

# Stulaigh South, South Uist

## Hydrographic Data Report: Deployment ID208

### 8<sup>th</sup> March to 17<sup>th</sup> April 2018

October 2022  
Mowi Scotland Limited

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**QUALITY ASSURANCE**

Mowi Scotland Ltd is ISO9001 and ISO14001 accredited and all project management follows policies designed to ensure that the collection, collation and reporting of information produced in the course of our operations is done to a consistently high standard meeting the requirements of the end user.

# 1. Introduction

Mowi Scotland Ltd. is preparing an application to the Scottish Environmental Protection Agency (SEPA) for a new salmon farm site, Stulaigh South, located just south of Stulaigh island, South Uist. Mowi Scotland Ltd. propose to equip the new site at Stulaigh south with 6 x 200m circumference pens, with 16m deep nets, held in a 120m grid.

Mowi Scotland Ltd have carried out hydrographic surveys at the site in 2018. Hydrographic data at Stulaigh South was gathered during this time in two deployments:

- i. 8<sup>th</sup> March 2018 to 17<sup>th</sup> April 2018 (ID208)
- ii. 22<sup>nd</sup> May 2018 to 14<sup>th</sup> August 2018 (ID224)

This report describes the data from the 8<sup>th</sup> March to 17<sup>th</sup> April 2018 deployment at Stulaigh South. The purpose of this report is to assess the suitability of the collected hydrographic data for calibration of a hydrodynamic model of the South Uist region and input into the NewDepomod model.



Figure 1. Site location (top) and layout (bottom) and of the proposed salmon farm off South Uist. The current meter deployment locations are marked by the black triangles.

## 2. Materials & Methods

### 2.1 Bathymetry

Bathymetry was taken from the ECLH model which has reasonably high spatial resolution around South Uist, supplemented by a local depth survey (Figure 2). The combined data were interpolated onto the South Uist model mesh.

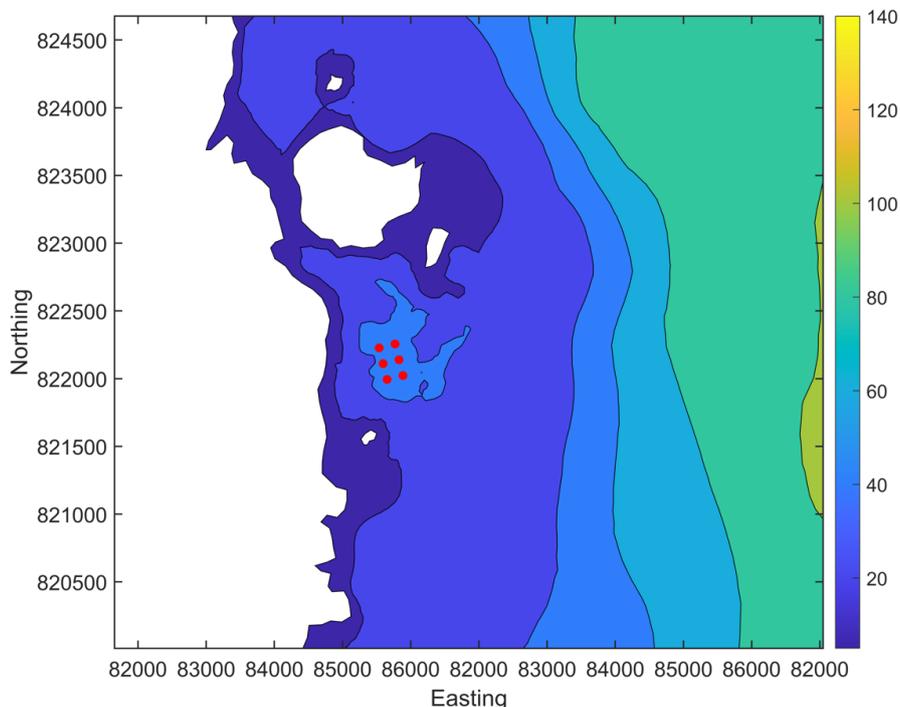


Figure 2. Bathymetry in the region around the proposed Stulaigh South salmon farm.

### 2.2 Current Data

Mowi staff carried out hydrographic surveys at the site during 2018. The purpose of this hydrographic report is to assess the suitability of the collected hydrographic data for use with the NewDepomod and Hydrodynamic models. The data contained in this report were recorded at the site from 8<sup>th</sup> March to 17<sup>th</sup> April 2018 (39 days and 21 hours of data; deployment ID208). The data from another deployment (ID224) are presented in a separate hydrographic report.

The Sentinel V100 (Wide) ADCP (Table 1), within its mooring frame, was positioned at 57.1812N, -7.24217W (83371E 822233N), which was approximately 490m from the nearest shoreline and approximately 110m from the centre of the proposed cage group (Figure 1). The transducer head was 70 cm from the base of the mooring frame. The mean depth (derived from the pressure sensor) at the Sentinel V100 ADCP position was 46.54 m.

Initial soundings were taken to establish the possible depth the Sentinel V100 ADCP would be situated at during high tide and so that the most appropriate cell size could be determined. The cell size was set at 1.0 m and the number of cells to 60.

Data was automatically written and stored to the internal memory within the Sentinel V100 ADCP main body and then downloaded to computer after completion of the deployment period via WiFi.

### *2.3 Magnetic Variation*

No magnetic variation correction was made to the Sentinel V100 ADCP during deployment, this was undertaken to the data after the instrument was recovered and data downloaded. The magnetic variation used was  $-4.17^\circ$ ; this was determined using the World Magnetic Model, produced jointly with the US National Oceanographic and Atmospheric Administration's National Geophysical Data center. Further details can be found at <http://www.geomag.bgs.ac.uk/navigation.html>

### *2.4 Data Processing*

Upon retrieval of the Sentinel V100 ADCP current meter, all data was downloaded to a computer for analysis. The raw data file was opened in Teledyne's "Velocity" software and Matlab. Deployment diagnostic data (beam intensity, correlation, pitch and roll) were analysed to confirm that the deployment was successful with the instrument orientated upright. The heading data were also examined to identify any movement of the Sentinel V100 ADCP mooring frame during the deployment.

