

# Linnhe

## Hydrographic Data Report: Deployment ID277

### 23<sup>rd</sup> May to 16<sup>th</sup> August 2019

December 2021  
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**QUALITY ASSURANCE**

MowiScotland 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 technical variation of CAR/L/1009970 to increase the Azamethiphos (Salmosan) consent at the existing salmon farm located in Loch Linnhe, Linnhe (Figure 1. Site layout of the salmon farm Linnhe. The current meter deployment locations are marked by the black triangles., following a change in equipment to 10 x 120m circumference pens.

MowiScotland Ltd have carried out hydrographic surveys at the site in 2019. Hydrographic data at Linnhe was gathered during this time in two deployments:

- i. 23<sup>rd</sup> May to 16<sup>th</sup> August 2019 (ID277)
- ii. 27<sup>th</sup> August to 27<sup>th</sup> September 2019 (ID282)

This report describes the data from the 23<sup>rd</sup> May to 16<sup>th</sup> August deployment at Linnhe. The purpose of this report is to assess the suitability of the collected hydrographic data for input into a hydrodynamic model of the Loch Linnhe region.

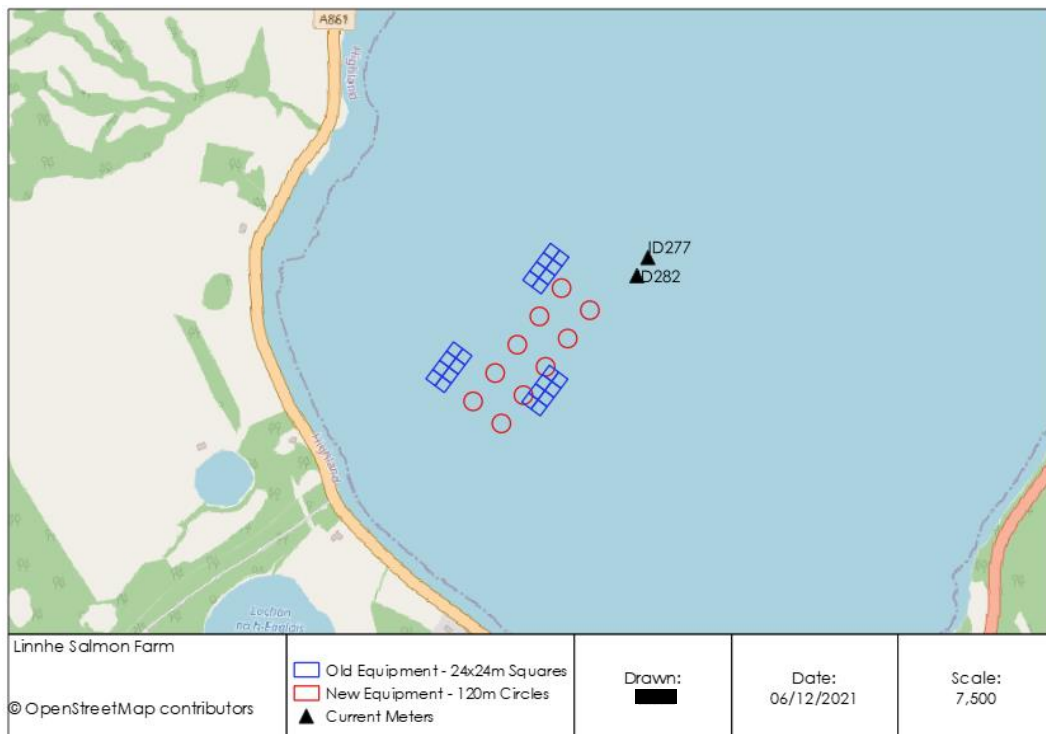


Figure 1. Site layout of the salmon farm Linnhe. The current meter deployment locations are marked by the black triangles.

