

Tabhaigh, Loch Erisort

Hydrographic Data Report: Deployment ID368

10th February to 7th May 2021

February 2023
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 an equipment change at the Tabaigh salmon farm, located at the mouth of Loch Erisort, Isle of Lewis. Mowi Scotland Ltd. propose to change the site from 10 x 120m pens to 8 x 160m circumference pens, with 20m deep nets on the pen string closest to Tabaigh Beag and 15m deep nets on the pen string furthest from Tabaigh Beag, held in a 100m grid.

Mowi Scotland Ltd have carried out hydrographic surveys at the site in 2020 and 2021. Hydrographic data at Stulaigh South was gathered during this time in two deployments:

- i. 9th November 2020 to 3rd February 2021 (ID363)
- ii. 10th February 2021 to 7th May 2021 (ID368)

This report describes the data from the 10th February 2021 to 7th May 2021 deployment at Tabaigh (ID368). The purpose of this report is to assess the suitability of the collected hydrographic data for calibration of a hydrodynamic model of the Loch Erisort region and input into the NewDepomod model.

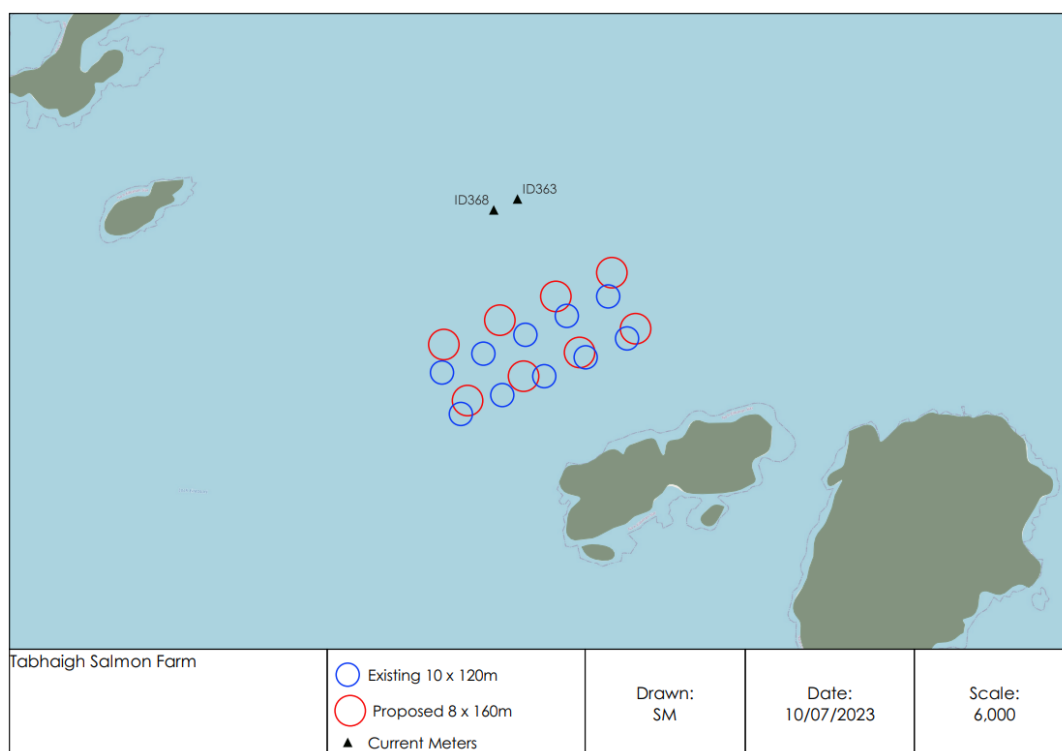


Figure 1. Proposed and existing layouts at the Tabaigh site. The current meter deployment locations are marked by the black triangles.

2. Materials & Methods

2.1 Bathymetry

Bathymetry was taken from the ECLH model which has reasonably high spatial resolution around Loch Erisort (Figure 2).