The diagnostic data suggested that velocities from the first 34 bins were valid (Figure 3). Calculations were undertaken to identify the cells to be used for surface and middle currents. Surface data was taken at an average depth (derived from the pressure sensor) of 7.58 m (cell 34), and cage-bottom data at 14.58 m (cell 27). Surface and middle cell heights were 36.71 m and 29.71 m from the seabed respectively. The bottom cell (cell 1) was at a depth of 40.58 m and 3.71 m above the seabed.

Table 1: Sentinel V100 ADCP Specifications.

Depth Cell Size <sup>1</sup>	V20 (1000kHz)		V50 (500kHz)		V100 (300kHz)		
	Depth Cell Size <sup>1</sup>	Range (m) <sup>2,3</sup> Wide/Narrow	Std Dev (cm/s) <sup>3,4</sup> Wide/Narrow	Range (m) <sup>2,3</sup> Wide/Narrow	Std Dev (cm/s) <sup>3,4</sup> Wide/Narrow	Range (m) <sup>2,3</sup> Wide/Narrow	Std Dev (cm/s) <sup>3,4</sup> Wide/Narrow
	0.25m	18.0/22.6	19.2/36.5				
	0.3m	19.3/24.0	11.1/20.8				
	0.5m	20.2/24.9	7.1/13.4	44.1/57.6	19.2/36.5		
	1.0m	22.1/26.9	3.6/6.7	50.5/64.6	7.1/13.5	94.5/120.6	10.9/20.6
	2.0m	24.5/29.4	1.7/3.2	56.0/70.6	3.6/6.7	103.5/130.4	5.5/10.3
	4.0m	26.9/32.0	0.8/1.6	63.1/78.2	1.7/3.2	114.6/142.3	2.7/5.2
	6.0m			67.4/82.8	1.1/2.1	121.7/151.5	1.8/3.3
<b>Communications and Recording</b>	Wireless			802.11b/g/n			
	Internal memory			One 16GB Micro SD Card included			
<b>Profile Parameters</b>	Velocity accuracy			V20/V50: 0.3% of the water velocity relative to the ADCP ±0.3cm/s V100: 0.5% of the water velocity relative to the ADCP ±0.5cm/s			
	Velocity resolution			0.1cm/s			
	Velocity range			±5m/s (default); ±20m/s (maximum)			
	Ping rate			Up to 4Hz			
<b>Echo Intensity Profile</b>	Vertical resolution			Depth cell size			
	Dynamic range			80dB			
	Precision			±1.5dB			
<b>Transducer and Hardware</b>	Beam angle			25°			
	Configuration			4-beam, convex; 5th beam vertical			
	Depth rating			200m			
	Materials			Transducer, housing, and end cap: plastic Connector: metal shell			
<b>Standard Sensors</b>	Temperature (mounted on transducer)			Range -5° to 45°C, precision ±0.4°C, resolution 0.1°			
	Compass (magneto-inductive sensor)			Accuracy 2° RMS, resolution 0.1°, max. dip angle 85°			
	Tilt (MEMS accelerometers)			Pitch range ±90°, roll range ±180°, accuracy 2° RMS, precision 0.05° RMS, resolution 0.1°			
	Pressure sensor (mounted on transducer)			Range 300m, accuracy 0.1%FS			
<b>Power</b>	External DC input			12–20VDC			
	Internal battery voltage			18VDC new			
	Battery capacity; over-the-counter @0°C			100 watt hours (typical)			
	Battery pack @5°C			510 watt hours			
<b>Software</b>	Teledyne RDI's new software included			ReadyW—Pre-deployment (testing, planning, and data recovery) <sup>5</sup> Velocity—Post-processing (data handling, display, and export) <sup>6</sup>			
<b>Environmental</b>	Standard depth rating			200m			
	Operating temperature			-5° to 45°C			
	Storage temperature (without batteries)			-30° to 60°C			
	Weight in air			7.5kg – 16.0kg			
	Weight in water			1.6kg – 6.0kg			
<b>Available Options</b>	External battery case			• AC/DC power converter • 5th beam (at time of order only) • Waves processing • Straight or right-angle metal shell connector			
<b>Dimensions</b>	Special configuration drawing available upon request						

1. User's choice of depth cell, not limited to the typical values specified.  
2. Ranges specified are typical at temperature of 5°C and salinity of 35psu; longer ranges are possible.  
3. User selects the bandwidth mode; wide = 25% or narrow = 6%.  
4. Standard deviations (Std Dev) are typical values for single ping data.  
5. Resident in ADCP accessed via a web browser.  
6. Windows<sup>®</sup> based software program.

Specifications subject to change without notice.