## 2. Materials & Methods

### 2.1 Bathymetry

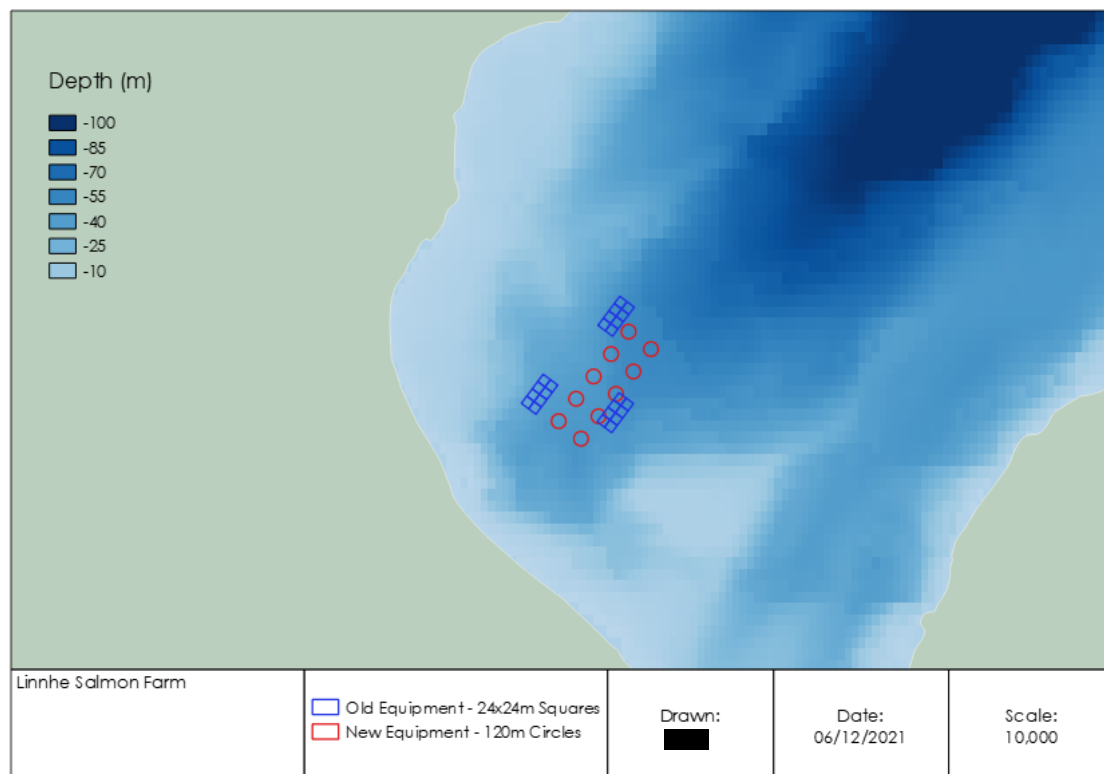


Figure 2. Bathymetry in the region around Linnhe salmon farm.

### 2.2 Current Data

Mowistaff carried out hydrographic surveys at the site during 2019. The purpose of this hydrographic report is to assess the suitability of the collected hydrographic data for use with a Hydrodynamic model. The data contained in this report were recorded at the site from 23<sup>rd</sup> May to 16<sup>th</sup> August (85 days and 3 hours of data; deployment ID277). The data from a later deployment (ID282) are presented in a separate hydrographic report.

The Sentinel V100 (Wide) ADCP (Table 1), within its mooring frame, was positioned at 56.73220°N, 5.24348°W (201688E 764762N), which was approximately 690m from the nearest shoreline and approximately 315m from the centre of the new 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 69 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 69.

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  $-2.99^\circ$ ; 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 57 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 9.29 m (cell 57), and cage-bottom data at 17.29 m (cell 49). Surface and middle cell heights were 59.71 m and 51.71 m from the seabed respectively. The bottom cell (cell 1) was at a depth of 65.29 m and 3.71 m above the seabed.

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

The average StdDev values for the surface middle and bottom cells was 0.63cm/s, 0.63cm/s and 0.63cm/s respectively which are all within the SEPA criteria of 2cm/s.

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>                                                                                                                                                                                                                    | Std Dev (cm/s) <sup>3,4</sup> | Range (m) <sup>2,3</sup> | Std Dev (cm/s) <sup>3,4</sup> | Range (m) <sup>2,3</sup> | Std Dev (cm/s) <sup>3,4</sup> |
|                              |                                                                                                                                                        | Wide/Narrow                                                                                                                                                                                                                                 | Wide/Narrow                   | Wide/Narrow              | Wide/Narrow                   | Wide/Narrow              | 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                       |
| Communications and Recording | Wireless<br>Internal memory                                                                                                                            | 802.11b/g/n<br>One 16GB Micro SD Card included                                                                                                                                                                                              |                               |                          |                               |                          |                               |
| Profile Parameters           | Velocity accuracy<br><br>Velocity resolution<br>Velocity range<br>Ping rate                                                                            | V20/V50: 0.3% of the water velocity relative to the ADCP ±0.3cm/s<br>V100: 0.5% of the water velocity relative to the ADCP ±0.5cm/s<br>0.1cm/s<br>±5m/s (default); ±20m/s (maximum)<br>Up to 4Hz                                            |                               |                          |                               |                          |                               |
| Echo Intensity Profile       | Vertical resolution<br>Dynamic range<br>Precision                                                                                                      | Depth cell size<br>80dB<br>±1.5dB                                                                                                                                                                                                           |                               |                          |                               |                          |                               |
| Transducer and Hardware      | Beam angle<br>Configuration<br>Depth rating<br>Materials                                                                                               | 25°<br>4-beam, convex; 5th beam vertical<br>200m<br>Transducer, housing, and end cap: plastic<br>Connector: metal shell                                                                                                                     |                               |                          |                               |                          |                               |
| Standard Sensors             | Temperature (mounted on transducer)<br>Compass (magneto-inductive sensor)<br>Tilt (MEMS accelerometers)<br><br>Pressure sensor (mounted on transducer) | Range -5° to 45°C, precision ±0.4°C, resolution 0.1°<br>Accuracy 2° RMS, resolution 0.1°, max. dip angle 85°<br>Pitch range ±90°, roll range ±180°, accuracy 2° RMS,<br>precision 0.05° RMS, resolution 0.1°<br>Range 300m, accuracy 0.1%FS |                               |                          |                               |                          |                               |
| Power                        | External DC input<br>Internal battery voltage<br>Battery capacity; over-the-counter @0°C<br>Battery pack @5°C                                          | 12–20VDC<br>18VDC new<br>100 watt hours (typical)<br>510 watt hours                                                                                                                                                                         |                               |                          |                               |                          |                               |
| Software                     | Teledyne RDI's new software included                                                                                                                   | ReadyV—Pre-deployment (testing, planning, and data recovery) <sup>5</sup><br>Velocity—Post-processing (data handling, display, and export) <sup>6</sup>                                                                                     |                               |                          |                               |                          |                               |
| Environmental                | Standard depth rating<br>Operating temperature<br>Storage temperature (without batteries)<br>Weight in air<br>Weight in water                          | 200m<br>-5° to 45°C<br>-30° to 60°C<br>7.5kg – 16.0kg<br>1.6kg – 6.0kg                                                                                                                                                                      |                               |                          |                               |                          |                               |
| Available Options            | External battery case<br>• AC/DC power converter • 5th beam (at time of order only) • Waves processing • Straight or right-angle metal shell connector |                                                                                                                                                                                                                                             |                               |                          |                               |                          |                               |
| Dimensions                   | Special configuration drawing available upon request                                                                                                   |                                                                                                                                                                                                                                             |                               |                          |                               |                          |                               |

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

Specifications subject to change without notice.



