



05th August 2025

Modelling Data Collection Report

Vementry

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Summary

A hydrographic survey was carried out by Cooke Aquaculture Scotland (CAS) for the development of a new aquaculture site, Vementry, located ~0.35 km off the Vementry island coastline.

An acoustic profiling current meter was deployed at the proposed site for ~97 days, from the 31st October 2023 and the 6th February 2024 at 430307E, 1161464N, from which a 90-day subset was selected. The data presented is considered representative of the period sampled and suitable for determining the impacts of solid and solute wastes arising from farm operations.

Sensor records confirm that there were some minor, short-lived disturbances around the mooring during the deployment that resulted in pitch, roll and heading changes, but these instances did not exceed SEPA thresholds. The raw velocity dataset contained a few fast outliers that were assumed not to be a real representation of flow dynamics at Vementry. Velocities above 0.9m/s were removed from all depth bins, replaced with NaN values and interpolated. The extracted 90-day sub-dataset included no pitch, roll and heading exceedances or measurement errors. Data quality parameters indicate that current speed and direction estimates should be of sufficient precision for modelling operational impacts.

The current meter dataset describes a moderately quiescent, weakly flushed area with mean velocities around 0.047 near the seabed. Residual current magnitudes contribute ~54.2% to the mean velocity values at the bed. Near the surface, residual current velocities decrease to ~22.34% of mean current speeds.

1. Quality assurance statement

Cooke Aquaculture Scotland confirms the collection, analysis and reporting of all information is attested by a suitably qualified person and is completed to a consistently high standard to ensure the data presented is representative of the conditions at the site. This is in line with the current SEPA standards outlined in the 2019 Regulatory Guidance documents (SEPAa & SEPAb).

2. Site description

Vementry is a proposed site to be operated by Cooke Aquaculture Scotland. The site is located ~0.35 km off the coast of Vementry, Swarbucks Minn (Figure 1). The proposed biomass is 1,350 tons across 10 pens with a circumference of 120m and net depths of 21m, arranged in 2 x 5 pattern on 85m mooring grids. This provides a stocking density of 5.61 kg/m³ during peak biomass.

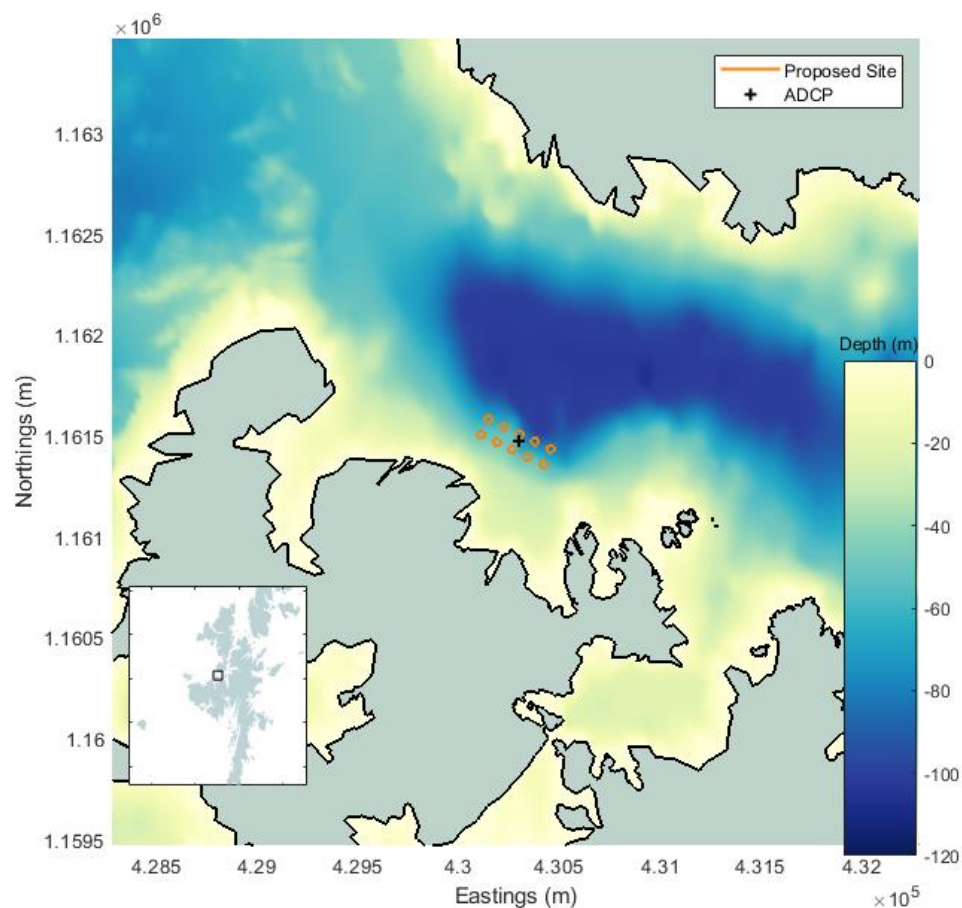


Figure 1. Current meter deployment location ('+'), proposed pens ('o') and bathymetry.

Further information on the proposed site infrastructure and pen layout is presented in Table 1.

Table 1 – Site infrastructure and pen layout.

	Vementry (Proposed)
Consent number	-
Company	Cooke Aquaculture Scotland
Receiving water	Swarbacks Minn
Site centre (OSGB36)	430285.5E, 1161466.9N
Current meter location (OSGB36)/year of deployment	430307E, 1161464N/ 2023
Distance to shore (km)	0.35 km
Average water depth (m)	58.8
Maximum biomass (t)	1,350
Total number of pens	10
Number of pen groups	1
Formation	2x5
Pen group orientation (°)	295.5
Pen shape	Circular
Pen circumference (m)	120
Mooring grid (m)	85

3. Scope of report

Hydrographic data collected in 2023 has been assessed with a 90-day subset of data being selected for analysis. This will then be used to drive NewDepomod, a particle tracking model to determine waste particle fate using default model parameters. These results can then be used to assess the environmental performance of the site.