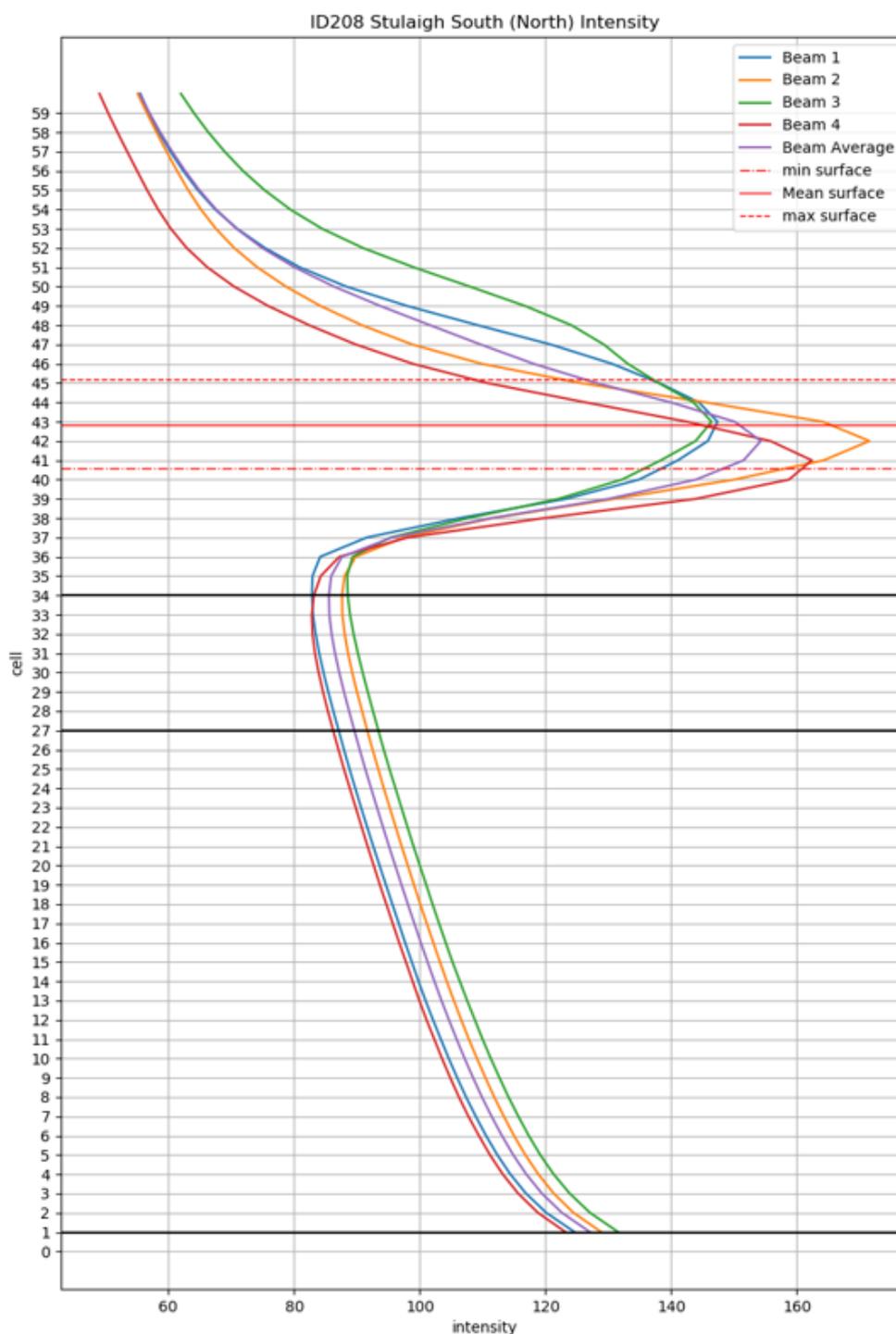


Figure 3. Mean intensity of the ADCP signal for the ID208 dataset plotted by bin number

The ‘first cell range’ is automatically calculated by the instrument, which is the distance from the transducer head to the first cell. For this deployment, the first cell range was calculated as 3.01 m. This value is then added to the height of the instrument frame (0.7 m) to get the first cell height above the seabed, which equated to 3.71 m

Standard deviation has been assessed throughout the deployment to identify accurate and reliable data for near bed, middle (net depth) and surface cells using the following equation:

$$Cell\ StdDev = \frac{Instrument\ StdDev}{\sqrt{No.\ valid\ pings}} \quad (1)$$

The Instrument Standard Deviation (StdDev) in Equation 1 is determined using the deployment settings when the meter is programmed, examples of the StdDev values for different configurations are shown in Table 1. This deployment had a cell size of 1m which equates to an Instrument StdDev of 10.9 cm/s.

The Percentage of valid pings used to calculate Cell StdDev is derived using “Percentage Good” data which allows us to relate the StdDev to the actual data gathered. The percent good data is available for 1, 2, 3 and 4 beams which represent the following:

- Percent good 1 = % of good data computed from 3 Beams
- Percent good 2 = % of bad data due to more than 2 Beam bad
- Percent good 3 = % of bad data due to error velocity exceeded
- Percent good 4 = % of good data computed from 4 Beams

The method described has been used to calculate the Standard deviation throughout the deployment for the surface, middle and bottom cells; the average StdDev values for the surface, middle and bottom was 0.63cm/s, 0.63cm/s and 0.63cm/s respectively which are all within the SEPA criteria of 2cm/s.

### *2.5 Meteorological Data*

The collection of meteorological data is no longer required to support the assessment process and consequently has not been undertaken. The current data used is collected using multiple deployments and over a longer period and thus provides a more realistic representation of site conditions than short deployments, thus allowing an assessment of the influence of meteorological conditions.

## 3. Results and Discussion

A summary of the current data is shown in Figure 4 to Figure 12 and in Table 2 to Table 5. Over the period analysed for this report, the near-surface, middle and bottom cells had current speed averages of 9.5 cm/s, 9.2 cm/s and 9.3 cm/s respectively. This gave an overall average of 9.33 cm/s. The orientation of the tidal velocities was north-west – south-east.

Residual currents at the surface and mid-depth (99°G, 93°G, Figure 7, Figure 8) were toward the east while near-bottom cells were toward the north-east (53°G, Figure 9). The magnitude of the residual currents for the surface, middle and bottom cells were moderate, with mean values of 0.029 m/s, 0.022 m/s and 0.013 m/s respectively.

