HYDROGRAPHIC REPORT

Caolas Loch Portain Finfish Pen Site, Loch Portain, North Uist

Prepared for

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Quality Assurance

The data presented within this document have undergone a quality assurance review which follows established TransTech Ltd procedures. The information and results presented herein constitute an accurate representation of these data.

Document Details

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List of Abbreviations

ADCP	Acoustic Doppler Current Profiler
ATT	Admiralty Total Tide
BGS	British Geological Survey
CD	Chart Datum
GMT	Greenwich Mean Time
GPS	Global Positioning System
LST	Lowest Spring Tide
MSL	Mean Sea Level
OS	Ordnance Survey
OSGB36	Ordnance Survey Great Britain 1936
SEPA	Scottish Environment Protection Agency

1. INTRODUCTION

This report has been prepared by TransTech for current meter data collected by Loch Duart at their Caolas Loch Portain site in North Uist. Three consecutive deployments were performed in order to obtain 90 days of data for use in NewDEPOMOD modelling of a modification to the site.

2. HYDROGRAPHIC SURVEY DETAILS

2.1 ADCP Deployments

A 300 kHz Teledyne RDI Workhorse was used for all three deployments (serial number: 11132). This was mounted in a gimballed seabed frame and deployed using a single-point mooring arrangement (figure 1). The mooring was positioned where local topographic features and other features such as mooring lines would not cause spurious data collection. For each deployment the transducer head was located 0.60 m from the base of the seabed frame.

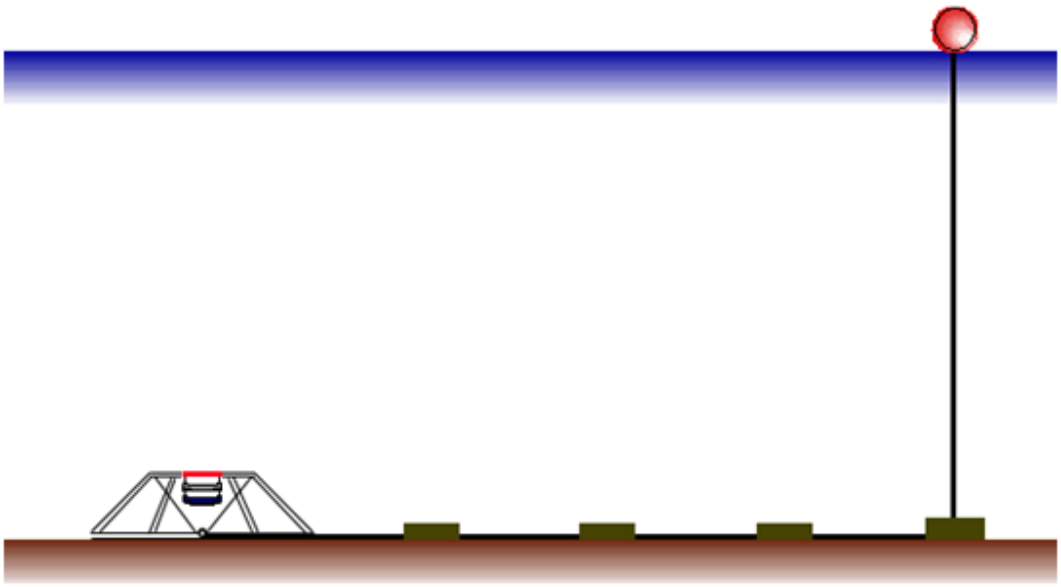

Figure 1. Schematic diagram of mooring array.

The instrument was set-up and deployed as described in Tables 1 and 2 respectively. Ensemble length was 1200 seconds (i.e., 20 minutes).

Table 1. Set-up details of the ADCP used during the survey.

Start of Reported Dataset (time in GMT)	End of Reported Dataset (time in GMT)	Pings/Ensemble	Bin Size (m)	Total No. Bins	Standard Deviation (cm/s)
22/11/22 16:11:57	21/12/22 09:31:57	700	1.0	34	0.516 (Sub-Surface Bin) 0.526 (Net-Bottom Bin) 0.524 (Near-Bed Bin)
21/12/22 13:44:29	01/02/23 08:24:29	700	1.0	34	0.519 (Sub-Surface Bin) 0.526 (Net-Bottom Bin) 0.525 (Near-Bed Bin)
01/02/23 12:02:24	13/03/23 12:42:24	700	1.0	34	0.525 (Sub-Surface Bin) 0.522 (Net-Bottom Bin) 0.507 (Near-Bed Bin)

Table 2. Deployment details of the ADCP used during the survey.