4. Methods

4.1 Hydrographic measurements

A hydrographic survey was undertaken for the existing site. A Nortek Signature 500kHz (serial no. 101514) Acoustic Doppler Current Profiler (ADCP) was deployed between the 31st October 2023 and the 6th February 2024 at 430307 E, 1161464 N. This deployment provided ~97 days of usable data.

The sensor was mounted in a weighted mooring frame with a gimble and deployed in a specific location to represent flow conditions at the site. The transducer head is located 0.62m from the seabed. More detail on sensor configuration is given in table 2.

Table 2. Sensor configuration for the deployment.

Signature 500 – Serial no. 101514	
Site name	Vementry
Measurement interval (minutes)	10 (600 secs)
Average interval (minutes)	5 (300 secs)
Number pings	480
Orientation	Up looking
Salinity (ppt)	35
Cell size (m)	1
Number cells	65
Coordinate system	BEAM
Blanking distance (m)	0.5
Vertical precision (cm/s)	0.27
Measurement load (%)	40

4.2 Hydrographic data parameters

The data recorded by the ADCP allows the calculation of flow profiles every 600 seconds. These results were logged on an internal memory card. The specific parameters logged by the ADCP, alongside their accuracy, resolution and range are outlined in table 3.

Table 3. ADCP data collection parameters and specifications.

	Accuracy	Resolution	Range
Speed	0.3% of 0.3cm/s	0.1cm/s	2.5m/s
Compass	2° tilt <30°	0.01°	-
Tilt	0.2° tilt <30°	0.01°	-
Pressure	0.1% full scale	-	0-100m
Heading	± 3° (dynamic)	0.01°	360° all axes
Pitch/roll	± 2° (dynamic)	0.01°	± 90° (p) ± 180° (r)
Temperature	0.1°	0.01°	-4-+40°

4.3 Data processing

Raw data recorded on the Signature500 was downloaded as binary data files using the Nortek AS Signature Deployment program. The Deployment program was then used to convert and export the binary files into a .mat file format, suitable for reading into MATLAB.

The averaged current data was assessed in Signature Viewer, a post processing software programme, to ensure the data was of high quality. The data was then imported into MATLAB, where in-house scripts performed quality control (QC) and post processing. These QC checks included the assessment of:

- Heading, Pitch and Roll (°) – checking the meter has an upward orientation and limited frame movement during the survey using a threshold exceedance method with a range of ± 20°.
- Pressure record (m) – comparing the depth recorded by the meter with the bathymetry for the area. Clear spring and neap tides were observed in the pressure record with no unusual increases or decreases in the record.
- Amplitude (Signal Strength - dB) – should be decreasing with distance from the sensor. Be aware of any unusual spikes, large increases or the amplitude becoming constant. Dramatic increases in amplitude will be seen when the signal meets a boundary such as the surface or seabed. Minimum amplitude threshold = 30dB.
- Correlation (%) – quality measure of velocity data, a decrease in correlation means a decrease in data accuracy. Minimum correlation threshold = 50% of the maximum correlation.

Any data out with the QC parameters were removed and replaced with NaN values. These were later interpolated to repair any missing values. Only depth cells with less than 5% missing/repaired data are considered for use in further modelling work.

5. Bathymetry

Figure 1 shows the bathymetry around the site sourced from UKHO (UKHO, 2021). This shows a shoaling seabed south of the site, towards the Vementry coastline, while the depth is increasing north of the site. The average depth at the existing site is ~58.2m.

6. Flow data

The current profiling device was deployed on the seabed at (OSGB1936) 430307E, 1161464N (figure 1) for 97 days from the 31st October 2023 to 6th February 2024, with usable data recorded across the full deployment. During the recording period, a mean water depth of 58.2m was recorded. The quality control process identified 0 pitch and roll exceedances (figure 3).

The raw velocity dataset contained some abnormally fast outliers (figure 2), which predominantly occurred in the near-bed bin, and they are not a real representation of flow dynamics at Vementry. Therefore, velocities above 0.9m/s were removed from all depth bins and replaced with NaN values.