## 4. Hydrographic Data Summary Sheets

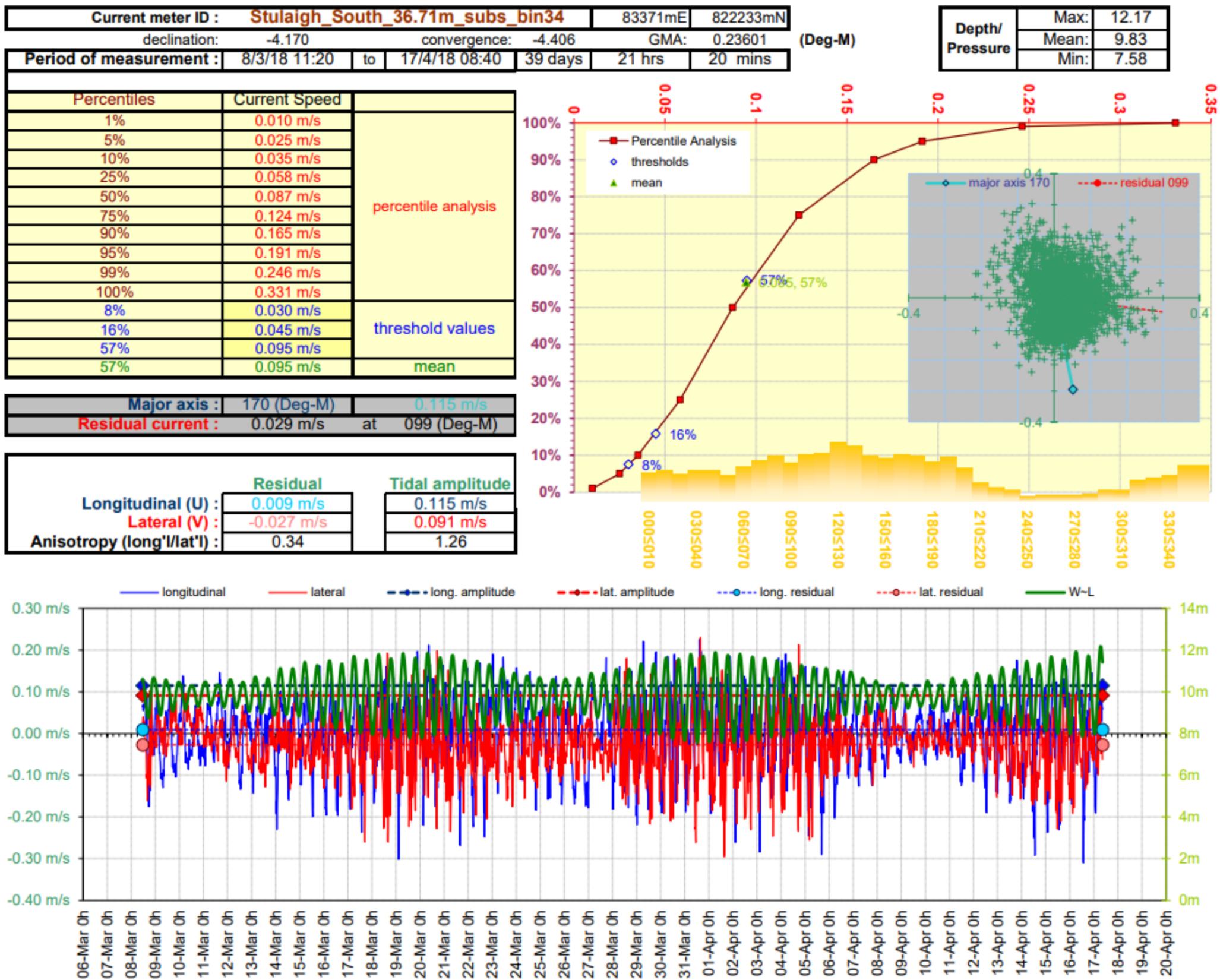


Figure 4. Current Data Summary Sheet for the surface current cell 34, 36.7m from seabed, 8<sup>th</sup> March to 17<sup>th</sup> April 2018 inclusive (ID208).

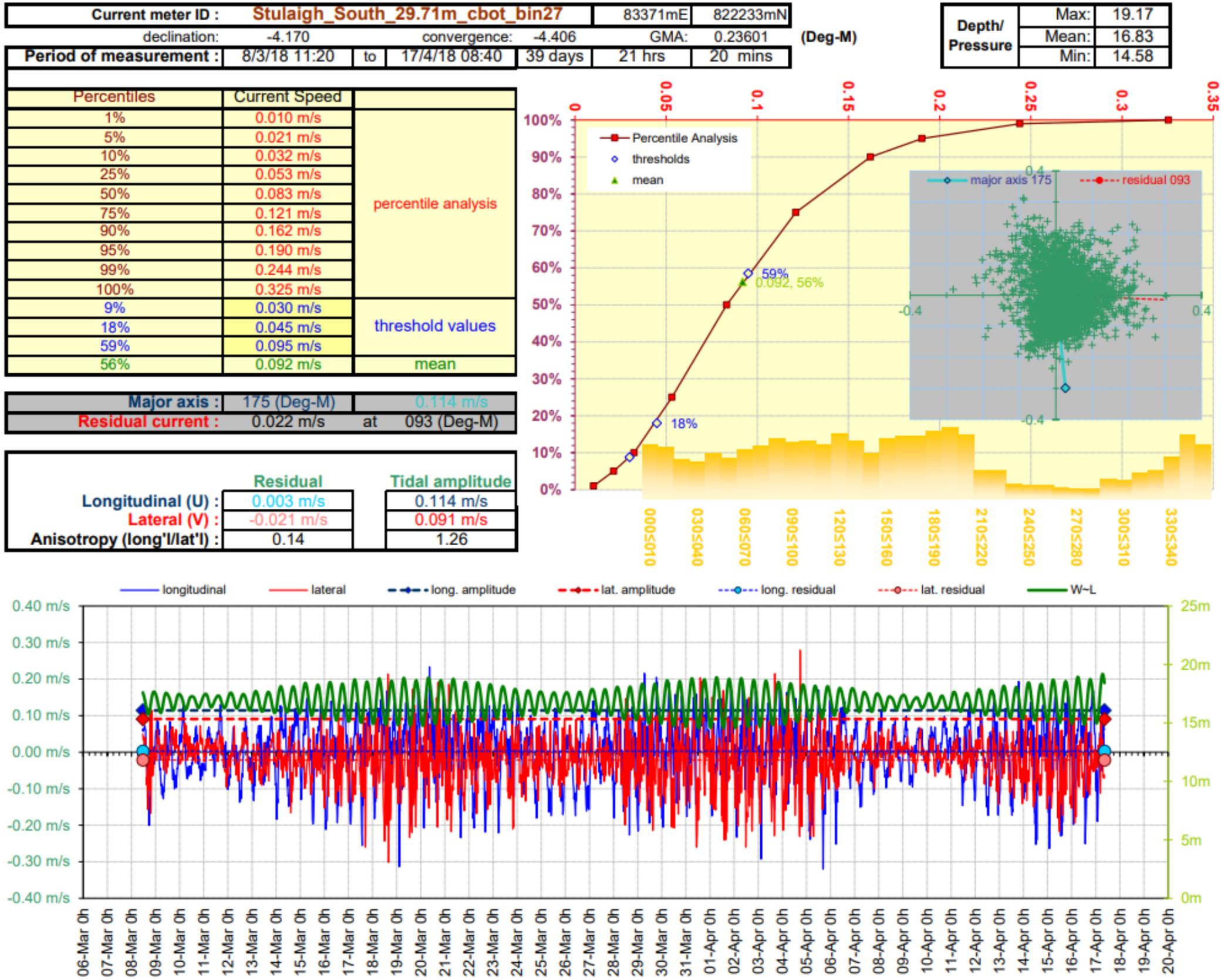


Figure 5. Current Data Summary Sheet for the cage bottom current cell 27, 29.7m from seabed, 8<sup>th</sup> March to 17<sup>th</sup> April 2018 inclusive (ID208).