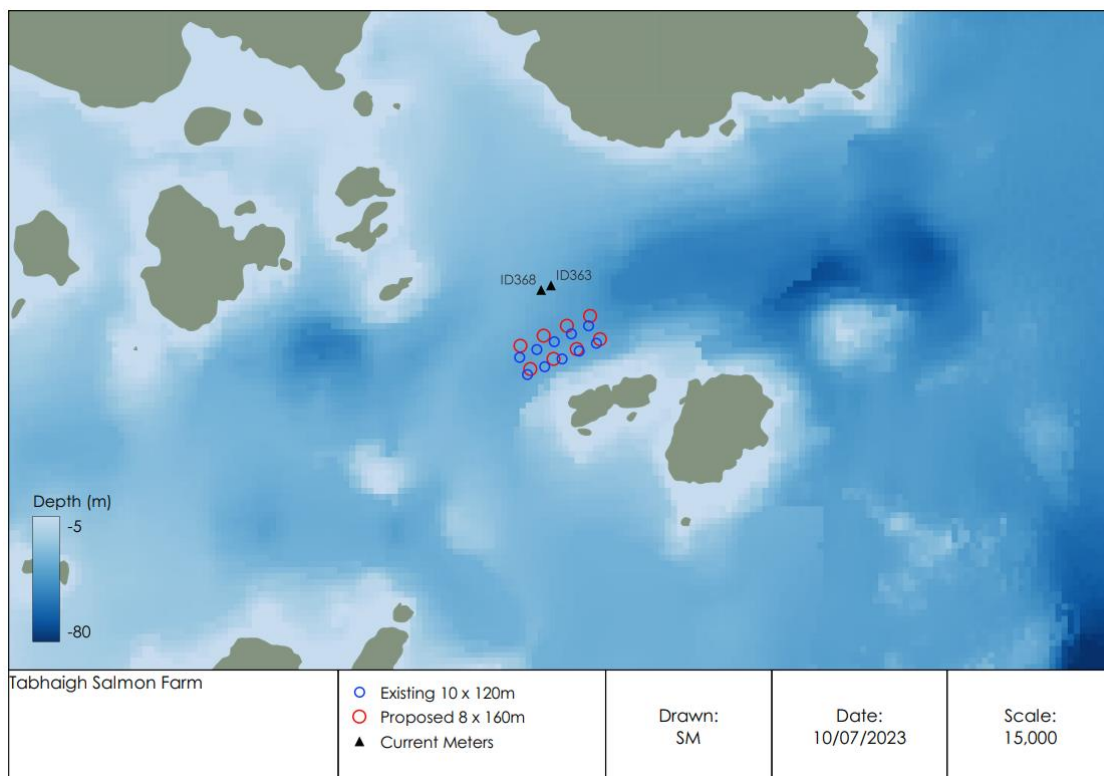


Figure 2. Bathymetry in the region around the proposed Tabhaigh salmon farm.

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 10th February to 7th May 2021 (85 days and 16 hours of data; deployment ID363). The data from another deployment (ID368) are presented in a separate hydrographic report.

The Sentinel V100 (Wide) ADCP (Table 1), within its mooring frame, was positioned at 58.12333N, -6.39127W (141533E 92335N), which was approximately 440m from the nearest shoreline and approximately 240m 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 38.2 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 49.

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 -3.45°; 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 28 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 7.49 m (cell 28), and cage-bottom data at 18.49 m (cell 17). Surface and middle cell heights were 30.71 m and 19.71 m from the seabed respectively. The bottom cell (cell 1) was at an average depth of 34.49 m and 3.71 m above the seabed.

Table 1: Sentinel V100 ADCP Specifications.

Depth Cell Size ¹	V20 (1000kHz)		V50 (500kHz)		V100 (300kHz)		
	Depth Cell Size ¹	Range (m) ^{2,3} Wide/Narrow	Std Dev (cm/s) ^{3,4} Wide/Narrow	Range (m) ^{2,3} Wide/Narrow	Std Dev (cm/s) ^{3,4} Wide/Narrow	Range (m) ^{2,3} Wide/Narrow	Std Dev (cm/s) ^{3,4} 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 Internal memory	802.11b/g/n One 16GB Micro SD Card included					
Profile Parameters	Velocity accuracy Velocity resolution Velocity range Ping rate	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 0.1cm/s ±5m/s (default); ±20m/s (maximum) Up to 4Hz					
Echo Intensity Profile	Vertical resolution Dynamic range Precision	Depth cell size 80dB ±1.5dB					
Transducer and Hardware	Beam angle Configuration Depth rating Materials	25° 4-beam, convex; 5th beam vertical 200m Transducer, housing, and end cap: plastic Connector: metal shell					
Standard Sensors	Temperature (mounted on transducer) Compass (magneto-inductive sensor) Tilt (MEMS accelerometers) Pressure sensor (mounted on transducer)	Range -5° to 45°C, precision ±0.4°C, resolution 0.1° Accuracy 2° RMS, resolution 0.1°, max. dip angle 85° Pitch range ±90°, roll range ±180°, accuracy 2° RMS, precision 0.05° RMS, resolution 0.1° Range 300m, accuracy 0.1%FS					
Power	External DC input Internal battery voltage Battery capacity; over-the-counter @0°C Battery pack @5°C	12–20VDC 18VDC new 100 watt hours (typical) 510 watt hours					
Software	Teledyne RDI's new software included	ReadyW—Pre-deployment (testing, planning, and data recovery) ⁵ Velocity—Post-processing (data handling, display, and export) ⁶					
Environmental	Standard depth rating Operating temperature Storage temperature (without batteries) Weight in air Weight in water	200m -5° to 45°C -30° to 60°C 7.5kg – 16.0kg 1.6kg – 6.0kg					
Available Options	External battery case • 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						

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 InADCP accessed via a web browser.
6 Windows™ based software program.