Position of reported bins (m above seabed)		ADCP Deployment Position*	Start of Reported Dataset (time in GMT)	End of Reported Dataset (time in GMT)	No. of 20 minute Ensembles	Depth** (mCD)†
Sub-Surface: Net-Bottom: Near-Bed:	22.85 17.85 2.85	94756 E, 869232 N (N 57.609389°, W 07.112956°)	22/11/22 16:11:57	21/12/22 09:31:57	2069	27.9 *(29.1)*
			"gap" in dataset patched to stitch 90 dataset (see §3.2)		12	
Sub-Surface: Net-Bottom: Near-Bed:	22.86 17.86 2.86	94738 E, 869223 N (N 57.609304°, W 07.113229°)	21/12/22 13:44:29	01/02/23 08:24:29	3009	28.0 *(28.9)*
			"gap" in dataset patched to stitch 90 dataset (see §3.2)		10	
Sub-Surface: Net-Bottom: Near-Bed:	22.85 17.85 2.85	94754 E, 869227 N (N 57.609346°, W 07.112986°)	01/02/23 12:02:24	13/03/23 12:42:24	1381	27.8 *(28.4)*

* Positions recorded relative to WGS84 datum. OS GridInquest was used to convert the WGS84 coordinates to OSGB36.

** A large vessel was used for deployment and recovery and it was therefore difficult to get a precise depth at the deployment location using the on-board sounder or a handheld unit. As such, the ADCP's pressure sensor results are deemed to be more accurate and it is these that have been used for bin height determination (NB: the depths in brackets are the mean of depth soundings at deployment and recovery).

† Correction is from Admiralty Total Tide predicted tidal amplitude at Loch Maddy.

2.2 GPS Calibration

Positions were recorded relative to WGS84 datum using a Garmin GPSMap 78s. Prior to its use on each deployment/recovery it was checked against a second Garmin GPSMap 78s to ensure that it was functioning correctly.

During the deployments these positions were recorded when the ADCP's frame landed on the seabed immediately prior to the tension on the winch cable being slackened. At recovery it was taken as soon as the winch cable was observed to begin lifting the frame. These waypoints were taken at the winch cable i.e., directly above the gimbal.

The displayed accuracy of the GPS for each deployment/recovery was ≤±3 m.

Table 3 gives deployment distances from the existing group centre.

Table 3. Deployment distances from group centre.

Proposed Group Centre Position with Approximate Existing in Brackets	ADCP Deployment Position (Mean of Deployment & Recovery)	Start of Reported Dataset* (time in GMT)	End of Reported Dataset* (time in GMT)	Distance from Proposed (m)
94829 E, 869326 N (94824E, 869346 N)	94756 E, 869232 N	22/11/22 16:11:57	21/12/22 09:31:57	119.0
	94738 E, 869223 N	21/12/22 13:44:29	01/02/23 08:24:29	137.4
	94754 E, 869227 N	01/02/23 12:02:24	13/03/23 12:42:24	124.2

2.3 Pitch, Roll and Heading

The changes in pitch, roll and heading during the deployments are shown in Table 4. These were <10° which are well within the ADCP's tolerances for auto-correction of the data and significantly below SEPA's maximum of 20°[(1)].

Table 4. Set-up and deployment details of the ADCP used during survey.

Start of Reported Dataset (time in GMT)	End of Reported Dataset (time in GMT)	Maximum Pitch (degrees)	Maximum Roll (degrees)	Maximum Change in Heading (degrees)
22/11/22 16:11:57	21/12/22 09:31:57	1.70	4.55	16.12
21/12/22 13:44:29	01/02/23 08:24:29	5.80	4.16	1.74
01/02/23 12:02:24	13/03/23 12:42:24	5.53	6.51	9.62

3. DATA PROCESSING

3.1 Magnetic North to Grid North Conversion

Current direction was collected in degrees Magnetic North and is reported in this document relative to Grid North.