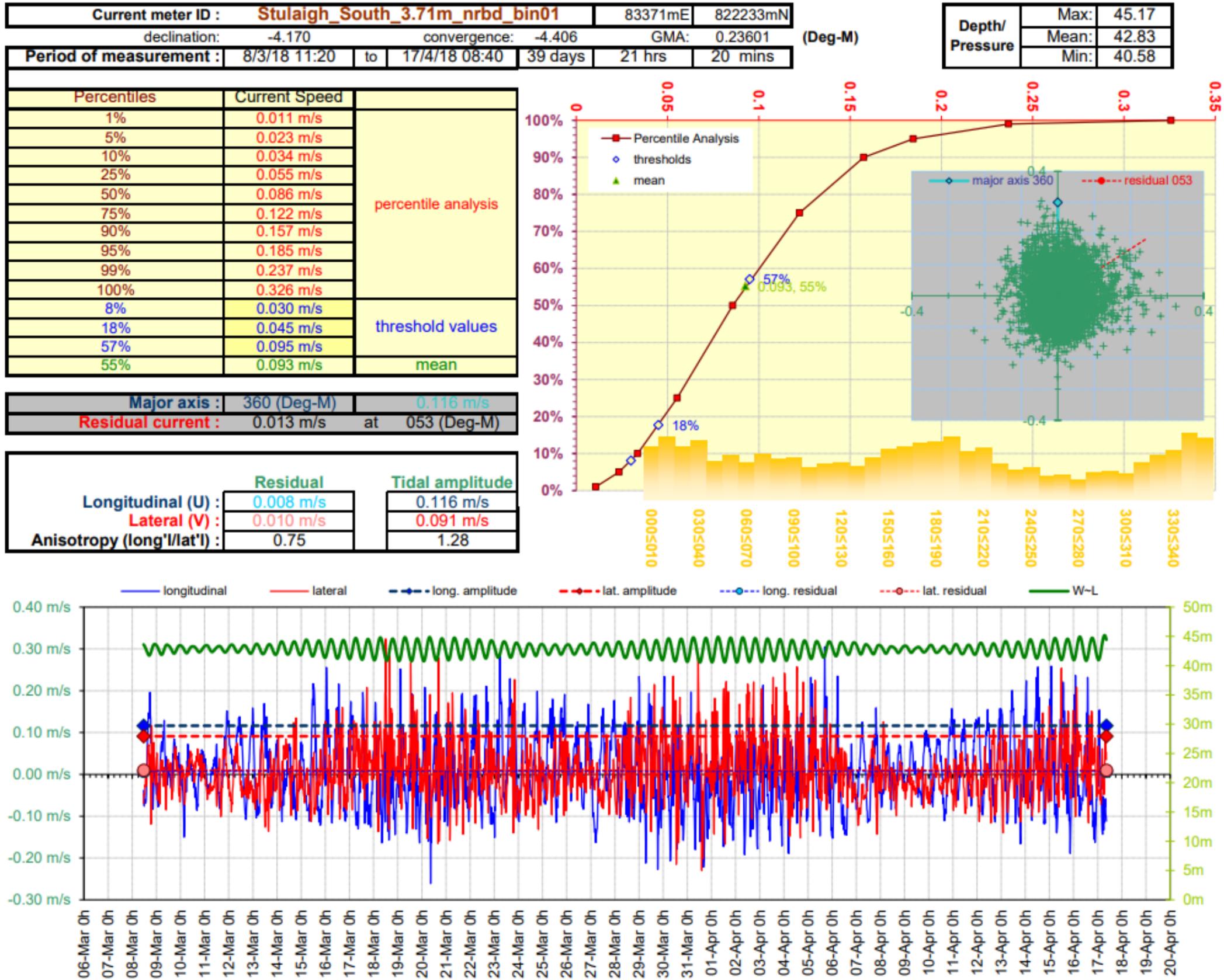


Figure 6. Current Data Summary Sheet for the near bottom current cell 1, 3.7m from seabed, 8<sup>th</sup> March to 17<sup>th</sup> April 2018 inclusive (ID208).