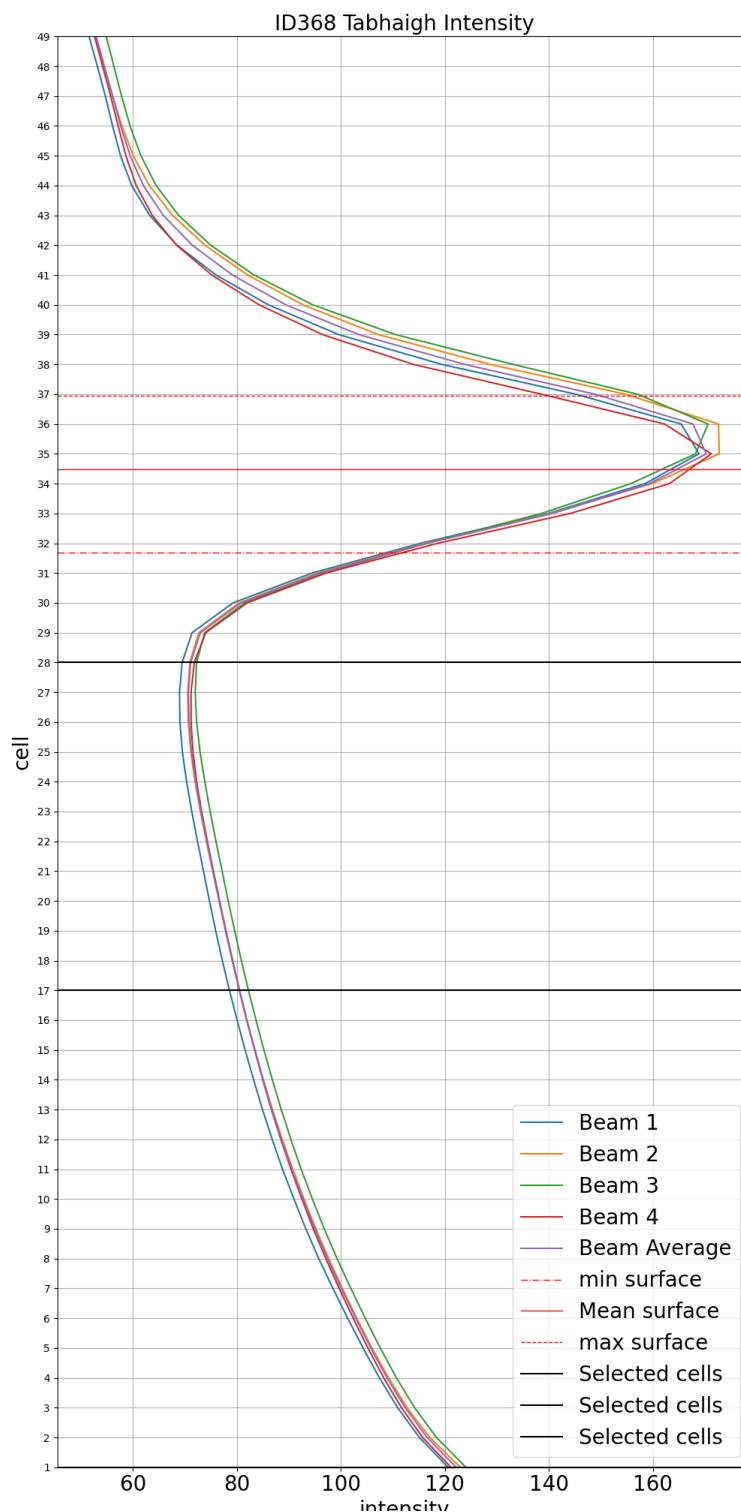


Figure 3. Mean intensity of the ADCP signal for the ID368 dataset plotted by bin number.

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 6.7 cm/s, 6.65 cm/s and 5.74 cm/s respectively. This gave an overall average of 6.36 cm/s. The orientation of the tidal velocities was north-west – south-east.

Residual currents at the surface (46°G, Figure 7) were toward the north-east while the mid-depth (268°G, Figure 8) were towards the west and near-bottom cells were toward the south-west (245°G, Figure 9). The magnitude of the residual currents for the surface, middle and bottom cells were moderate, with mean values of 0.022 m/s, 0.019 m/s and 0.029 m/s respectively.