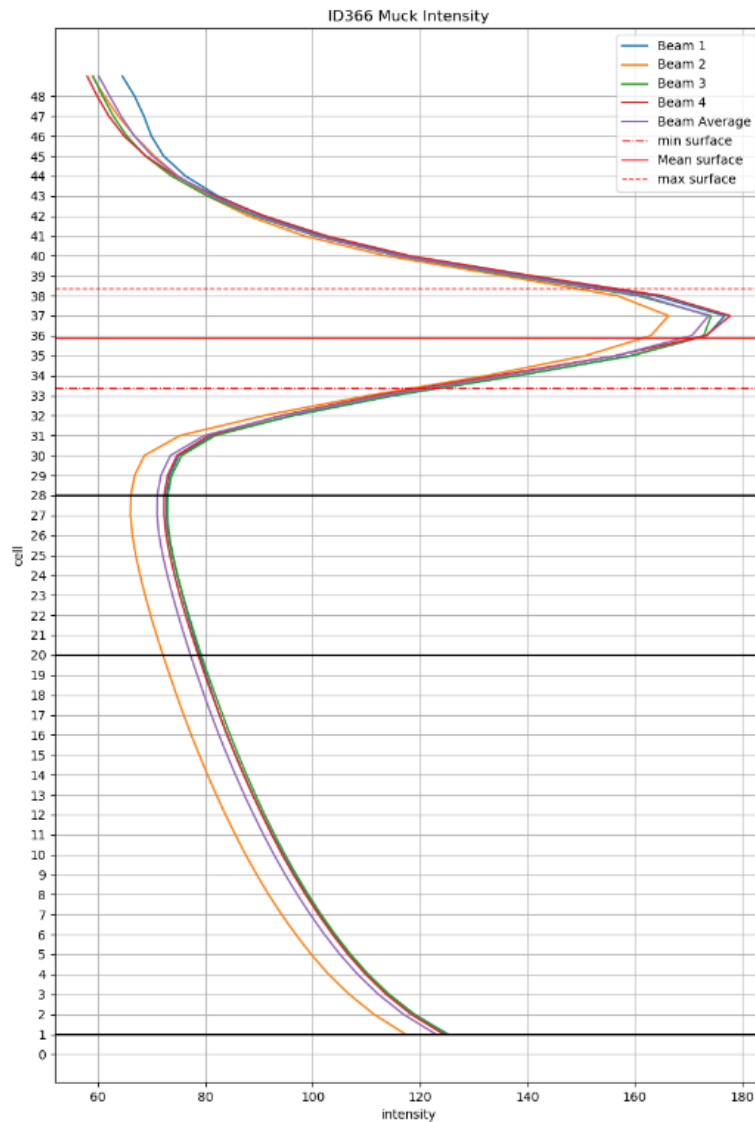


Figure 3. Mean intensity of the ADCP signal for the ID277 dataset plotted by bin number

## 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 11.10 cm/s, 8.5 cm/s and 5.34 cm/s respectively. This gave an overall average of 8.3 cm/s. The orientation of the tidal velocities was NorthEast – SouthWest for the near bed cell.

Residual currents at the surface and mid-depth were toward the south (190.1°G and 179.4°G respectively); near the seabed, the residual flows during the deployment period were to the west (092.8°G, Figure 9). The magnitude of the residual currents for the surface, middle and bottom cells were moderate, with mean values of 0.075 m/s, 0.054 m/s and 0.007 m/s respectively.