During the deployment magnetic north was approximately 1º 10' (1.1667º) east of Grid North (obtained from Grid Magnetic Angle Calculator Results (bgs.ac.uk), figure 2). The hydrographic data were corrected from Magnetic North to Grid North by adding 0.2833º to the magnetic north direction data using SEPA's HG_data_analysis_v7.11.xls tool (rev 12).

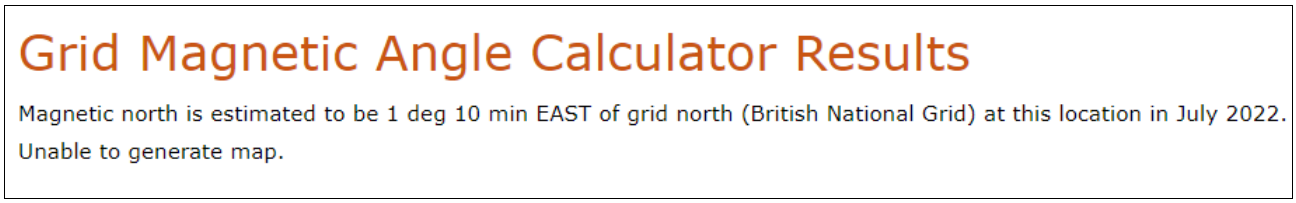

Figure 2. BGS Magnetic North to Grid North conversion.

3.2 Speed and Direction Data Patching

On 21/12/22 and 01/02/23 the ADCP was recovered and the data downloaded by Loch Duart Ltd to ensure that the ADCP was operating as intended. This was found to be the case and on both occasions the ADCP was redeployed after a battery change. The recoveries and redeployments resulted in gaps in valid data of 4 hours (12 ensembles) and 3 hours 20 minutes (10 ensembles) and 26 hours (78 ensembles) respectively.

The gaps in the data were patched using speeds and directions for which data was gathered at the same times in the tidal cycle.

SEPA will have the worksheet used to patch the data as this was previously provided in a spreadsheet titled Stitching of Deployments A,B & C.xlsx in a directory named A., B. & C. CAOLAS DEPLOYMENTS COMBINED.

3.3 90 Day Dataset

The following pages contain tabulated and graphic outputs for the selected sub-surface, net-bottom and near-bed bins for the 90-day dataset. This data was previously provided to SEPA in spreadsheets named: B - hgdata_analysis_v7.xls, M - hgdata_analysis_v7.xls and S - hgdata_analysis_v7.xls within a directory named A., B. & C. CAOLAS DEPLOYMENTS COMBINED.

Table 5 provides mean speed, ranked percentage of the mean current speed and ≤0.095 m/s as a ranked percentage within the current speed record for the sub-surface, net-bottom and near-bed bins.

Table 6 shows the tidal ellipse major axis used; the decomposition of easterly and northerly vector components relative to the tidal ellipse major axis; and the tidal current amplitude relative to the tidal ellipse major axis.

With respect to table 5 below note that according to Admiralty Total Tide (ATT) the Mean Sea Level (MSL) at Caolas Loch Portain is 2.75 m above Chart Datum (based on Loch Maddy, the nearest location for which this data is available) and that the lowest measured deployment depth (i.e., lowest spring tide) for the pressure sensor + frame during the 90 day dataset was 28.306 m.

Table 5. Current speed during the 90-day period.

Bin	Mean speed (m/s)	Percentage ≤0.095 m/s	Amplitude anisotropy	Residual speed (m/s)	Residual Direction (°Grid N)
Sub-Surface 1st dataset: 5.45 m below LST 2nd dataset: 5.44 m below LST 3rd dataset: 5.45 m below LST	0.04	95%	1.20	0.01	186
Net-Bottom 1st dataset: 12.80 m below MSL 2nd dataset: 12.89 m below MSL 3rd dataset: 12.70 m below MSL	0.04	99%	1.13	0.01	307
Near-Bed	0.04	93%	1.24	0.01	22

Table 6. Summary data for the 3 bins during the 90-day period.