4. Hydrographic Data Summary Sheets

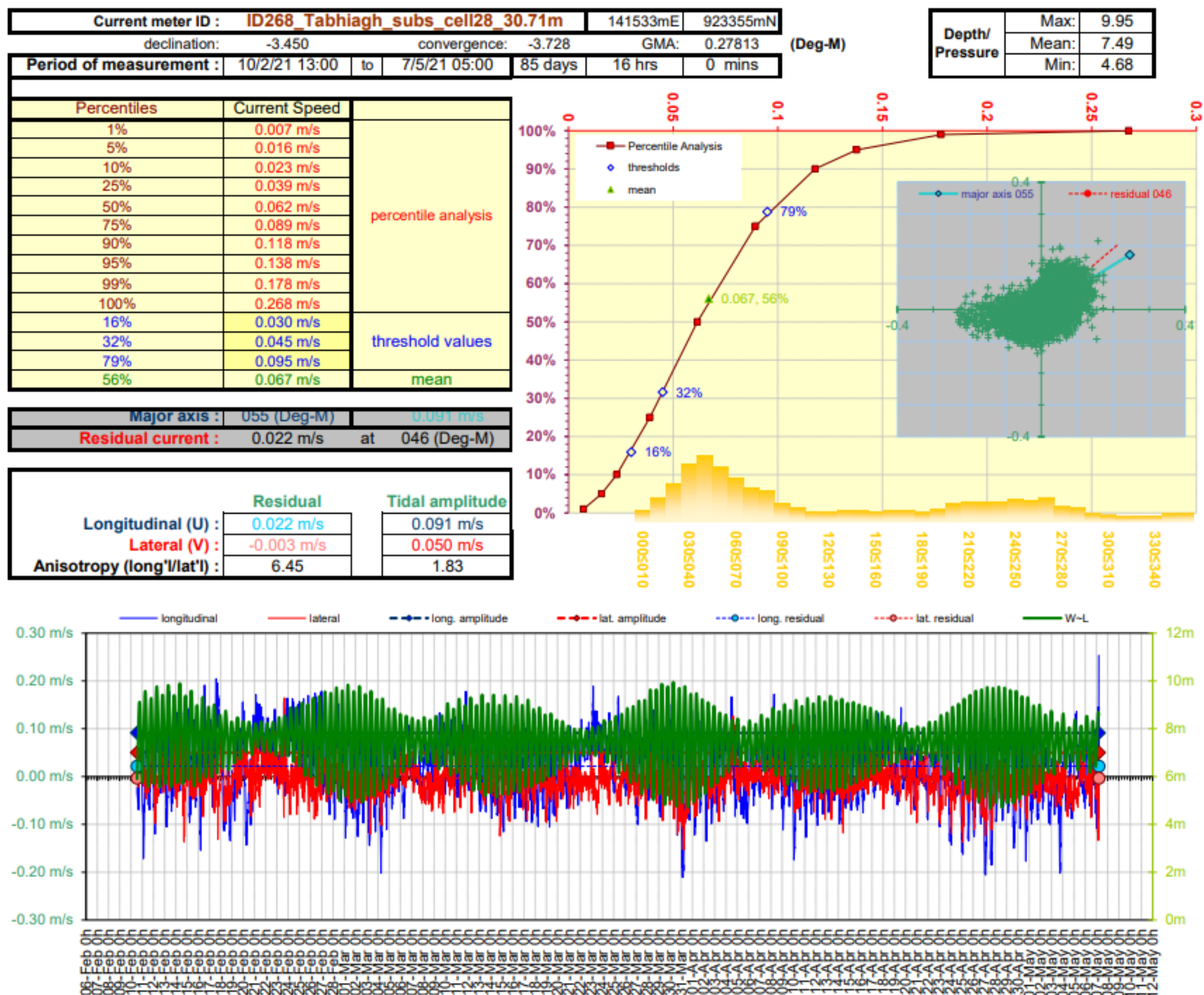


Figure 4. Current Data Summary Sheet for the surface current cell 28, 30.71m from seabed, 10th February to 7th May 2021 inclusive (ID368).

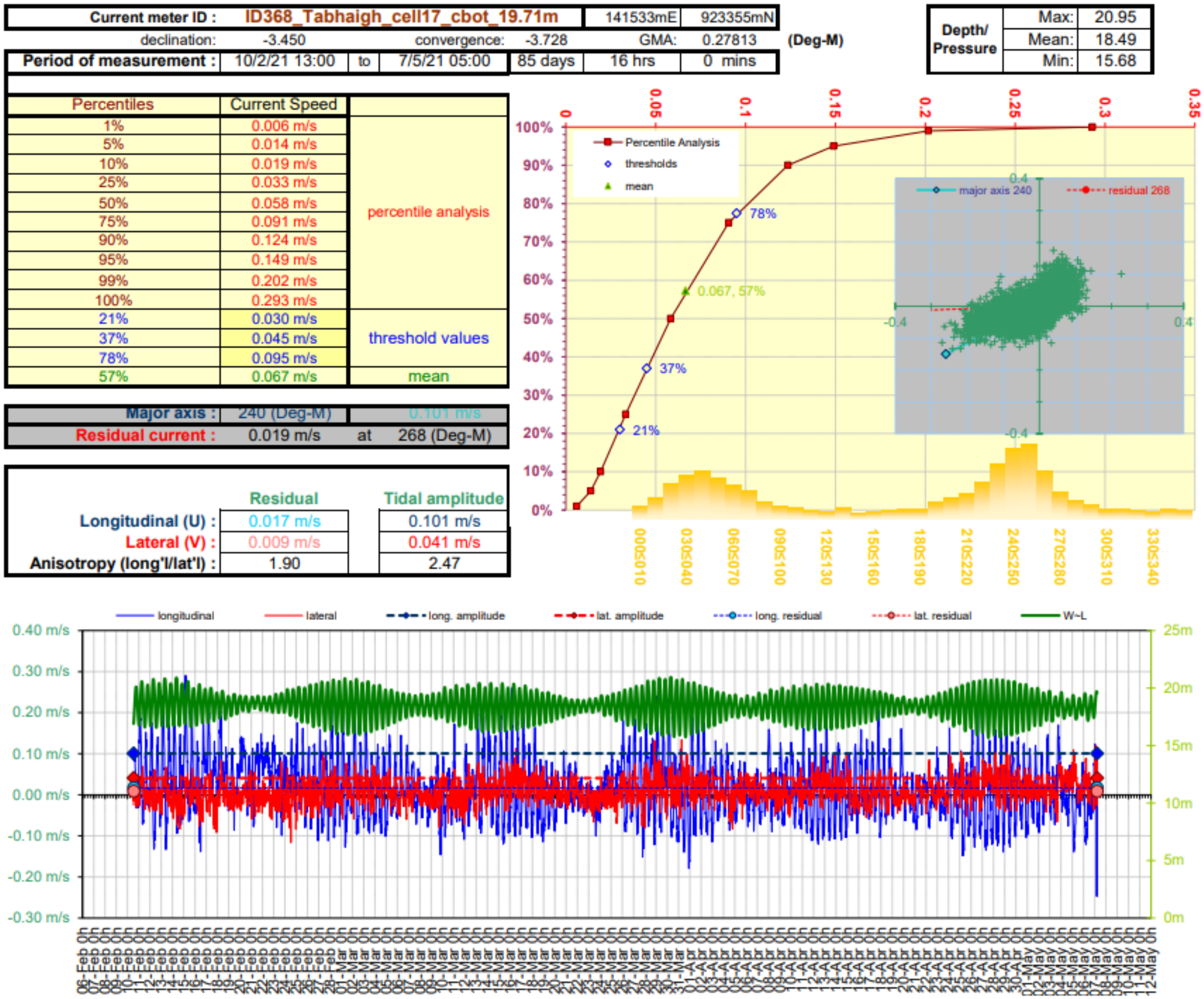


Figure 5. Current Data Summary Sheet for the cage bottom current cell 17, 19.71m from seabed, 10th February to 7th May 2021 inclusive (ID368).