#### 4. Hydrographic Data Summary Sheets

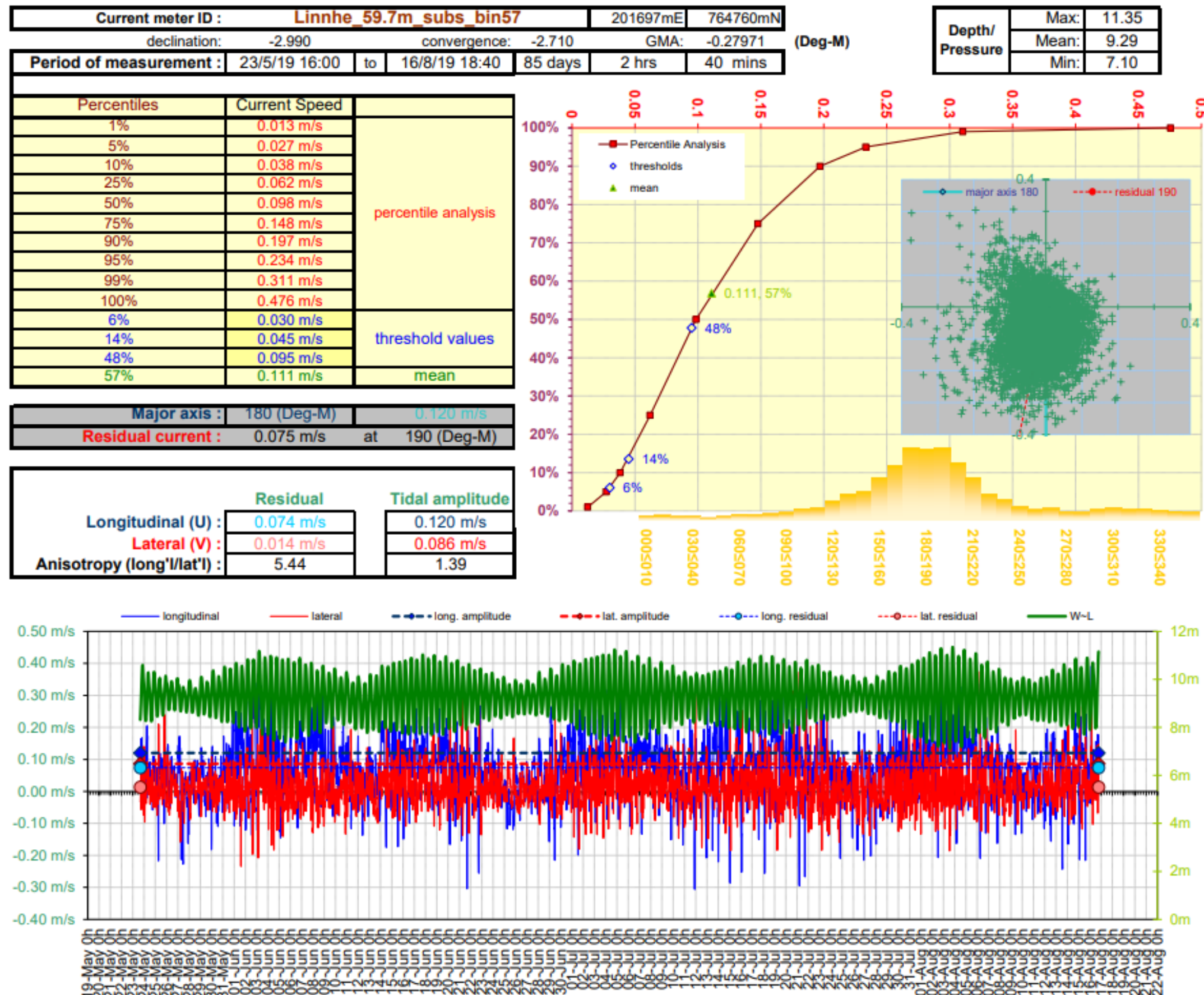


Figure 4. Current Data Summary Sheet for the surface current cell 57, 59.71m from seabed, 23<sup>rd</sup> May to 16<sup>th</sup> August 2019 inclusive (ID277).

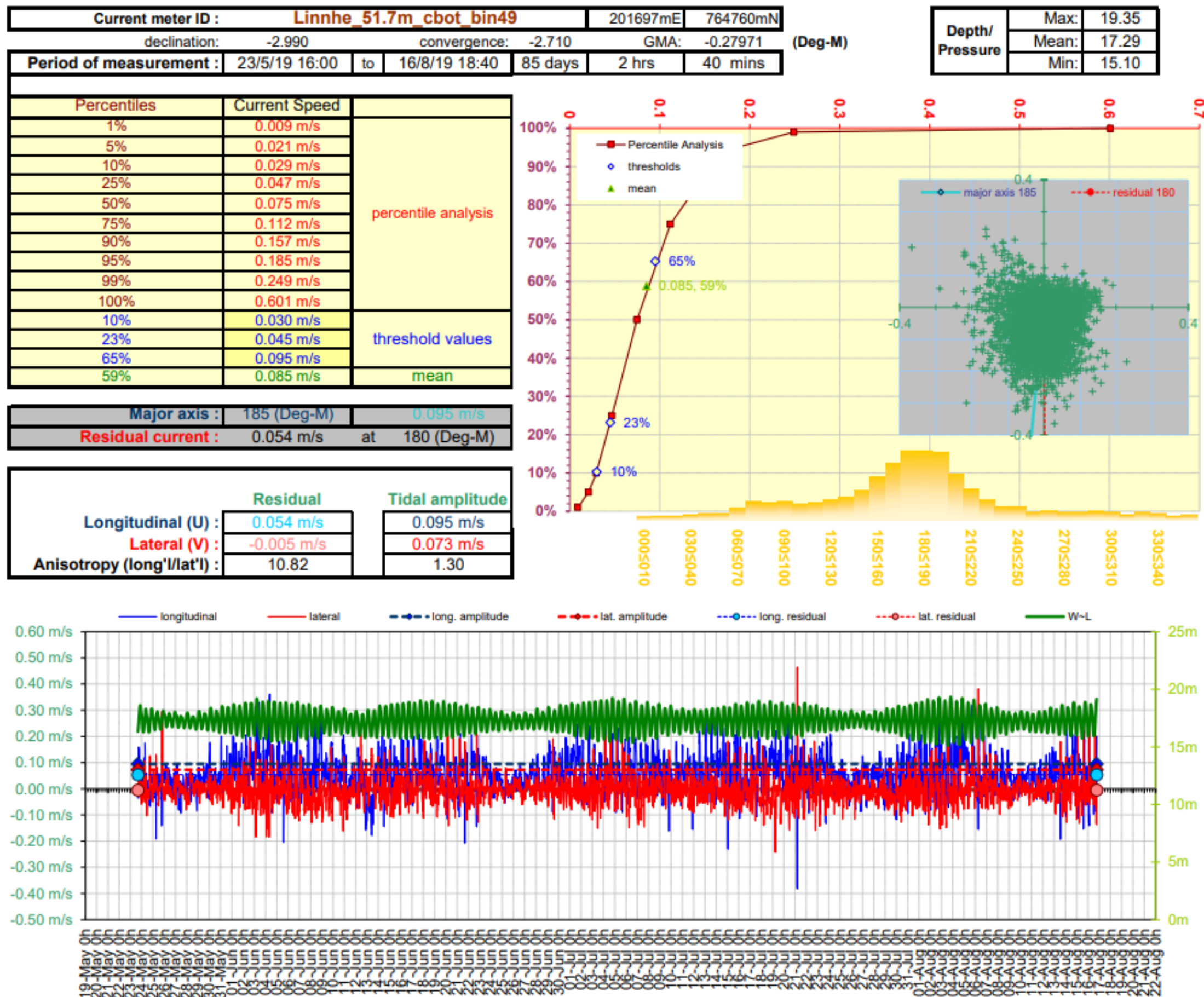


Figure 5. Current Data Summary Sheet for the cage bottom current cell 49, 51.71m from seabed, 23<sup>rd</sup> May to 16<sup>th</sup> August 2019 inclusive (ID277).