Bin	Tidal ellipse major axis Bearing (°Grid N)	Components of current residual (m/s)		Components of tidal current amplitude (m/s)	
		Parallel (U)	Normal (V)	Parallel (U)	Normal (V)
Sub-Surface	195	0.008	-0.001	0.053	0.044
Net-Bottom	360	0.003	-0.005	0.042	0.037
Near-Bed	85	0.004	-0.009	0.057	0.046

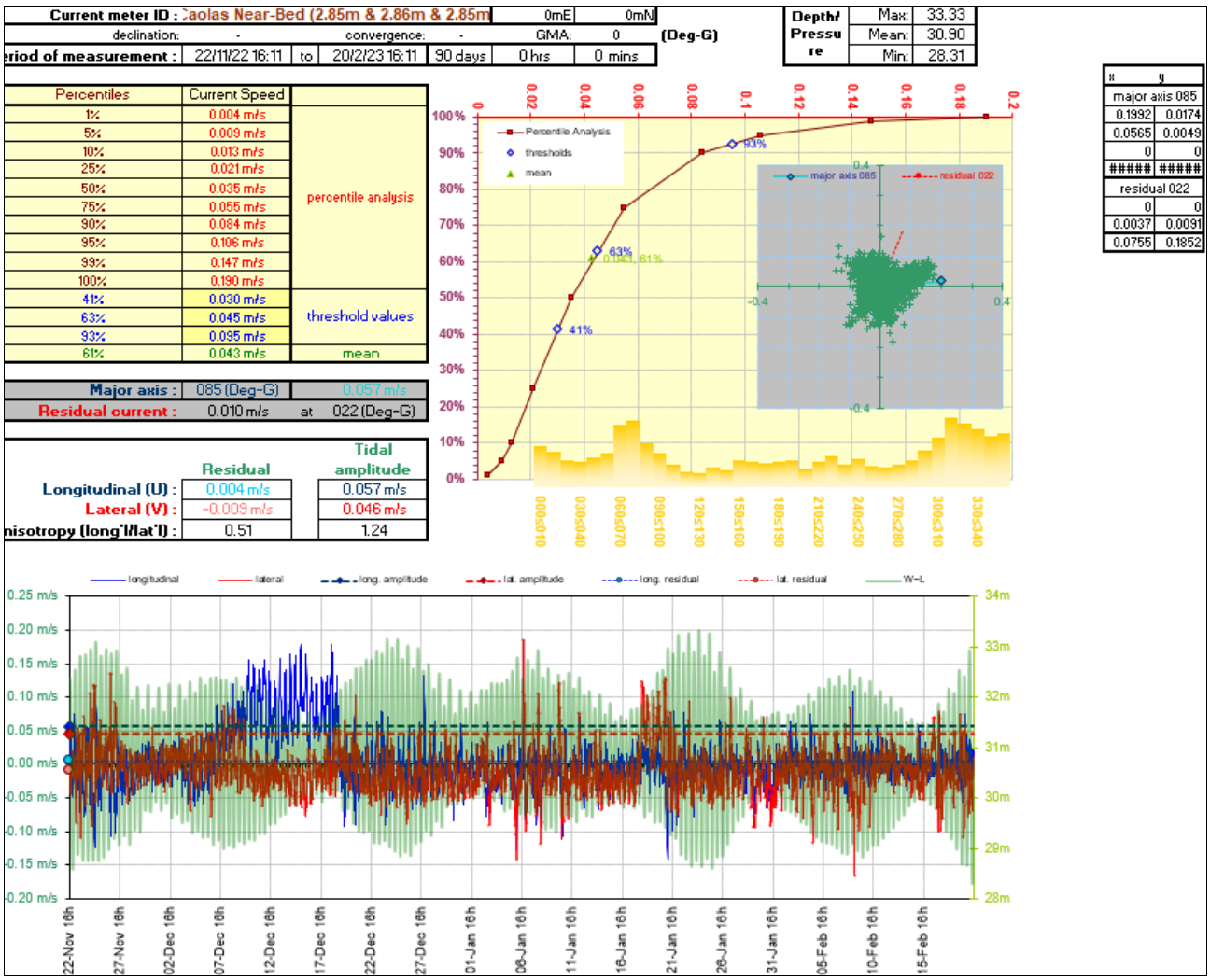

Figure 3. Summary data for sub-surface bin during the 90-day period.