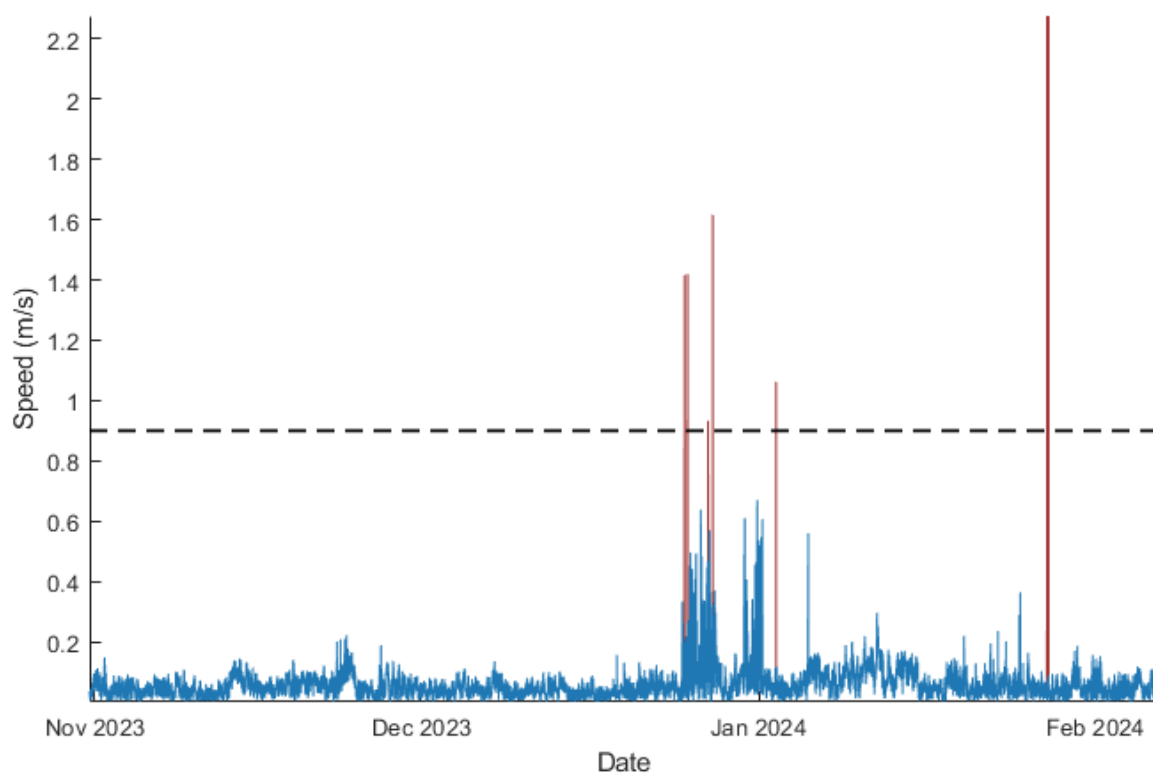


Figure 2 – Unfiltered near-bed velocity time series containing outliers (red) and filtered near-bed velocity time series (blue).

To comply with SEPA’s NewDepomod regulatory modelling guidelines, a total of 90 days of current meter data must be used. Applying a timestep of 600 seconds, this provides a total number of 12,960 timesteps, forming 90 days of data. The length of the usable data set exceeds the 90-day minimum by ~7 days. The 90-day period selected was from 31/10/2023 13:20 to 29/01/2024 13:20 (GMT).

Within the 90-day subset no pitch and roll exceedances or water column errors were identified. The sensor heading, pitch and roll for the 90-day period are shown in figure 3. Some disturbances in the sensor variables occur throughout the deployment period. However, these variations in pitch, roll and heading were within the operating constraints advised by SEPA, suggesting the ADCP gimble remained stable and no significant frame movements occurred.

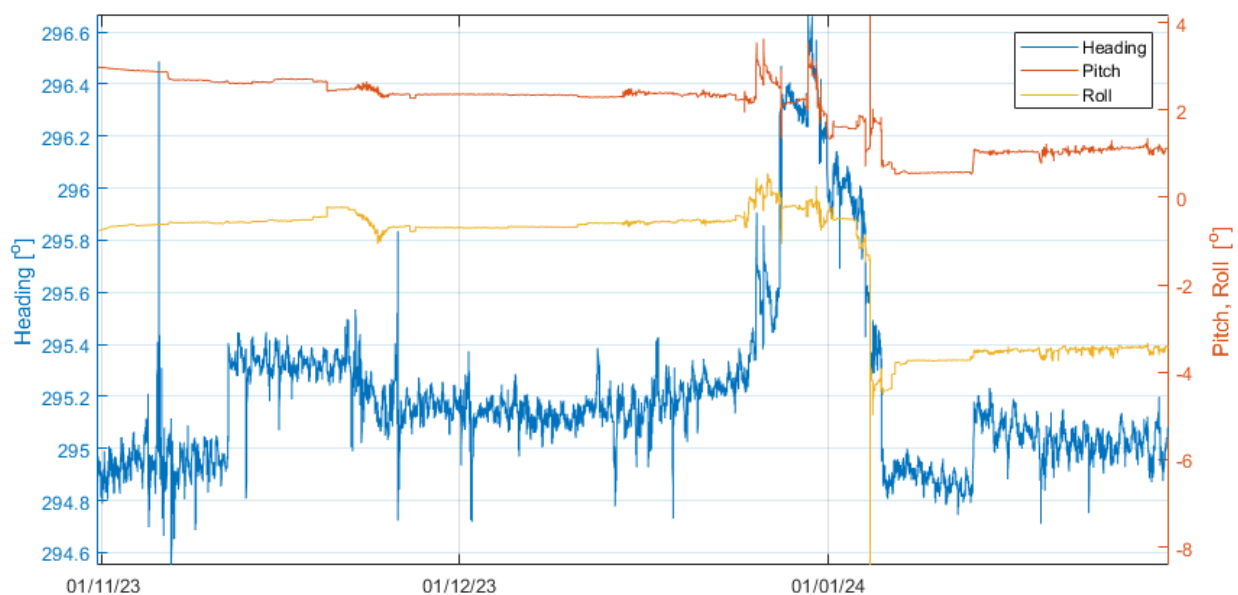


Figure 3. Sensor heading, pitch and roll for the 90-day period.

The flow statistics over the 90-day subset are given in table 4. This shows the site experiences flow speeds with mean velocities ~0.04m/s at all depths. The exposed nature of the site means surface noise penetrated deeper in the water column, meaning a relatively large surface buffer was applied when selecting the near surface bin.