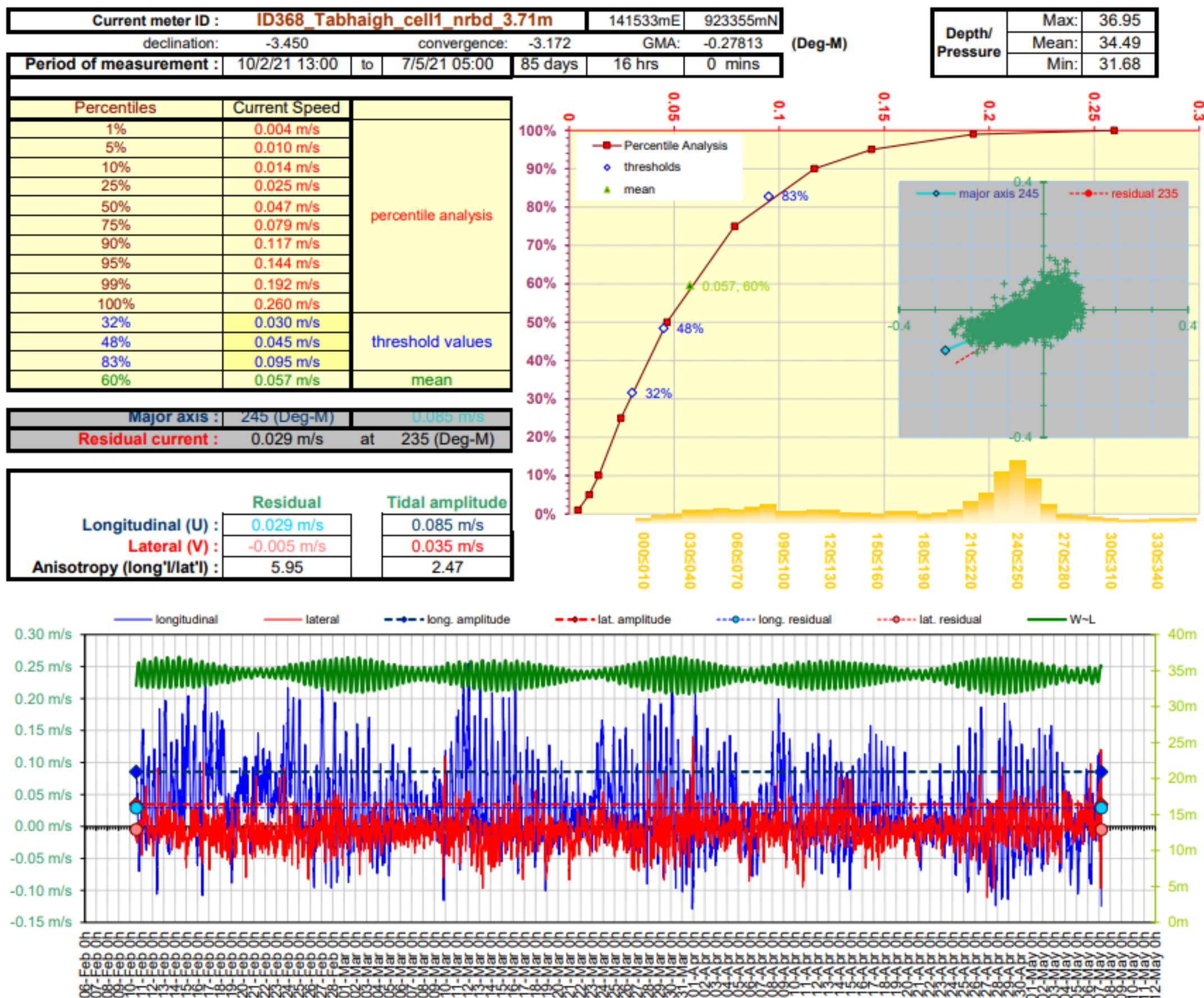


Figure 6. Current Data Summary Sheet for the near bottom current cell 1, 3.7m from seabed, 10th November to 7th May 2021 inclusive (ID368).