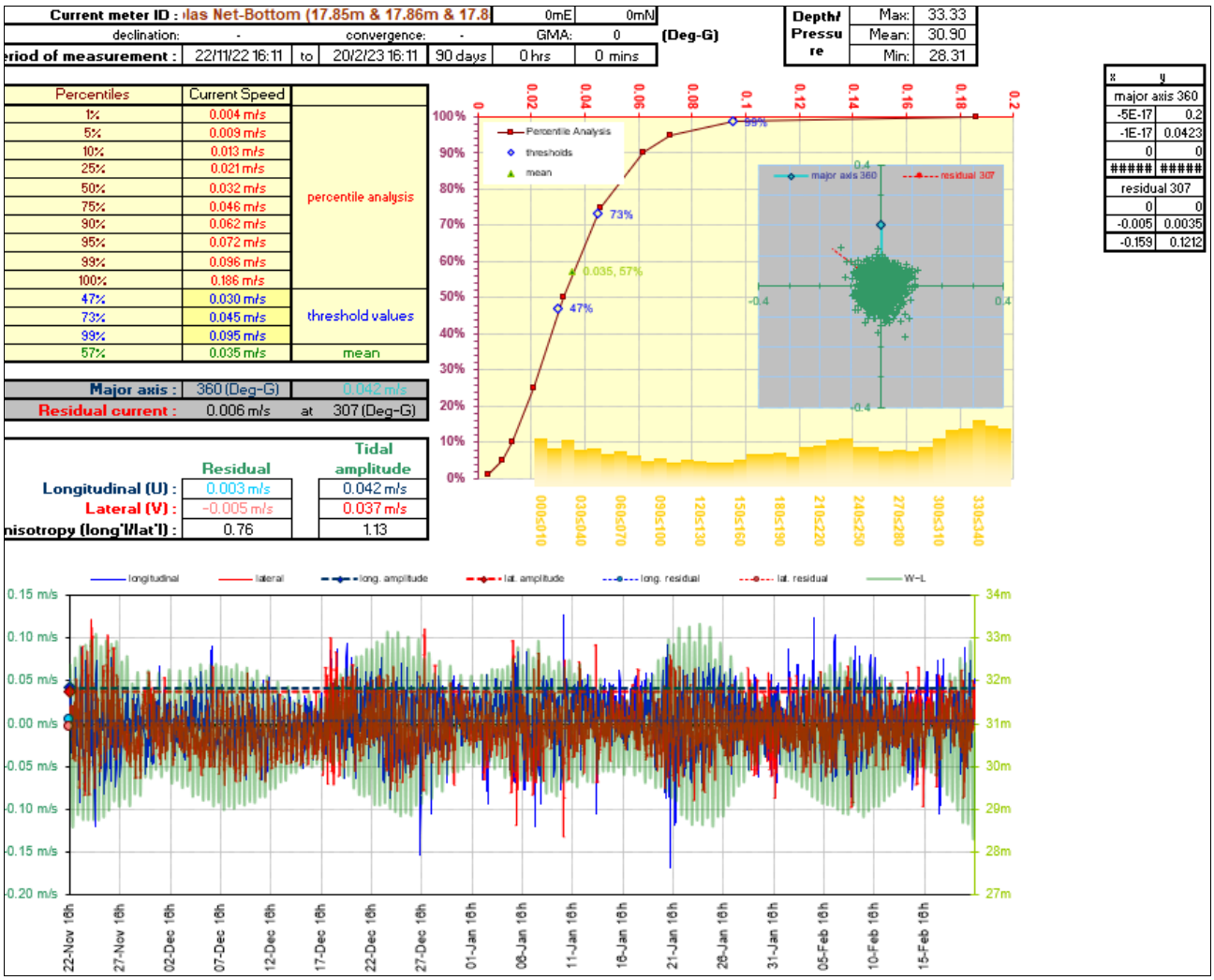

Figure 4. Summary data for net-bottom bin during the 90-day period.