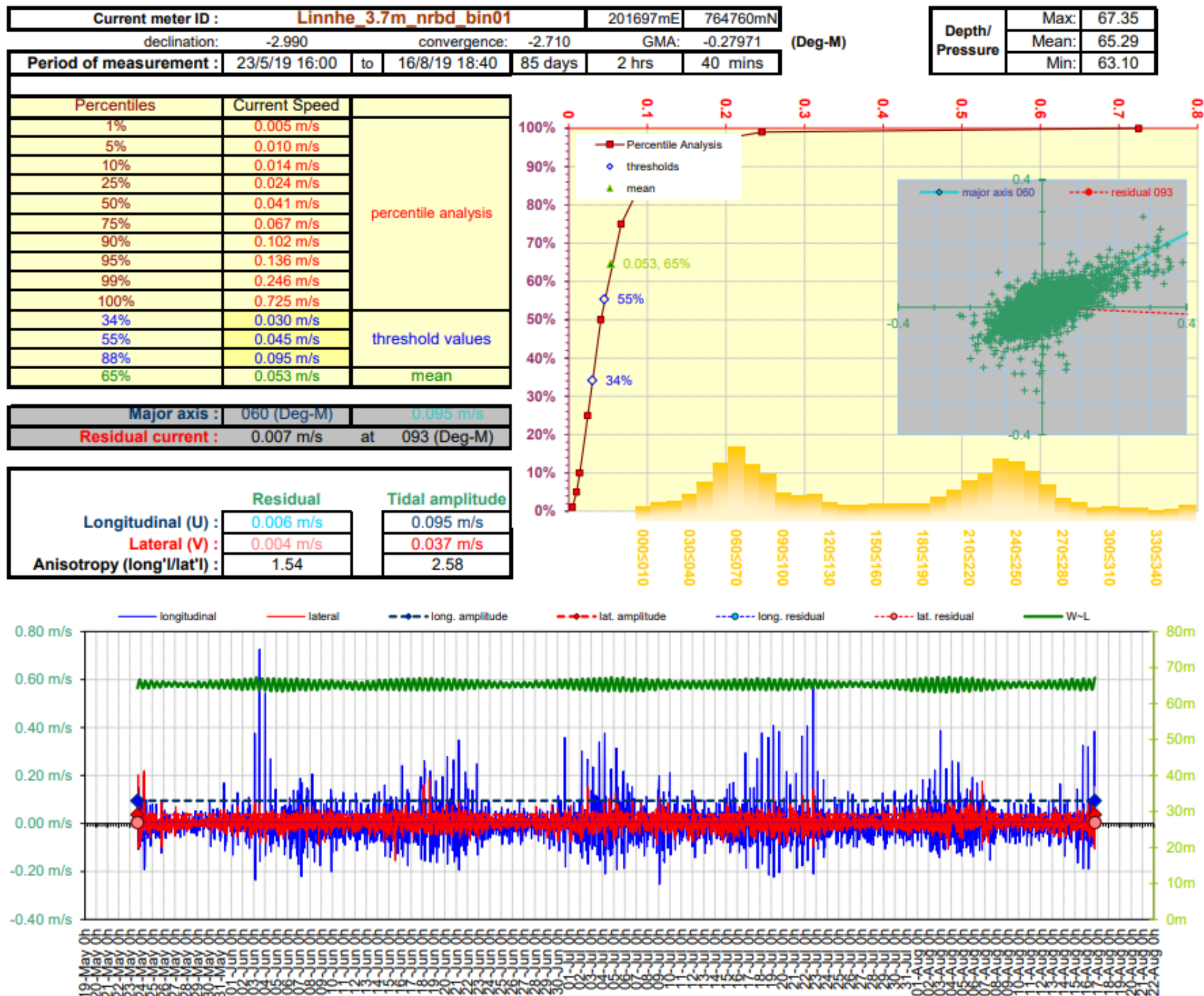


Figure 6. Current Data Summary Sheet for the near bottom current cell 1, 3.71m from seabed, 23<sup>rd</sup> May to 16<sup>th</sup> August 2019 inclusive (ID277).

