAL	5.34	2.77	2.12	1.89	1.96	2.75	4.48	12.24	18.86	4.29	1.88	1.17	1.20	1.29	2.00	4.99	15.71	15.07	100.00

LOCATION: Washington State Outer Coast
DATE: October 30 2002 - March 12, 2003
DEPTH: 10 Meters
NUMBER OF OBSERVATIONS: 12780

DIRECTION (DEGREES TRUE)

SPEED CM/SEC	0-20	20-40	40-60	60-80	80-100	100-120	120-140	140-160	160-180	180-200	200-220	220-240	240-260	260-280	280-300	300-320	320-340	340-360	TOTAL
0.0 - 5.0	0.34	0.29	0.33	0.28	0.25	0.41	0.29	0.25	0.34	0.23	0.27	0.24	0.26	0.21	0.16	0.20	0.26	0.24	4.84
5.0 - 10.0	0.74	0.52	0.60	0.55	0.77	0.74	0.94	1.03	0.90	0.93	0.55	0.50	0.41	0.39	0.41	0.47	0.72	0.71	11.86
10.0 - 15.0	0.95	0.68	0.52	0.67	0.52	0.77	1.00	1.32	1.32	0.73	0.46	0.25	0.31	0.36	0.49	0.65	1.14	1.08	13.23
15.0 - 20.0	0.88	0.41	0.29	0.33	0.29	0.45	0.82	1.98	1.82	0.72	0.23	0.20	0.22	0.30	0.44	0.83	1.44	1.22	12.88
20.0 - 25.0	0.58	0.34	0.16	0.16	0.11	0.20	0.67	1.77	2.00	0.38	0.09	0.08	0.07	0.10	0.22	0.86	1.78	1.64	11.20
25.0 - 30.0	0.52	0.09	0.07	0.06	0.13	0.11	0.26	1.85	1.94	0.26	0.08	0.06	0.05	0.07	0.20	0.79	2.07	1.49	10.10
30.0 - 35.0	0.33	0.09	0.03	0.03	0.08	0.05	0.21	1.52	1.85	0.16	0.04	0.01	0.02	0.08	0.14	0.59	2.05	1.31	8.58
35.0 - 40.0	0.18	0.10	0.02	0.03	0.05	0.04	0.03	1.13	1.90	0.12	0.00	0.00	0.01	0.01	0.05	0.52	1.82	1.18	7.21
40.0 - 45.0	0.20	0.05	0.03	0.01	0.02	0.01	0.02	0.79	1.46	0.05	0.00	0.00	0.00	0.01	0.07	0.46	1.71	1.08	5.95
45.0 - 50.0	0.06	0.03	0.02	0.02	0.00	0.00	0.01	0.58	1.32	0.01	0.00	0.00	0.00	0.01	0.04	0.35	1.67	0.64	4.76
50.0 - 55.0	0.05	0.02	0.00	0.02	0.00	0.00	0.00	0.36	1.21	0.02	0.00	0.00	0.00	0.00	0.01	0.24	1.28	0.53	3.74
55.0 - 60.0	0.02	0.00	0.01	0.00	0.00	0.00	0.00	0.22	0.95	0.00	0.00	0.00	0.00	0.00	0.01	0.11	0.72	0.33	2.36
60.0 - 65.0	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.64	0.01	0.00	0.00	0.00	0.00	0.01	0.06	0.39	0.20	1.46
65.0 - 70.0	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.31	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.25	0.13	0.79
70.0 - 75.0	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.11	0.06	0.42
75.0 - 80.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.13	0.05	0.38
80.0 - 85.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.02	0.09
85.0 - 90.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.05	0.09
90.0 - 95.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.02
95.0 - 100.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01
100.0 - >	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02
TOTAL	4.87	2.62	2.08	2.16	2.21	2.77	4.24	13.05	18.29	3.62	1.71	1.35	1.34	1.53	2.26	6.30	17.64	11.97	100.00

LOCATION: Washington State Outer Coast
DATE: October 30 2002 - March 12, 2003
DEPTH: 6 Meters
NUMBER OF OBSERVATIONS: 12780

DIRECTION (DEGREES TRUE)