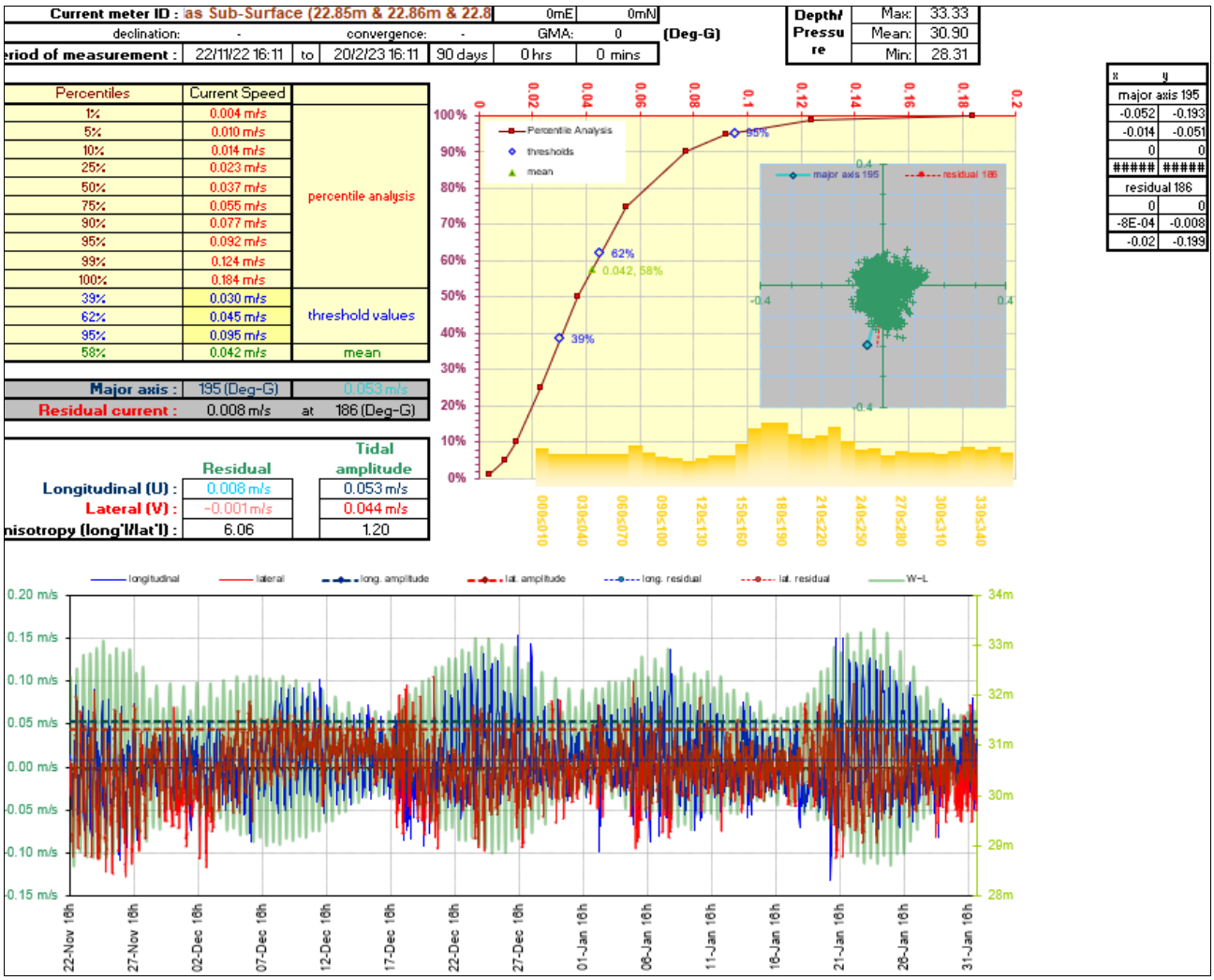

Figure 5. Summary data for near-bed bin during the 90-day period.

4. DISCUSSION & CONCULSIONS

The pressure sensor's depth record indicates that the ADCP remained undisturbed. There were some short-term changes in pitch, roll and heading during the 90-day dataset but these were minor and well within the ADCP's tolerances for auto-correction of the data.

The sub-surface and net-bottom bin heights reported in this document meet the criteria specified in Hydrographic Data for Aquaculture Application(1) i.e., ≤±1 m from the bottom of the nets at MSL and circa 5 m below LST during the deployment for the sub-surface bin. Note that it is proposed to "weight" the bin heights and deployment depth for NewDEPOMOD modelling as described in the accompanying document CLP_2023v1_ND_Modelling_Method_Statement.pdf.

The site and hydrographic survey reported in this document is considered to comply with the requirements of SEPA's guidelines(1) and the 90-day current speed and direction data are considered representative of conditions at the Caolas Loch Portain site.

REFERENCES

(1) Hydrographic Data for Aquaculture Applications. Scottish Environment Protection Agency. September 2022.

APPPENDIX A - LOCATIONS OF ADCP DEPLOYMENTS