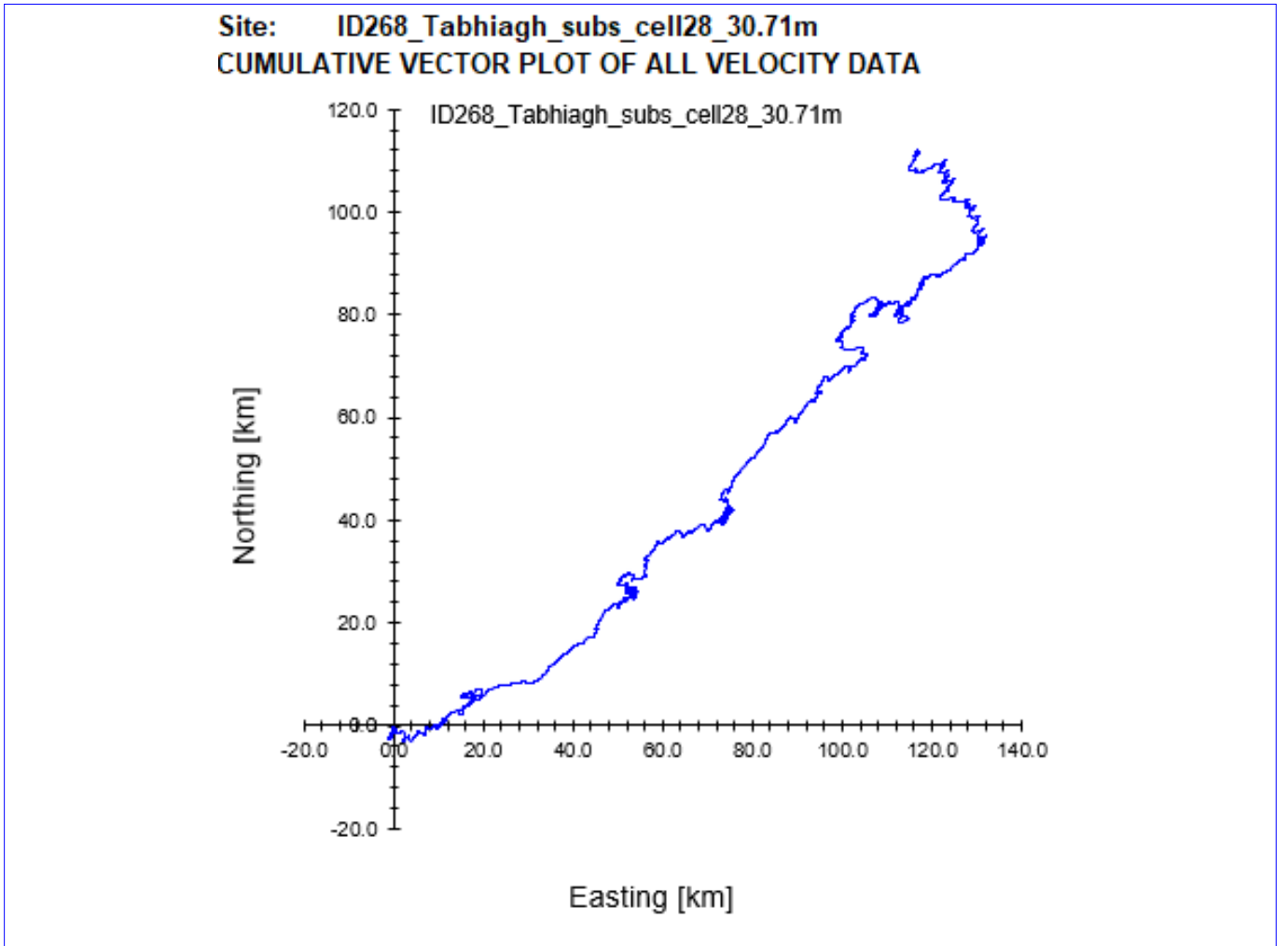


Figure 7. Cumulative Vector Plot of all velocity data from near surface cell for ID368.

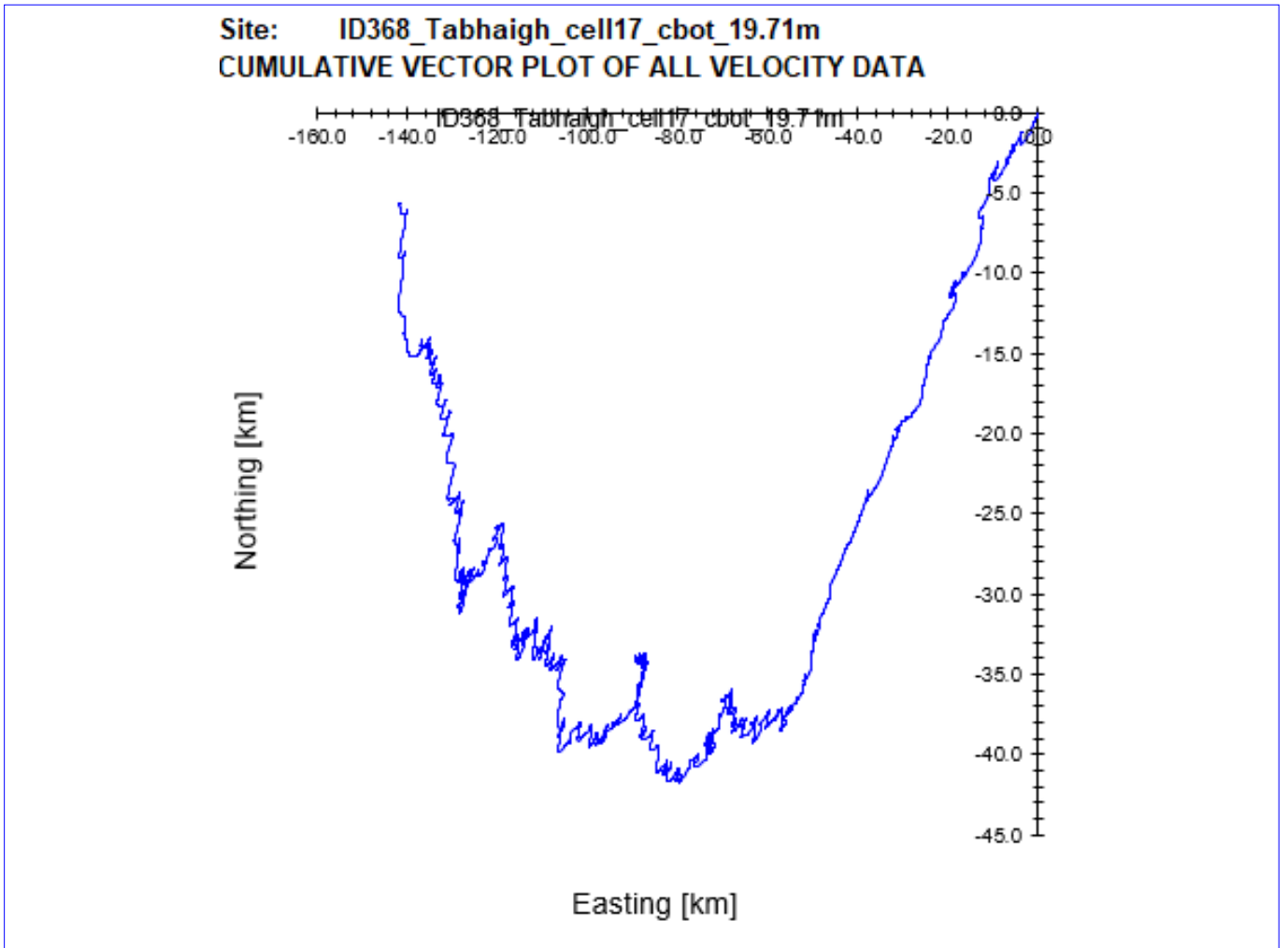


Figure 8. Cumulative Vector Plot of all velocity data from cage bottom cell for ID368.