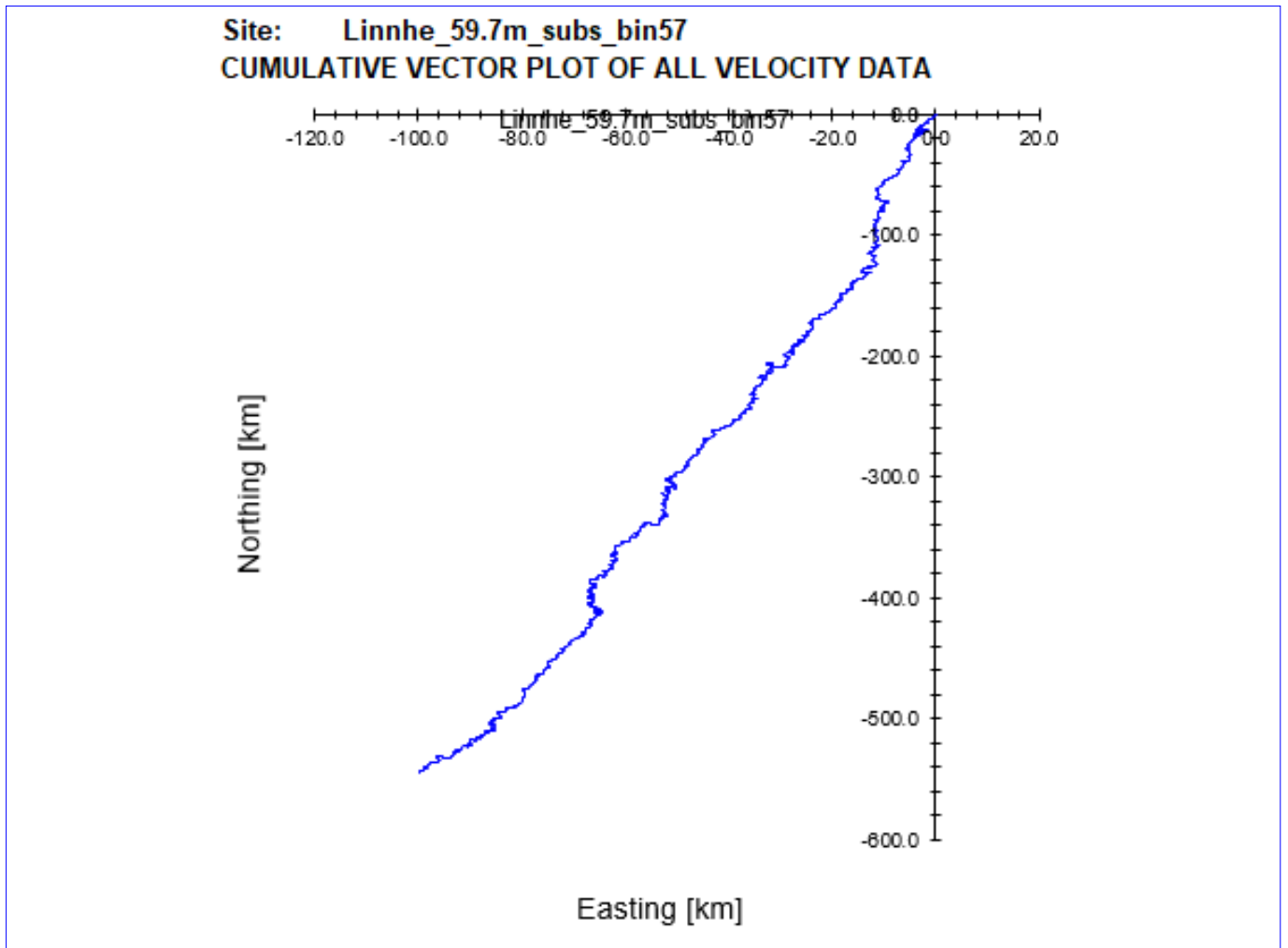


Figure 7. Cumulative Vector Plot of all velocity data from near surface cell for ID277.

Site: Linnhe\_51.7m\_cbot\_bin49  
CUMULATIVE VECTOR PLOT OF ALL VELOCITY DATA

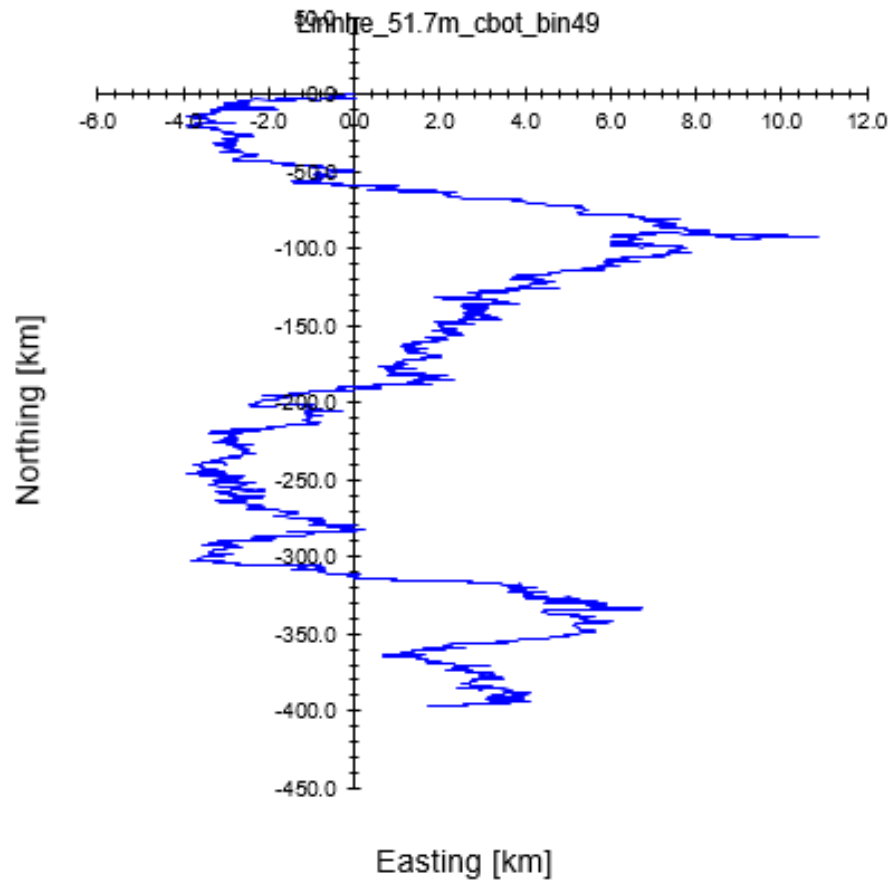


Figure 8. Cumulative Vector Plot of all velocity data from cage bottom cell for ID277.