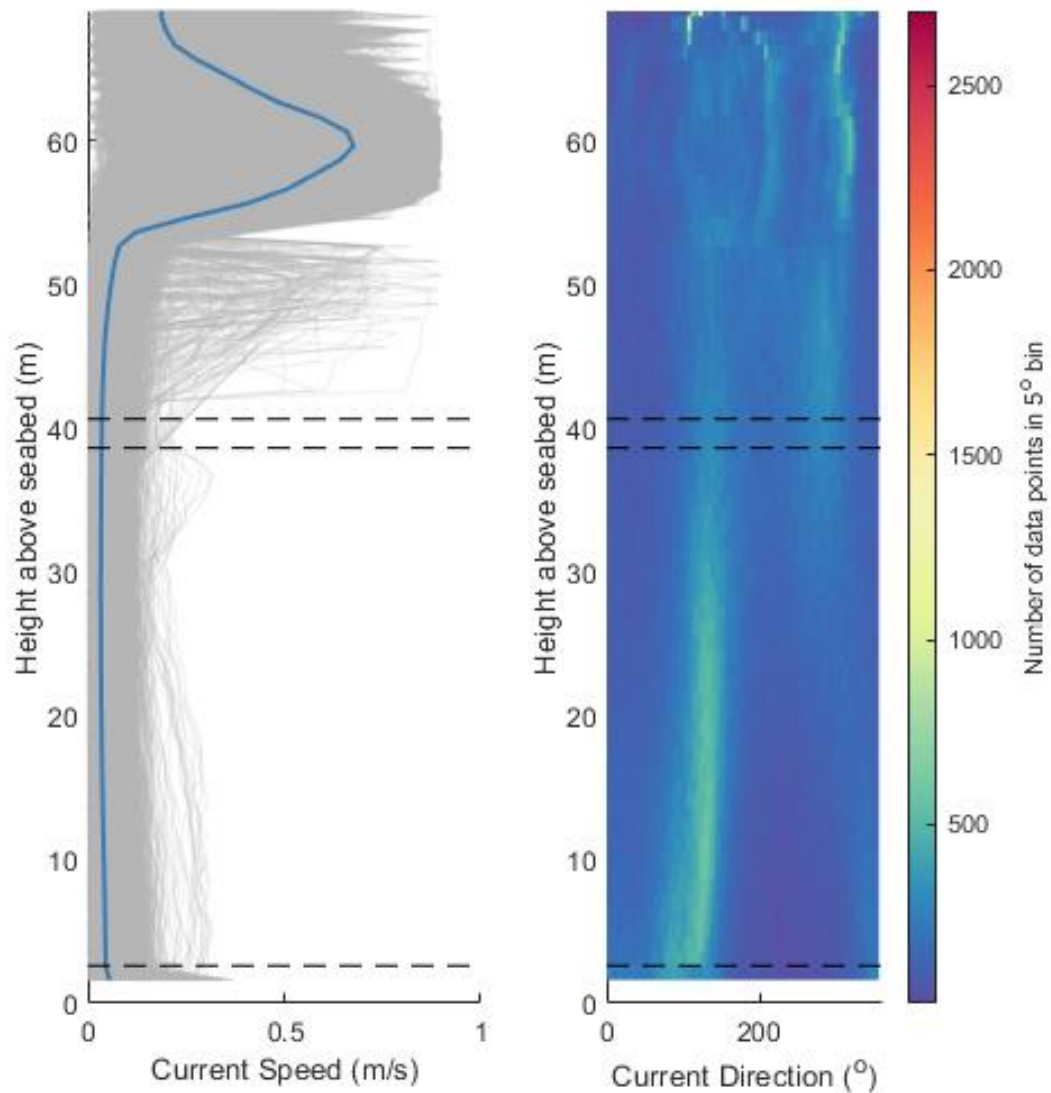


Figure 4. Left – Current velocity depth profiles for all timesteps (grey lines) and mean values (blue line), the depth locations of the near bed, cage bottom and near surface bins are shown by the dashed black lines. Right – Current direction occurrence with height above the seabed, the depth locations of the near bed, cage bottom and near surface bins are shown by the dashed black lines.

Residual current speeds are higher near the seabed. At the seabed, the residual currents comprise of 54.2% of the mean current velocity, whereas at the surface, they contribute 22.34%.

The ranked percentage of velocity 0.03, 0.045 and 0.095m/s represents the proportion of data below these speeds. This indicates whether a site is quiescent and determines the proportion of resuspension velocities.

Table 4. Flow statistics

	Near Surface	Cage Bottom	Near Bed
Height from seabed (m)	40.62	38.62	2.62
Depth cell	40	38	2
Mean speed (m/s)	0.036	0.035	0.045
Ranked percentage at 0.03m/s (%)	48.27	49.70	35.34
Ranked percentage at 0.045m/s (%)	72.22	73.23	58.48
Ranked percentage at 0.095m/s (%)	97.53	97.88	93.30
Maximum speed (m/s)	0.250	0.238	0.309
Residual speed (m/s)	0.008	0.007	0.025
Residual direction (°)	221.19	211.52	79.24
Major axis direction (°)	116.47	116.22	308.95

The near surface, cage bottom and near bed flow conditions are presented in Figures 5-8. Plot descriptions are as follows:

- A. Percentile current speed with 0.03, 0.045 and 0.095m/s indicated by black cross markers.
- B. Polar scatter plot of all speed and direction data points with residual marker in red.
- C. Percentage occurrence flow direction.
- D. Cumulative 3-dimensional particle displacement.
- E. Time series of current speed and water level.
- F. Time series of direction and water level.