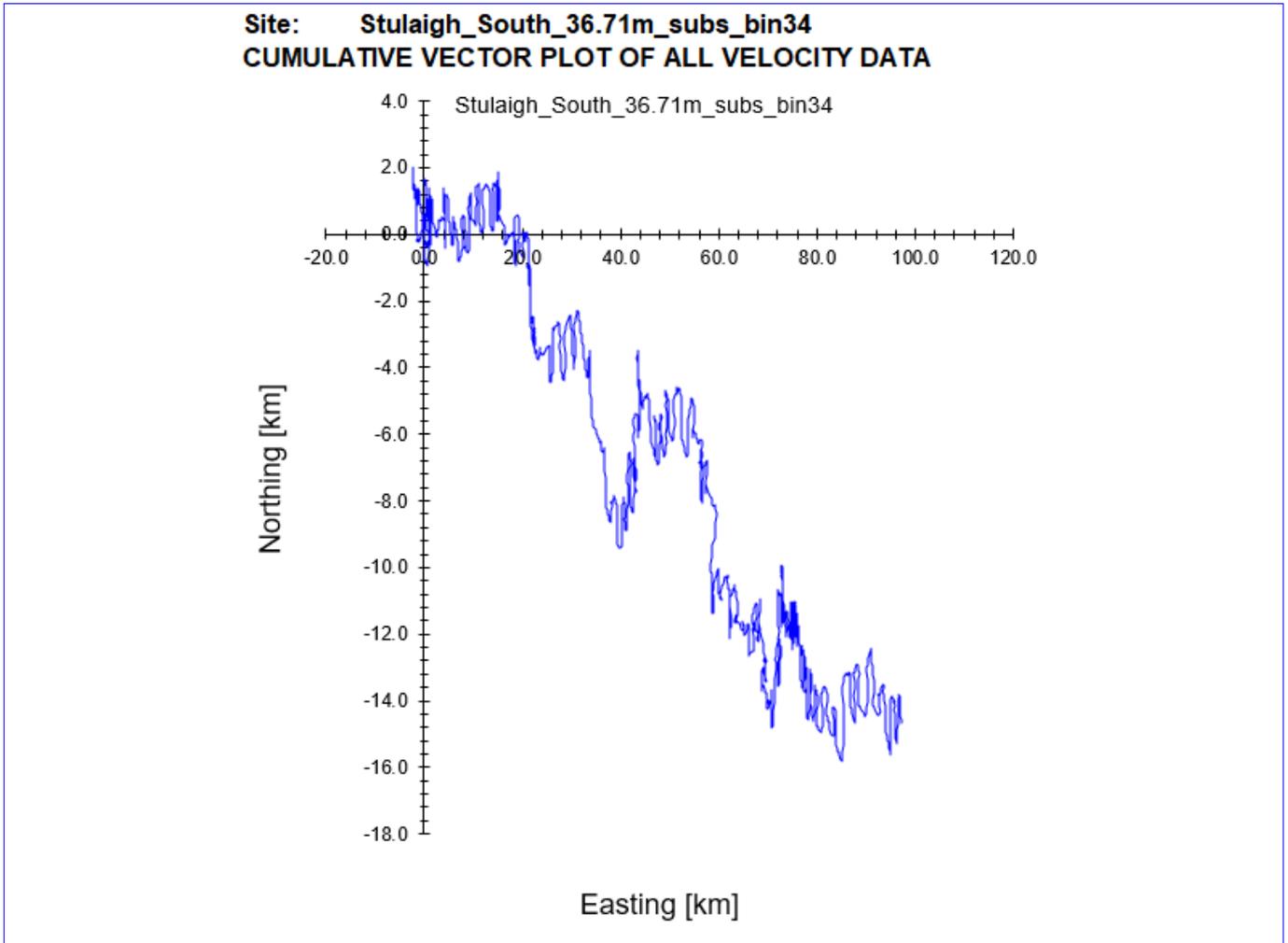


Figure 7. Cumulative Vector Plot of all velocity data from near surface cell for ID208.

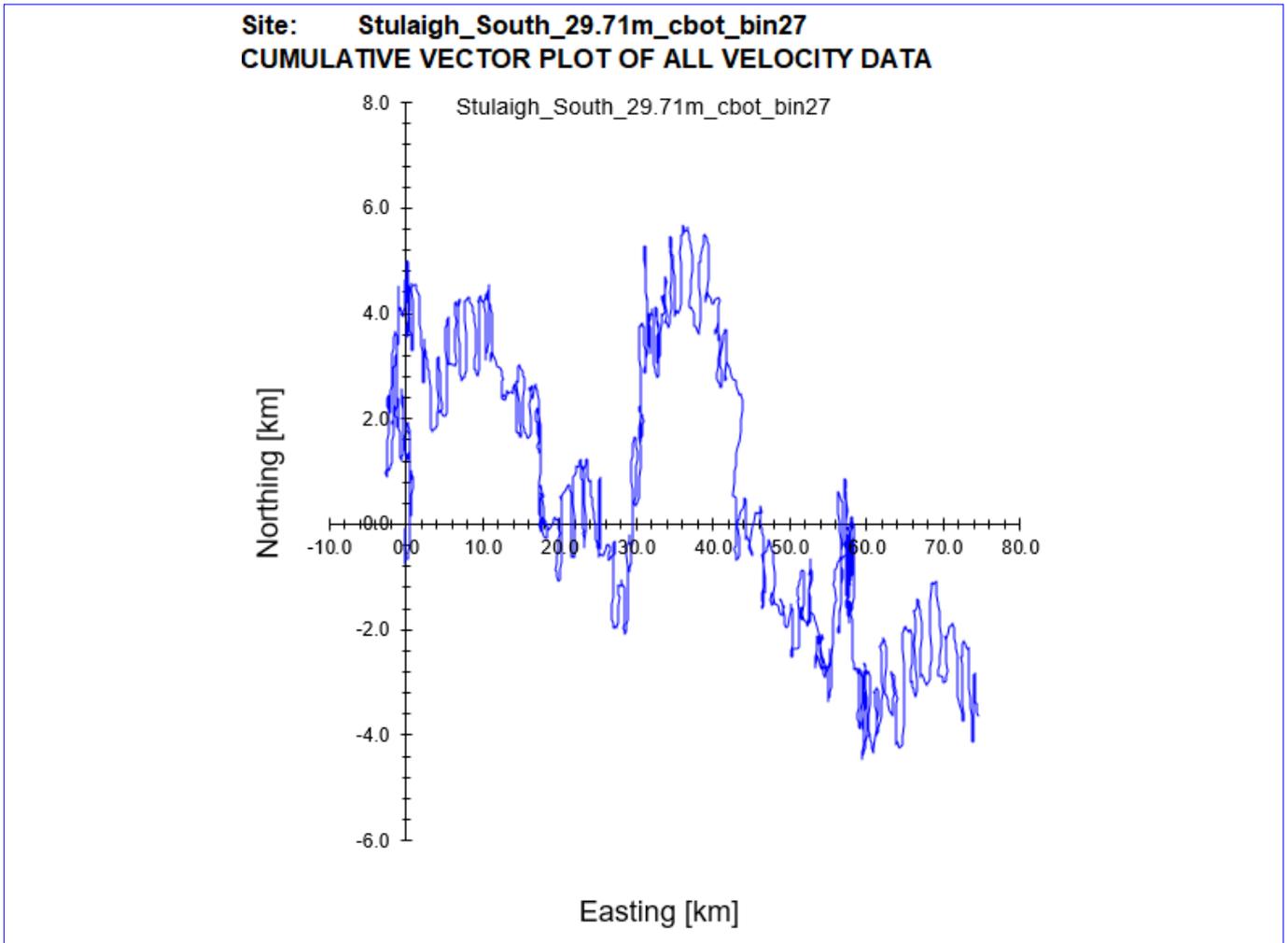


Figure 8. Cumulative Vector Plot of all velocity data from cage bottom cell for ID208.