SPEED CM/SEC	0-20	20-40	40-60	60-80	80-100	100-120	120-140	140-160	160-180	180-200	200-220	220-240	240-260	260-280	280-300	300-320	320-340	340-360	TOTAL
0.0 - 5.0	0.39	0.34	0.26	0.27	0.38	0.37	0.38	0.34	0.27	0.30	0.22	0.31	0.22	0.25	0.36	0.27	0.28	0.27	5.46
5.0 - 10.0	0.67	0.72	0.74	0.63	0.68	0.75	1.01	1.03	0.94	0.75	0.53	0.39	0.38	0.40	0.49	0.52	0.62	0.82	12.06
10.0 - 15.0	0.93	0.74	0.68	0.56	0.61	0.84	1.06	1.73	1.53	0.63	0.41	0.28	0.23	0.32	0.49	0.81	1.11	0.99	13.96
15.0 - 20.0	0.86	0.58	0.39	0.31	0.41	0.38	1.13	2.03	1.88	0.56	0.21	0.16	0.19	0.31	0.52	1.00	1.42	1.10	13.42
20.0 - 25.0	0.68	0.29	0.15	0.15	0.14	0.31	0.56	2.35	1.92	0.29	0.06	0.10	0.14	0.25	0.41	1.06	1.84	1.31	12.01
25.0 - 30.0	0.37	0.08	0.05	0.12	0.13	0.13	0.20	1.96	1.89	0.14	0.05	0.02	0.06	0.16	0.35	1.03	2.13	1.56	10.42
30.0 - 35.0	0.22	0.06	0.05	0.10	0.09	0.05	0.14	1.86	1.86	0.13	0.01	0.01	0.05	0.10	0.28	0.88	2.16	1.33	9.39
35.0 - 40.0	0.15	0.04	0.03	0.02	0.07	0.02	0.03	1.38	1.60	0.06	0.00	0.00	0.01	0.05	0.19	0.95	1.80	0.92	7.32
40.0 - 45.0	0.09	0.03	0.00	0.02	0.02	0.01	0.01	0.79	1.39	0.02	0.00	0.00	0.00	0.01	0.15	0.81	1.78	0.72	5.85
45.0 - 50.0	0.09	0.05	0.00	0.01	0.00	0.00	0.00	0.59	1.14	0.00	0.00	0.00	0.00	0.01	0.05	0.54	1.29	0.34	4.12
50.0 - 55.0	0.01	0.02	0.01	0.00	0.01	0.00	0.00	0.34	0.95	0.01	0.00	0.00	0.00	0.00	0.02	0.27	0.79	0.23	2.64
55.0 - 60.0	0.02	0.00	0.01	0.01	0.00	0.00	0.00	0.23	0.54	0.01	0.00	0.00	0.00	0.00	0.02	0.21	0.38	0.19	1.62
60.0 - 65.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.36	0.00	0.00	0.00	0.00	0.00	0.02	0.10	0.21	0.08	0.82
65.0 - 70.0	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.16	0.00	0.00	0.00	0.00	0.00	0.01	0.09	0.13	0.06	0.47
70.0 - 75.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.09	0.02	0.19
75.0 - 80.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.05	0.01	0.09
80.0 - 85.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.09
85.0 - 90.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.04
90.0 - 95.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01
95.0 - 100.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
100.0 - >	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01
TOTAL	4.49	2.95	2.36	2.19	2.53	2.85	4.51	14.75	16.54	2.90	1.49	1.27	1.29	1.85	3.36	8.56	16.13	9.99	100.00

LOCATION: Washington State Outer Coast
DATE: October 30 2002 - March 12, 2003
DEPTH: 2 Meters
NUMBER OF OBSERVATIONS: 12780

DIRECTION (DEGREES TRUE)

SPEED CM/SEC	0-20	20-40	40-60	60-80	80-100	100-120	120-140	140-160	160-180	180-200	200-220	220-240	240-260	260-280	280-300	300-320	320-340	340-360	TOTAL
0.0 - 5.0	0.41	0.25	0.33	0.32	0.42	0.50	0.52	0.39	0.46	0.41	0.29	0.38	0.24	0.21	0.38	0.33	0.32	0.44	6.61
5.0 - 10.0	0.99	0.76	0.75	0.81	0.82	1.08	1.35	1.37	1.17	0.99	0.49	0.47	0.46	0.60	0.78	0.79	0.97	1.06	15.72
10.0 - 15.0	1.13	0.96	0.61	0.70	0.72	0.96	1.56	2.33	1.61	0.71	0.40	0.28	0.42	0.52	0.91	1.13	1.35	1.53	17.84
15.0 - 20.0	1.12	0.55	0.38	0.27	0.44	0.55	1.12	3.08	1.94	0.53	0.16	0.15	0.20	0.53	0.70	1.27	2.09	1.71	16.78
20.0 - 25.0	0.77	0.27	0.20	0.15	0.16	0.26	0.70	2.60	1.98	0.22	0.05	0.04	0.14	0.20	0.65	1.30	2.38	1.86	13.93
25.0 - 30.0	0.36	0.11	0.05	0.10	0.06	0.05	0.22	2.23	1.58	0.06	0.00	0.01	0.08	0.11	0.50	1.26	2.35	1.36	10.49
30.0 - 35.0	0.17	0.05	0.02	0.02	0.04	0.00	0.09	1.64	1.24	0.02	0.01	0.00	0.03	0.06	0.37	0.75	2.08	1.04	7.63
35.0 - 40.0	0.13	0.02	0.00	0.02	0.02	0.00	0.02	1.05	0.95	0.02	0.00	0.00	0.00	0.02	0.23	0.65	1.56	0.61	5.31
40.0 - 45.0	0.05	0.05	0.02	0.00	0.01	0.00	0.01	0.56	0.56	0.01	0.00	0.00	0.00	0.01	0.06	0.41	0.80	0.38	2.93
45.0 - 50.0	0.03	0.01	0.00	0.02	0.00	0.00	0.00	0.30	0.43	0.00	0.00	0.00	0.00	0.00	0.01	0.19	0.35	0.13	1.46
50.0 - 55.0	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.09	0.18	0.00	0.00	0.00	0.00	0.00	0.05	0.09	0.13	0.08	0.64
55.0 - 60.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.05	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.13	0.04	0.31
60.0 - 65.0	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.09	0.01	0.16
65.0 - 70.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.09	0.01	0.13
70.0 - 75.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.03
75.0 - 80.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.02
80.0 - 85.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01
85.0 - 90.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
90.0 - 95.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
95.0 - 100.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
100.0 - >	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	5.20	3.04	2.36	2.40	2.70	3.40	5.59	15.73	12.17	2.97	1.39	1.33	1.58	2.25	4.64	8.25	14.73	10.27	100.00