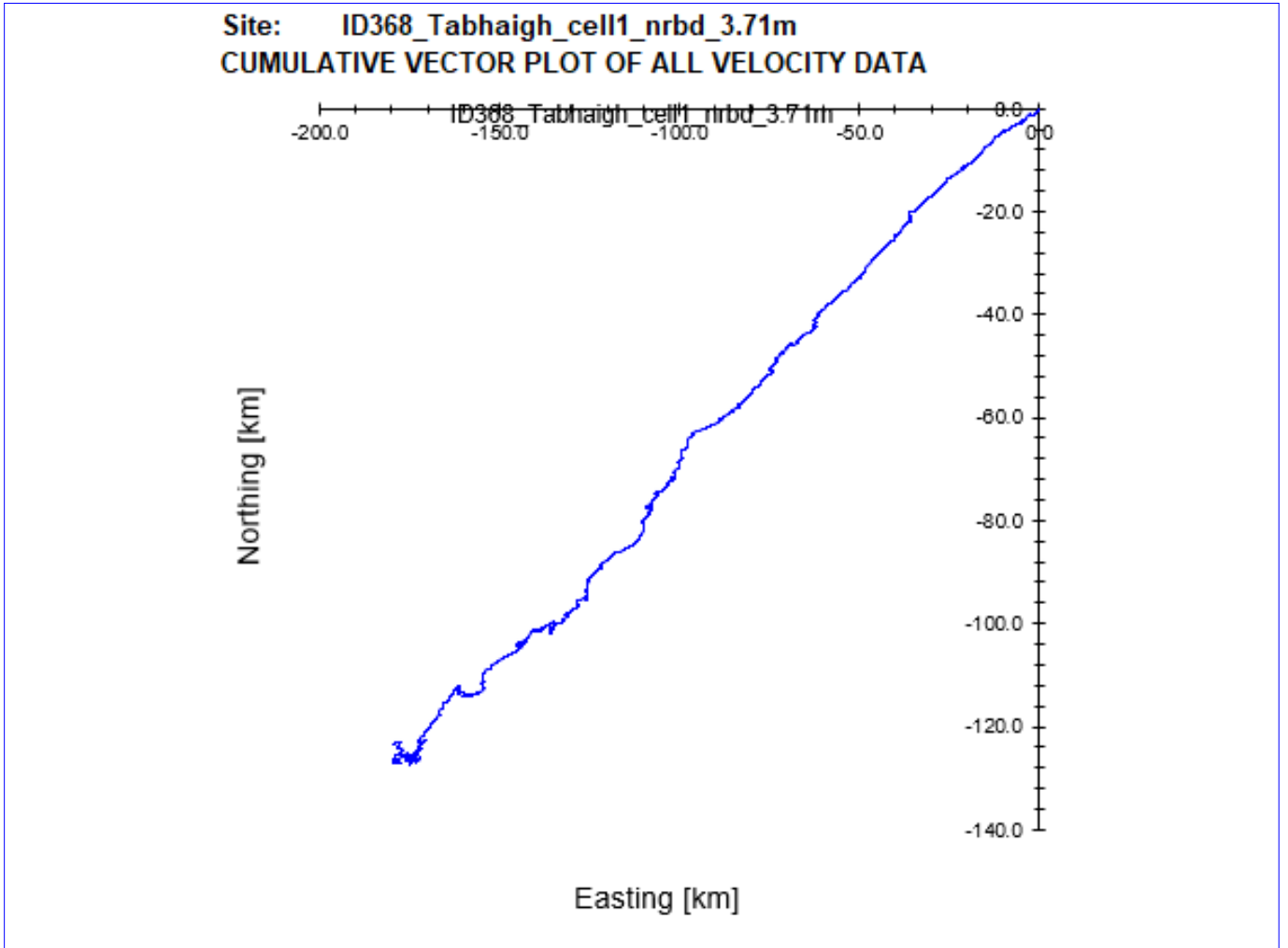


Figure 9. Cumulative Vector Plot of all velocity data from near bottom cell for ID368.