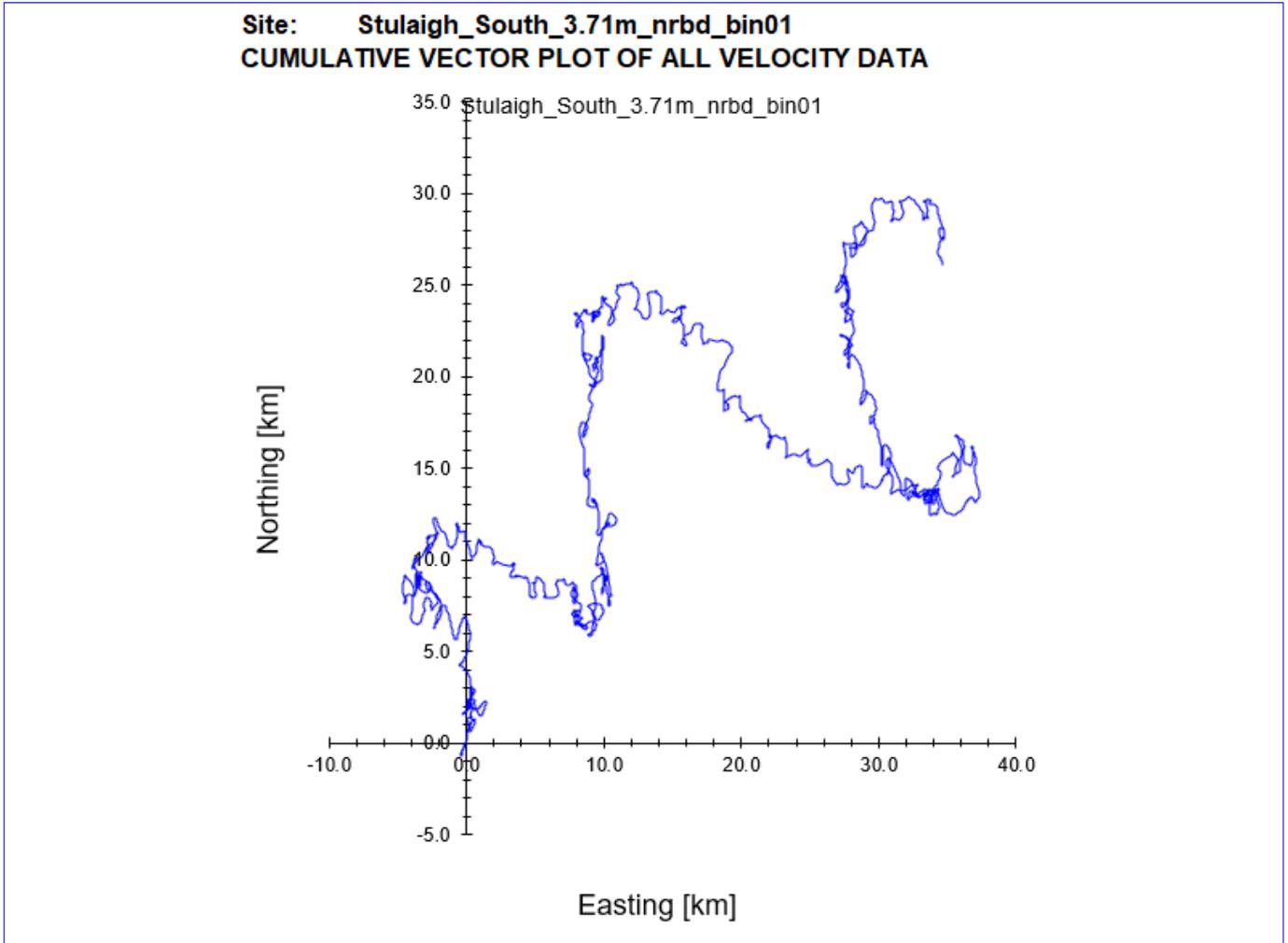


Figure 9. Cumulative Vector Plot of all velocity data from near bottom cell for ID208.

## 5. Summary of Current Data – ID208

Site Name: Stulaigh South  
 Data start date: 08/03/2018  
 Data end date: 17/04/2018  
 Mean Water Depth: 46.54m

Table 2. Summary of current meter deployment

	Cell	Depth Below Surface (m)	Distance from Seabed (m)	Mean current speed (cm/s)
Near surface:	34	7.58	36.71	9.5
Cage bottom:	27	14.58	29.71	9.2
Near bed:	1	40.58	3.71	9.3
Average current speed:				9.33

Table 3. Ranked percentiles for current speed at all three depths

Cell	Ranked Percentile (%) for mean speed	≤3cm/s (%)	≥4.5cm/s (%)	≥9.5cm/s (%)
Near surface:	57	8	84	43
Cage bottom:	56	9	82	41
Near bed:	55	8	82	43

Table 4. Major axis

Cell	Major Axis (Deg-G)
Near surface:	170
Cage Bottom:	175
Near bed:	360

Table 5. Mean and residual currents

Cell	Mean Speed (m/s)	Residual Speed (m/s)	Residual Parallel (m/s)	Residual Normal (m/s)	Tidal Amplitude Parallel (m/s)	Tidal Amplitude Normal (m/s)
Near Surface:	0.095	0.029	0.009	-0.027	0.115	0.091
Cage Bottom:	0.092	0.022	0.003	-0.021	0.114	0.091
Near Bed:	0.093	0.013	0.008	0.010	0.116	0.091