Near Surface: $z = 40.62\text{m}$ (Cell = 40)

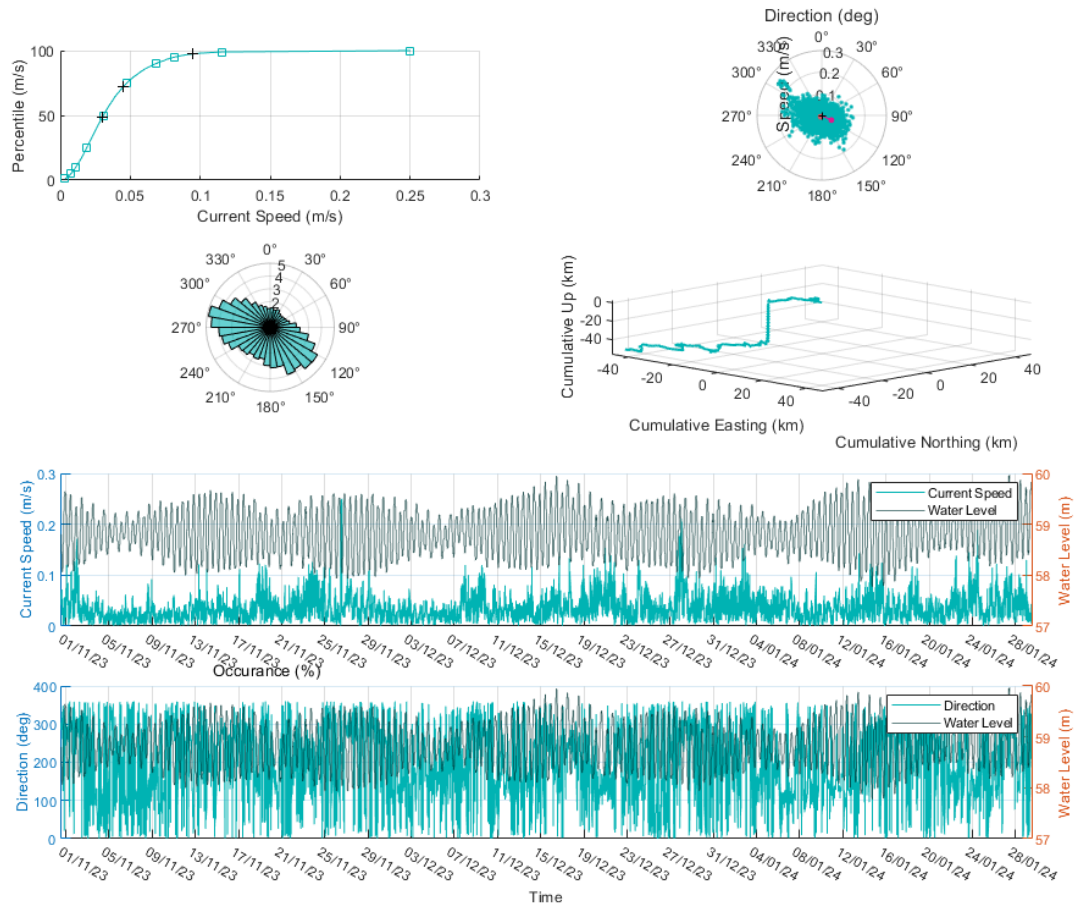


Figure 5. Near surface flow data.

Cage Bottom: z = 38.62m (Cell = 38)

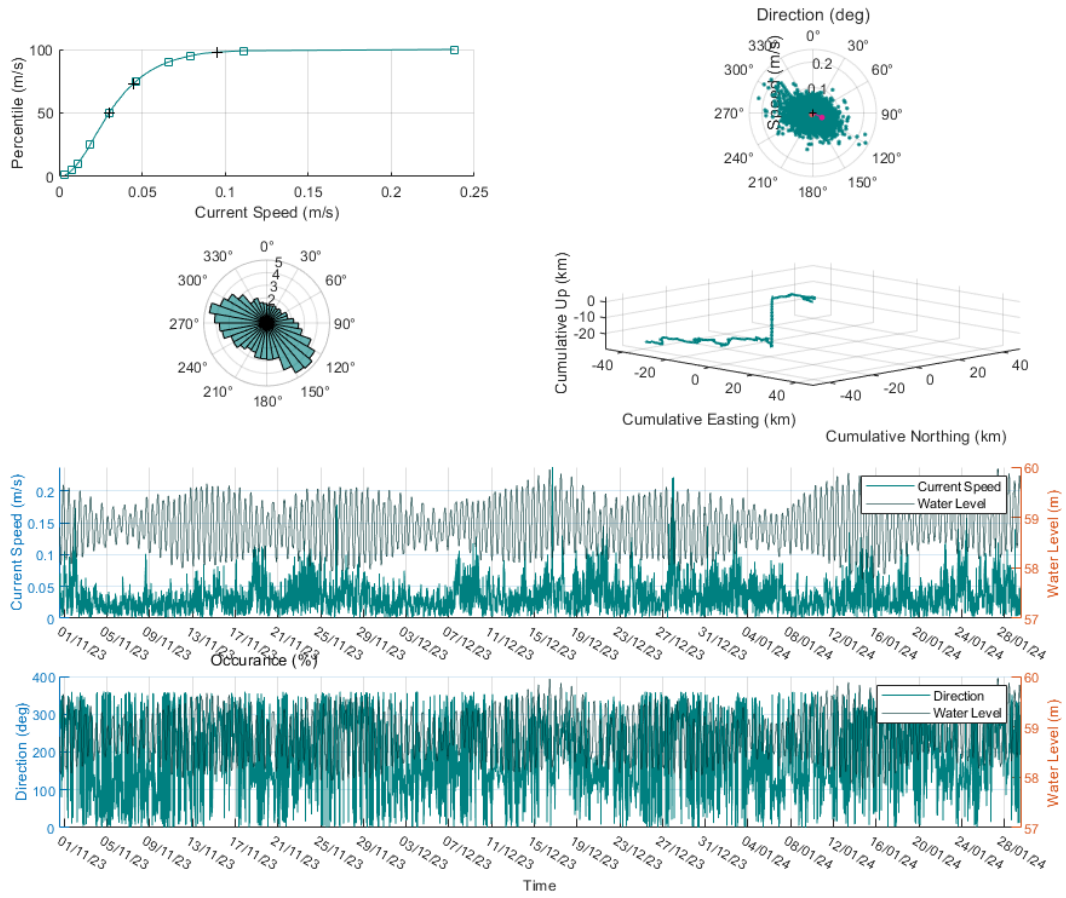


Figure 6. Cage bottom flow data.