Site: Linnhe\_3.7m\_nrbd\_bin01

CUMULATIVE VECTOR PLOT OF ALL VELOCITY DATA

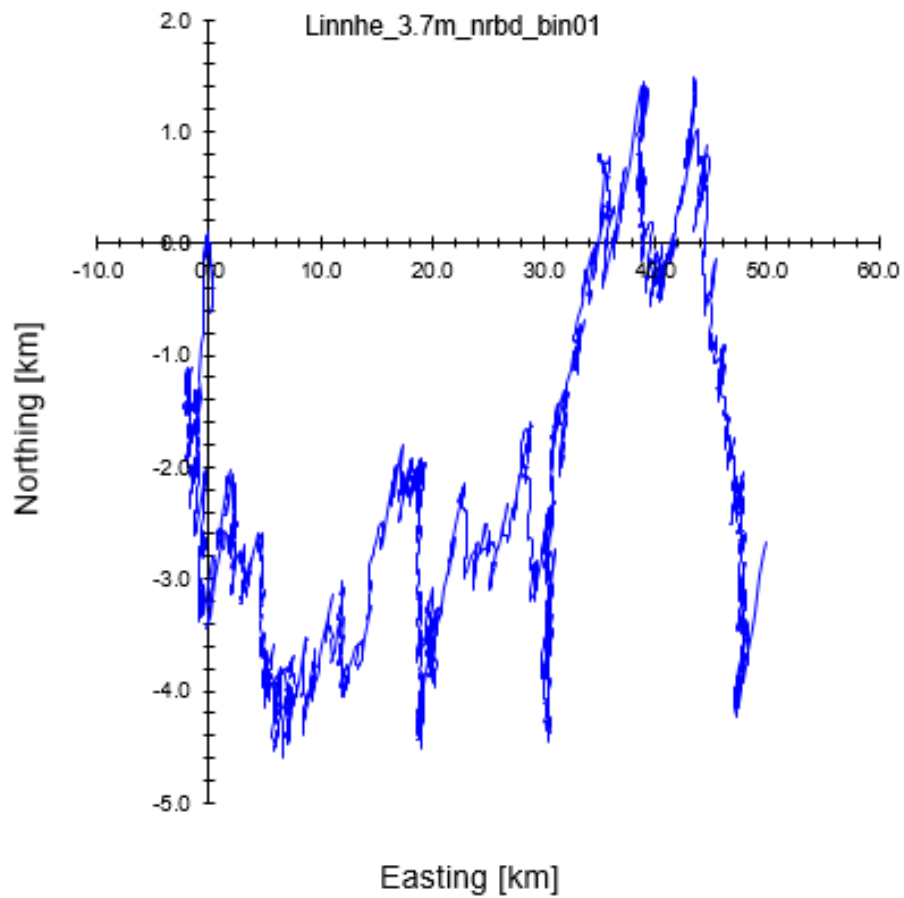


Figure 9. Cumulative Vector Plot of all velocity data from near bottom cell for ID277.

## 5. Summary of Current Data – ID277

Site Name: Linnhe  
 Data start date: 23/05/2019  
 Data end date: 16/08/2019  
 Mean Water Depth: 69m

Table 2. Summary of current meter deployment

|               | Cell | Depth Below Minimum Surface (m) | Distance from Seabed (m) | Mean current speed (cm/s) |
|---------------|------|---------------------------------|--------------------------|---------------------------|
| Near surface: | 57   | 7.1                             | 59.71                    | 11.1                      |
| Cage bottom:  | 49   | 15.1                            | 51.71                    | 8.52                      |
| Near bed:     | 1    | 63.1                            | 3.71                     | 5.34                      |
|               |      |                                 | Average current speed:   | 8.32                      |

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                                   | 6          | 86           | 52           |
| Cage bottom:  | 59                                   | 10         | 77           | 35           |
| Near bed:     | 65                                   | 34         | 44           | 12           |

Table 4. Major axis

| Cell          | Major Axis (Deg-G) |
|---------------|--------------------|
| Near surface: | 180                |
| Cage Bottom:  | 185                |
| Near bed:     | 060                |

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: | 0.111            | 0.075                | 0.074                   | 0.014                 | 0.120                          | 0.086                        |
| Cage Bottom:  | 0.085            | 0.054                | 0.054                   | -0.005                | 0.095                          | 0.073                        |
| Near Bed:     | 0.053            | 0.007                | 0.006                   | 0.004                 | 0.095                          | 0.037                        |



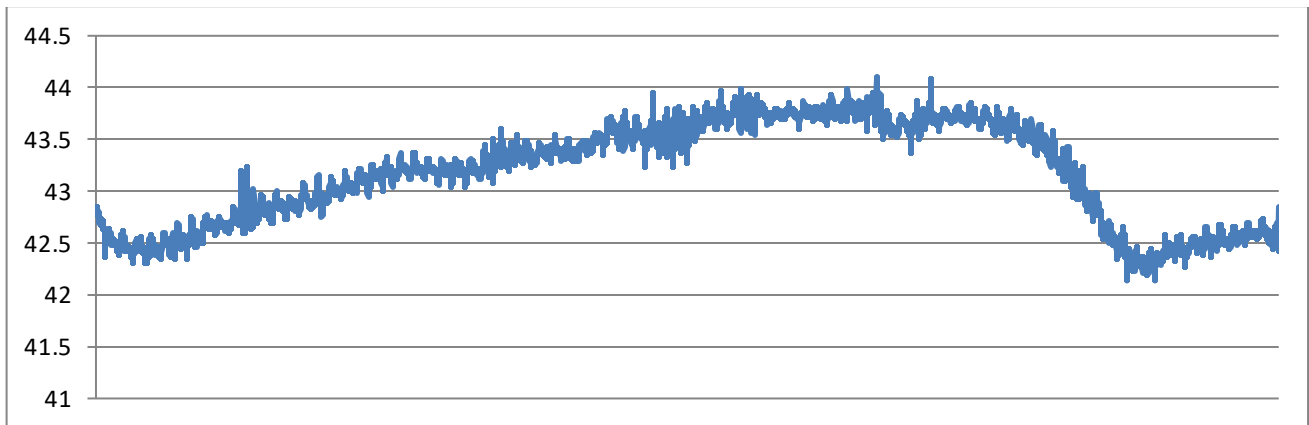


Figure 10. Summary of heading data from deployment ID277.