5. Summary of Current Data – ID368

Site Name: Tabhaigh
 Data start date: 10/02/2021
 Data end date: 07/05/2021
 Mean Water Depth: 38.2 m

Table 2. Summary of current meter deployment

	Cell	Depth Below Surface (m)	Distance from Seabed (m)	Mean current speed (cm/s)
Near surface:	28	4.68	30.71	6.7
Cage bottom:	17	15.68	19.71	6.65
Near bed:	1	31.68	3.71	5.74
Average current speed:				6.36

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:	56	16	68	21
Cage bottom:	57	21	63	22
Near bed:	60	32	52	17

Table 4. Major axis

Cell	Major Axis (Deg-G)
Near surface:	055
Cage Bottom:	240
Near bed:	245

Table 5. Mean and residual currents

Cell	Residual Speed (m/s)	Residual Parallel (m/s)	Residual Normal (m/s)	Tidal Amplitude Parallel (m/s)	Tidal Amplitude Normal (m/s)
Near Surface:	0.022	0.022	-0.003	0.091	0.050
Cage Bottom:	0.019	0.017	0.009	0.101	0.041
Near Bed:	0.029	0.029	-0.005	0.085	0.035

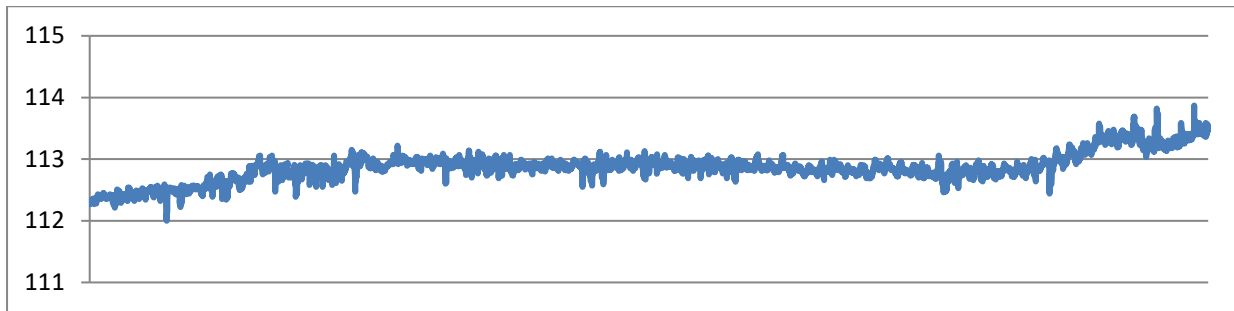


Figure 10. Summary of heading data from deployment ID368.

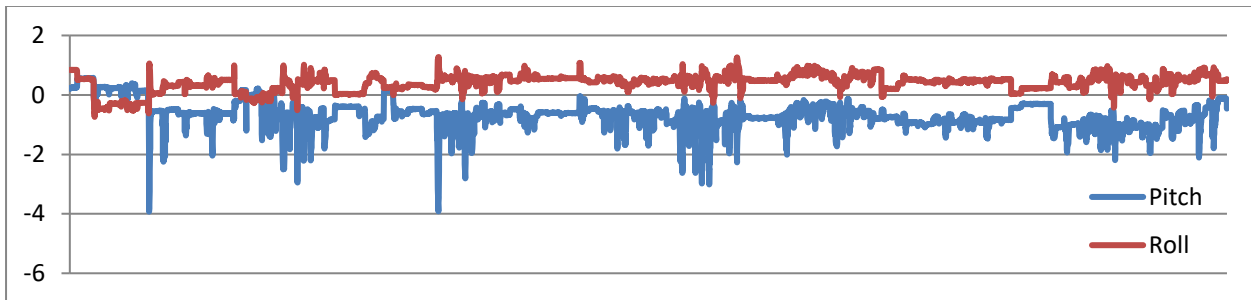


Figure 11. Summary of pitch and roll data from deployment ID368.

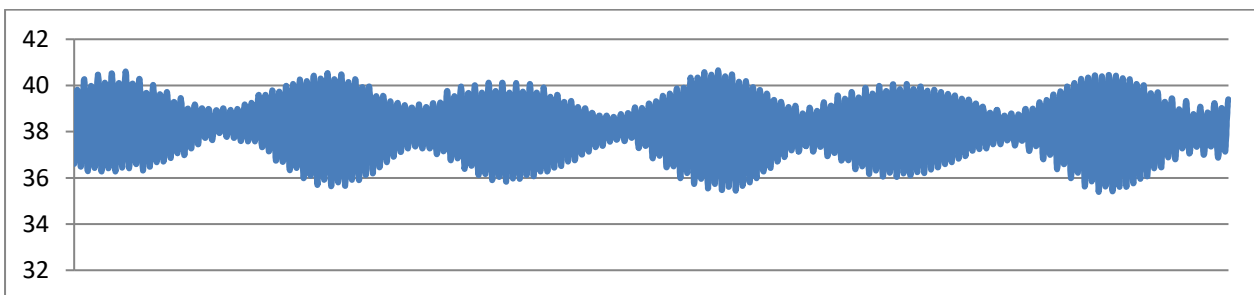


Figure 12. Pressure data from deployment ID368

6. Conclusion

MOWI has collected and analysed current and bathymetric data for the salmon farm at Tabhaigh. The analysed current data for the 85 days and 16 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:	Tabhaigh
Nearest tidal port:	Loch Shell
Time zone:	UTC
Meter switched on:	13:00 10/02/2021
Meter switched off:	05:00 07/05/2021
Period used for this report:	13:00 10/02/2021 – 05:00 07/05/2021
ADCP serial number:	24615
Meter position:	58.12333N, -6.39127W 141533 E 923355 N
Minimum water depth:	35.39 m (34.69 m measured by ADCP + 0.7 m *)
Water depth (Chart Datum):	35.29 m (minimum water depth - 0.1 m tide timetable)
Mean water depth:	38.9 m (38.2 measured by ADCP + 0.7 m *)
Depth of meter from surface:	34.59 m (below chart datum to transducer)
Height of meter from seabed:	0.7 m to transducer head
Sounding at deployment:	32.8 m @ 1035 on 10/02/2021

Table A1. ADCP meter settings:

Reference:	Transducer
Bin size (m):	1.0
Dist to 1 st bin (m):	3.01
Number of bins:	49
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