Near Bed: $z = 2.62\text{m}$ (Cell = 2)

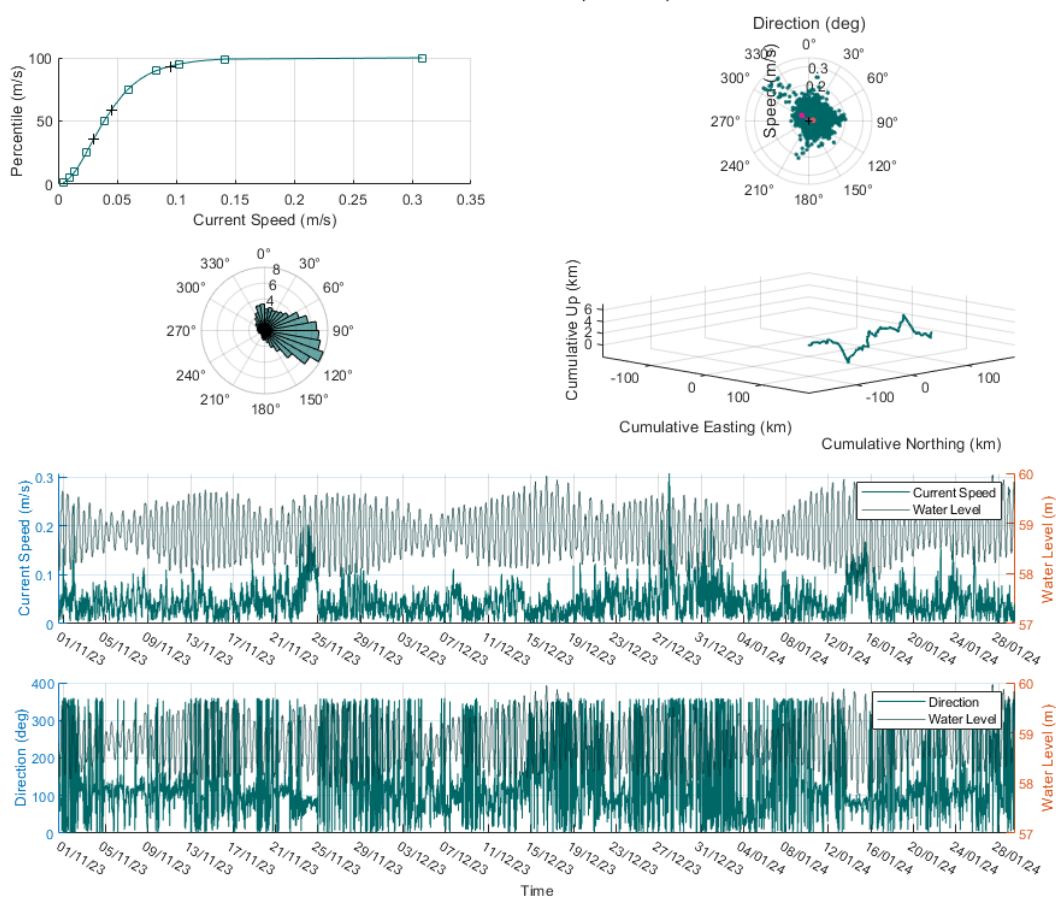


Figure 7. Near bed flow data.