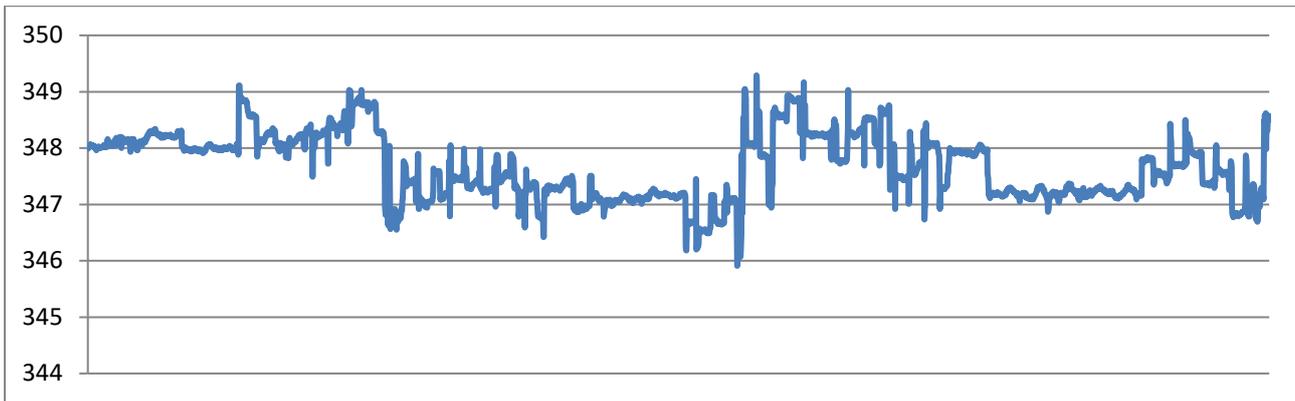


Figure 10. Summary of heading data from deployment ID208.

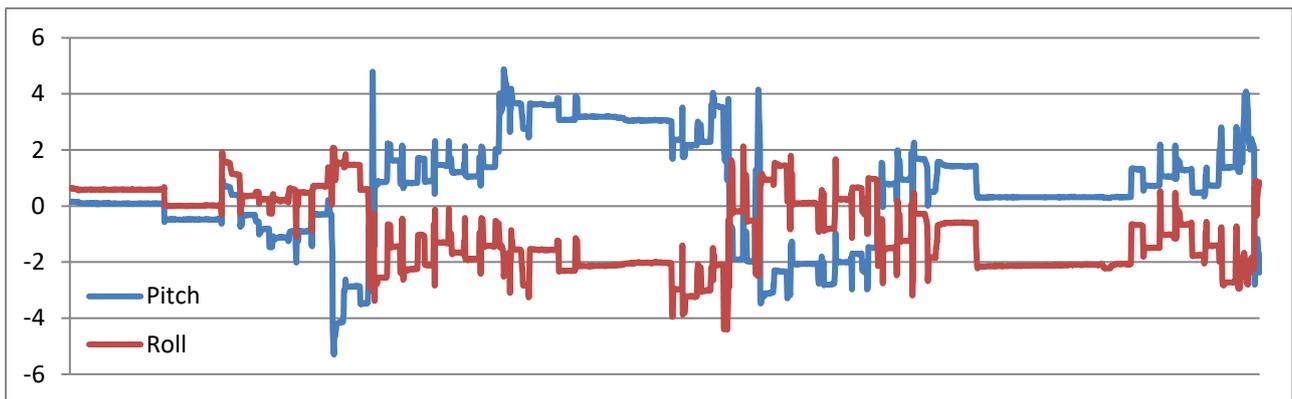


Figure 11. Summary of pitch and roll data from deployment ID208.

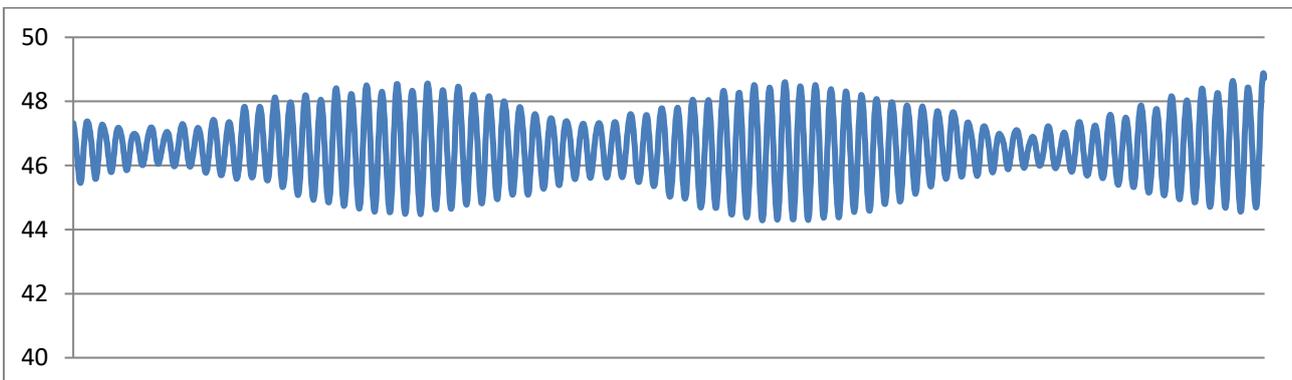


Figure 12. Pressure data from deployment ID208

## 6. Conclusion

MOWI has collected and analysed current and bathymetric data for the proposed salmon farm at Stulaigh South. The analysed current data for the 39 days and 21 hours period are believed to be reliable and representative of the proposed location. The bathymetric data from the ECLH bathymetry data and the local depth survey provided a coherent bathymetric dataset for the site.

## Annex 1. Survey Equipment Deployment Log

Location:	Stulaigh South
Nearest tidal port:	LochBoisdale
Time zone:	UTC
Meter switched on:	11:00 08/03/2018
Meter switched off:	09:00 17/04/2018
Period used for this report:	11:20 08/03/2018 – 08:40 17/04/2018
ADCP serial number:	24563
Meter position:	57.1812N, -7.24217W 83371 E 822233 N
Minimum water depth:	44.29 m (43.59 m measured by ADCP + 0.7 m *)
Water depth (Chart Datum):	44.09 (minimum water depth - 0.2 m tide timetable)
Mean water depth:	47.24 m (46.54 measured by ADCP + 0.7 m *)
Depth of meter from surface:	43.39 m (below chart datum to transducer)
Height of meter from seabed:	0.7 m to transducer head
Sounding at deployment:	43 m @ 11:20 on 07/06/2018

Table A1. ADCP meter settings:

Reference:	Transducer
Bin size (m):	1.0
Dist to 1 <sup>st</sup> bin (m):	3.01
Number of bins:	60
Frequency (kHz):	307
Recording interval (mins):	20
No. pings per ensemble:	300
Magnetic correction:	0
Ensemble:	300
Standard Deviation (cm/sec):	0.63
Time/Ping (seconds):	2