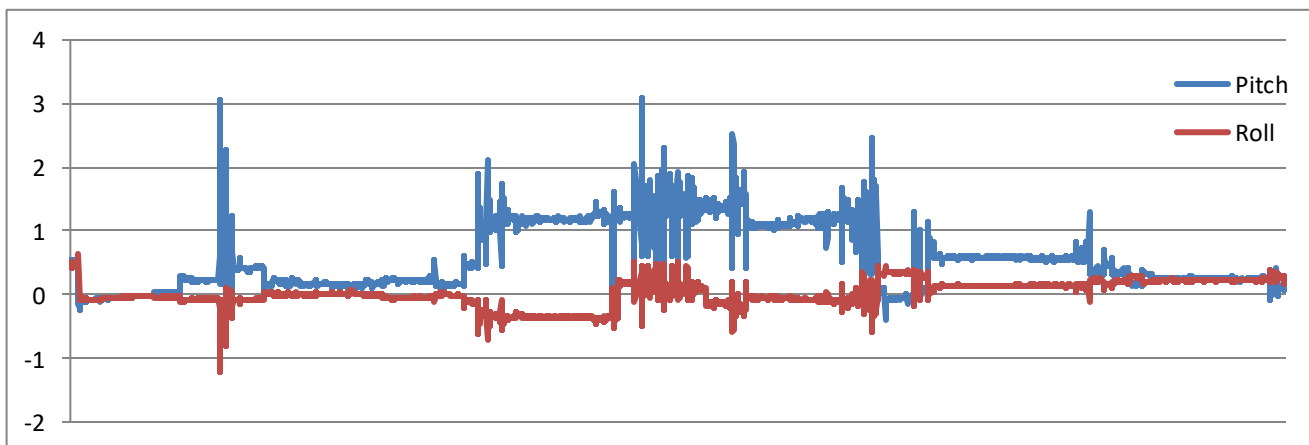


Figure 11. Summary of pitch and roll data from deployment ID277.

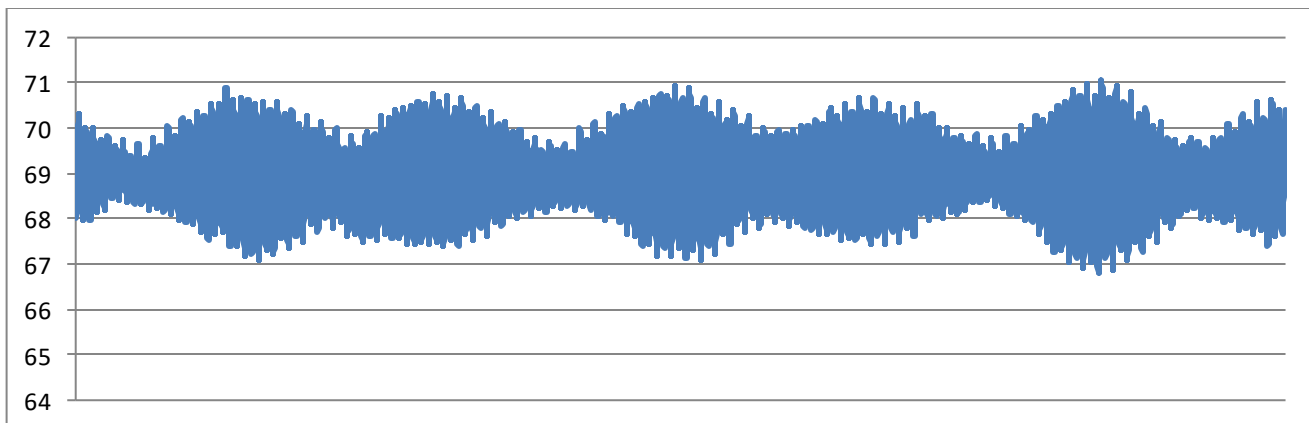


Figure 12. Pressure data from deployment ID277.

## 6. Conclusion

Mowi Scotland has collected and analysed current for the proposed increase in Azamethiphos consented at the Linnhe fish farm. The analysed current data for the 85 days and 3 hours period are believed to be reliable and representative of the proposed location.

## Annex 1. Survey Equipment Deployment Log

Location: Linnhe  
 Nearest tidal port: Corran  
 Time zone: UTC  
 Meter switched on: 16:00 23/05/2019  
 Meter switched off: 19:00 16/08/2019  
 Period used for this report: 16:00 23/05/2019 – 18:40 16/08/2019  
 ADCP serial number: 24559  
 Meter position: 56.73220'N 5.24348'W  
 201688 E 764762 N  
 Minimum water depth: 66.81 m (66.11m measured by ADCP + 0.7 m \*)  
 Mean water depth: 69.81 m (69.11 measured by ADCP + 0.7 m \*)  
 Depth of meter from surface: 67.27 m (below mean low water spring to transducer)  
 Height of meter from seabed: 0.7 m to transducer head  
 Sounding at deployment: 65.5 m @ 11:40 on 23/05/2019

Table A1. ADCP meter settings:

| Reference:                       | Transducer |
|----------------------------------|------------|
| Bin size (m):                    | 1.0        |
| Dist to 1 <sup>st</sup> bin (m): | 3.02       |
| Number of bins:                  | 69         |
| 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          |