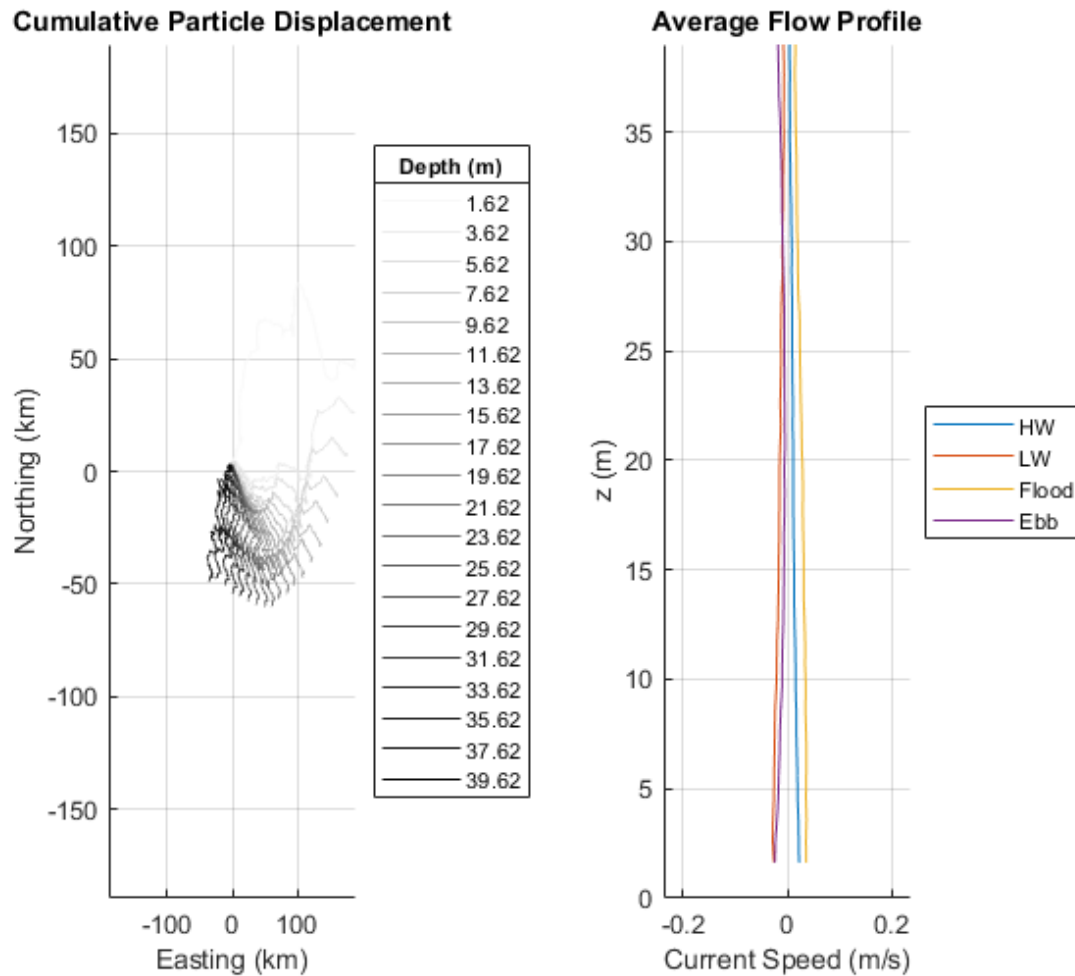


Figure 8 – Left: Cumulative particle displacement with depth. Right: Average velocity depth profile for high water (HW), low water (LW), flood tide (Flood) and ebb tide (Ebb).

8. Discussion

An ADCP was deployed near the proposed site centre for over 90-days. During this time, the sensor recorded minimal gimbal and heading movements, were no instances exceeded the SEPA advised thresholds. The raw velocity dataset contained several fast outliers that were assumed not to be a real representation of flow dynamics at Ventry. Velocities above 0.9m/s were removed from all depth bins and replaced with NaN values and interpolated to patch any missing data. The extracted 90-day sub-dataset included no pitch, roll and heading exceedances or water column errors. Overall, this suggests a successful deployment with results suitable for use in further applications.

The site experiences mean depth average velocities of ~0.04m/s across the 90-day subset period. Residual current speeds are higher near the seabed (~0.024m/s), comprising of 54.2% of the mean current velocity, whereas at the surface they contribute 22.34%. Flow direction near the sea surface is shown to be bidirectional oscillating between NW and SE directions, whereas near the seabed, flow direction is predominantly in the SE direction.

The hydrographic results can be used to classify the site in terms of flushing, quiescence and resuspension. The mean current speed is ~0.04m/s across all depth layers, putting Vementry on the weakly flushed sites (table 5).

Table 5. Flushing characteristics based on mean current speed.

Mean Current Speed (m/s)			
>0.1m/s	0.05-0.1m/s	0.03-0.05m/s	<0.03m/s
Strongly flushed	Moderately flushed	Weakly flushed	Quiescent

Periods defined as quiescent (<0.03m/s) makeup around 40% of the dataset across all depth layers, therefore classifying the site as moderately quiescent (table 6).

Table 6. Degrees of quiescence based on percentage current speeds below 0.03m/s.

Quiescent Period (0-0.03m/s)		
>50%	30-50%	<30%
Highly quiescent	Moderately quiescent	Slightly quiescent

Velocities were below the defined resuspension threshold of 0.095m/s approximately 95% of the time, meaning the site is between partially resuspensive and depositional (table 7).

Table 7. Resuspension characteristics based on percentage current speeds below 0.095m/s.

Resuspension (<0.095m/s)		
>95%	80-95%	<80%
Depositional/Quiescent	Partially resuspensive	Highly resuspensive

These parameters classify the Vementry site as a weakly flushed, partially resuspensive site.

9. Equipment list

- Garmin eTrex 10 handheld GPS
- Nortek Signature 500kHz Acoustic Doppler Current Profiler (Serial no. 101514)

10. Calibration reports

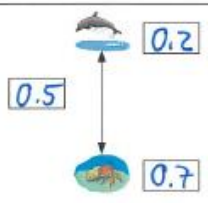
Below are the calibration documents for the Nortek Signature 500kHz ADCP (Serial no. 101514) used in the Vementry deployment.

Final test checklist AD2CP

Order number: 42931-1-78	Name: SIGNATURE 500 Instrument serial number: 101514 Frequency: 500 kHz Main board: AD2CP-1745 Firmware versions: 1.4.5217-2211-4/169
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Vangskroen 2
N-3851 800
Norway
Tel: +47 6727 4500
Fax: +47 6723 8770
Inquiry@nortek-as.com
www.nortek.no

Label checked ☒ OK Dock test ☒ OK Baudrate 115200 ☒ OK	Comments:
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Tilt check ☒ Pitch up ☒ Roll up ☒ Status bit ☒ Pitch down ☒ Roll down pitch & roll within +/- 0.2 °	Clock ☒ Set clock UTC Heading ☒ Up ☒ Down tolerance: +/- 2 °	Pressure  Psensor temp ☒ OK tolerance: +/- 0.1 % of 300 m	Temperature ☒ OK tolerance: +/- 0.1 °
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Beam check <table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>Correct order</th> <th>Beam Imp</th> <th>Noise floor</th> <th>Amplitude in tank</th> <th>Range</th> </tr> </thead> <tbody> <tr> <td>Beam 1 ☒ OK</td> <td>☒ Ω</td> <td>26 dB</td> <td>> 80 dB</td> <td>☒ OK</td> </tr> <tr> <td>Beam 2 ☒ OK</td> <td>☒ Ω</td> <td>26 dB</td> <td>> 80 dB</td> <td>☒ OK</td> </tr> <tr> <td>Beam 3 ☒ OK</td> <td>☒ Ω</td> <td>26 dB</td> <td>> 80 dB</td> <td>☒ OK</td> </tr> <tr> <td>Beam 4 ☒ OK</td> <td>☒ Ω</td> <td>26 dB</td> <td>> 80 dB</td> <td>☒ OK</td> </tr> <tr> <td>Beam 5 ☒ OK</td> <td>☒ Ω</td> <td>26 dB</td> <td>> 80 dB</td> <td>☒ OK</td> </tr> </tbody> </table>	Correct order	Beam Imp	Noise floor	Amplitude in tank	Range	Beam 1 ☒ OK	☒ Ω	26 dB	> 80 dB	☒ OK	Beam 2 ☒ OK	☒ Ω	26 dB	> 80 dB	☒ OK	Beam 3 ☒ OK	☒ Ω	26 dB	> 80 dB	☒ OK	Beam 4 ☒ OK	☒ Ω	26 dB	> 80 dB	☒ OK	Beam 5 ☒ OK	☒ Ω	26 dB	> 80 dB	☒ OK	Velocity direction <table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>XYZ coordinate system</th> <th>ENU coordinate system</th> </tr> </thead> <tbody> <tr> <td>X ☒ OK</td> <td>E ☒ OK</td> </tr> <tr> <td>Y ☒ OK</td> <td>N ☒ OK</td> </tr> <tr> <td>Z ☒ OK</td> <td>U ☒ OK</td> </tr> <tr> <td>Z2 ☒ OK</td> <td>U2 ☒ OK</td> </tr> </tbody> </table>	XYZ coordinate system	ENU coordinate system	X ☒ OK	E ☒ OK	Y ☒ OK	N ☒ OK	Z ☒ OK	U ☒ OK	Z2 ☒ OK	U2 ☒ OK
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Z ☒ OK	U ☒ OK																																								
Z2 ☒ OK	U2 ☒ OK																																								

Head file ☒ Headfile checked ☒ Saved as read only	Serial communication ☐ RS422 ☒ RS232 N/A	Recorder erased ☒ OK Rec size: 16GB
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Ethernet MAC address: 8C:68:78:00:06:D1 Static IP address: Set host name: 101514	DHCP enabled ☒ FTP OK ☒
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Licenses <table style="width: 100%; border-collapse: collapse;"> <tr> <td>Averaging mode ☒</td> <td>Wave mode ☒</td> <td>Vertical velocity ☐</td> <td>64GB recorder ☐</td> <td>Calibration license erased ☒</td> </tr> <tr> <td>Burst Five beams ☒</td> <td>Echo Sounder ☐</td> <td>Dual frequency low ☐</td> <td>128GB recorder ☐</td> <td>Production license erased ☒</td> </tr> <tr> <td>Bottom track ☐</td> <td>Ice Measurement ☐</td> <td>Dual frequency high ☐</td> <td>256GB recorder ☐</td> <td>Default configuration set ☒</td> </tr> <tr> <td>High Resolution ☐</td> <td>Altimeter ☐</td> <td>16GB recorder ☒</td> <td></td> <td></td> </tr> </table>	Averaging mode ☒	Wave mode ☒	Vertical velocity ☐	64GB recorder ☐	Calibration license erased ☒	Burst Five beams ☒	Echo Sounder ☐	Dual frequency low ☐	128GB recorder ☐	Production license erased ☒	Bottom track ☐	Ice Measurement ☐	Dual frequency high ☐	256GB recorder ☐	Default configuration set ☒	High Resolution ☐	Altimeter ☐	16GB recorder ☒			
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Cable/Harness <table style="width: 100%; border-collapse: collapse;"> <tr> <td>Cable Communication ☒</td> <td>Harness Communication ☒</td> </tr> <tr> <td>Battery ☒</td> <td>Battery ☒</td> </tr> </table>	Cable Communication ☒	Harness Communication ☒	Battery ☒	Battery ☒	Electrical isolation test 50V OK ☐	External sensors
Cable Communication ☒	Harness Communication ☒					
Battery ☒	Battery ☒					

Power down ☒ OK	Date Day: 24 Month: 07 Year: 2019
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Certificate of Calibrations and Tests

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Instrument Information

Customer Reference No.	42931-1-70
RMA No.	0
Instrument Type	Signature500
Instrument Frequency	500 kHz
Instrument S/N	101514
Head S/N	D-1514
Interface Board S/N	1745
Interface Board Mfr. S/N	4MO0613760067
Digital Board Mfr. S/N	4MO0609000072
Analog Board Mfr. S/N	4MO0619860011
Sensor Board Mfr. S/N	4MO0615010029
Interface Board Rev.	H-2
Digital Board Rev.	I-3
Analog Board Rev.	G-1
Sensor Board Rev.	I-0

Calibrations and tests performed

Pressure	Passed
Tilt and Compass	Passed

All the tested values are within Nortek AS specifications

July 23, 2019

Date

11. List of data files and description

Hydrographic data sheets (NS, CB, NB)

- CurrentMeterData_Vementry_Bottom2023
- CurrentMeterData_Vementry_Middle2023

- CurrentMeterData_ Vementry _Surface2023

Raw instrument files

- S101514A007_ Vementry.cfg
- S101514A007_ Vementry.ad2cp
- S101514A007_ Vementry _avgd.ad2cp

12. References

Scottish Environment Protection Agency (SEPAa) (2019) “Regulatory Modelling Process and Reporting Guidance for the Aquaculture Sector”. Version 1.1. Available at: <https://www.sepa.org.uk/media/450278/regulatory-modelling-process-and-reportingguidance-for-the-aquaculture-sector.pdf>

Scottish Environment Protection Agency (SEPAb) (2019) “Regulatory Modelling Guidance for the Aquaculture Sector” Version 1.1. Available at: <https://www.sepa.org.uk/media/450279/regulatory-modelling-guidance-for-theaquaculture-sector.pdf>

UK Hydrographic Office (2021) Marine Data Portal (Accessed 05/2021) Available at: <https://datahub.admiralty.co.uk/portal/apps/sites/#/marine-data-portal>