



INTERNATIONAL

Lough Ree Power Generating Station Continuous Monitoring Summary Report – Period 18: May 2018

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Lough Ree Power Generating Station Continuous Monitoring Summary Report –
Period 18: May 2018

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Change History of Report

Date	New Revision	Author	Summary of Change

Executive Summary

In July 2016, a programme of continuous temperature monitoring commenced at a number of locations on the River Shannon in the vicinity of the cooling water discharge from the Lough Ree Power Generating Station.

This report outlines the results of the eighteenth period of continuous temperature monitoring from the 1st May 2018 to the 31st May 2018. The detailed results of this period of monitoring are contained in the Irish Hydrodata document in Appendix 1 of this report.

In all, there are seven fixed temperature monitoring points in the river, one upstream of the cooling water inlet as a baseline for the data (designated as L1) and six downstream of the cooling water discharge (designated as locations L2 to L7).

This report compares the temperature data from the downstream monitoring points with the upstream baseline monitoring point to assess the temperature differential and determine whether a thermal effect is observed at those locations. In addition, the assessment considers station load, meteorological conditions, flow conditions and water level in the River Shannon. This is to analyse whether these conditions have either a potential direct or indirect effect on the thermal plume at those locations.

The station was on-load 100% of the time during this eighteenth period of monitoring. The average station load was 92 MW. Maximum output at Lough Ree Power Generating Station is 100 MW.

Conditions in the River Shannon were monitored using the data from the hydrometric gauge at Hodson's Bay (Gauge No. 26088) and at Athlone Weir. The water gauge level reading at Hodson's Bay was highest on 2nd May at 2.62 m and lowest on the 31st May at 2.31 m. The estimated flow at Athlone during the period was between 44 m³/s and 68 m³/s. The long-term average flow in the Shannon at Athlone is approximately 93 m³/s.

Records of wind direction and wind speed for the period of monitoring were obtained from the Met Éireann meteorological station at Mount Dillon, Co. Roscommon. During the period the wind varied between north east (35%) and southern (53%) directions. Wind speed generally varied between 1.9 to 31.5 km/hr.

Conclusions for each monitoring point are drawn based on the collected temperature data. In addition, the analysis considers station load, water level, meteorological and flow conditions.

From the results of the fixed monitoring points, it can be broadly concluded that for this assessment period, the thermal plume is experienced at all temperature logger locations for approximately 3% of the time. This occurred mainly from the 28th to the 31st of May 2018. Excluding location L4, the thermal plume occurred at all other locations for approximately 20% of the time.

The station is not compliant with Condition 5.5 of IE Licence P0610-02 at times during this period.

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Appendix 1: Irish Hydrodata Ltd Report “Lough Ree Power – Longterm Continuous Water Temperature Measurements Data Monthly Report For May 2018”

1 Introduction

Lough Ree Power Generating Station is located adjacent to the River Shannon at Lanesborough County Longford. The station is a peat fired base load station i.e. continuous operation, subject to availability. The installed capacity is 100 MW and the station was commissioned in 2004. The milled peat-fired boiler generates steam which is used to drive turbines which produce electricity. The steam is then cooled to hot water and recirculated to the boiler. The steam is cooled by water abstracted from and returned to the River Shannon.

The principal aqueous discharge from the power station is cooling water discharge. The station discharges approximately 135 MWth to the River Shannon when on full load. This consists of a flow through the condenser of 4 m³/s with a temperature rise of approximately 8.5°C. The flow through the condenser will vary slightly depending on the level of the River Shannon with a corresponding variation in the rise in temperature.

There has been continuous production of electricity on an adjacent site at Lanesborough since 1958 when a 20 MW unit was commissioned. The station was extended in 1966 and again in 1983. The installed capacity in 1983 was 85 MW and this discharged a thermal load to the River Shannon of approximately 185 MWth. This consisted of a flow through the condenser of 5.5 m³/s with an approximately 8°C temperature rise and all units on full load. This station, which was licenced by the EPA in May 2002 (P0629) was decommissioned in 2003 and the licence was surrendered in 2010.

In July 2016, a programme of continuous temperature monitoring commenced at a number of locations on the River Shannon in the vicinity of the cooling water discharge from Lough Ree Power Generating Station. The detailed results of the eighteenth period of continuous monitoring from the 1st May 2018 to the 31st May 2018 are contained in the Irish Hydrodata (IHD) document in Appendix 1 of this report.

This report outlines the results of this eighteenth period of continuous temperature monitoring. In addition, the assessment considers station load, flow conditions in the River Shannon and meteorological conditions.

2 Thermal Plumes

Thermal plumes have a complex physical structure. They are less dense than the receiving waters into which they flow because of their higher temperature. This causes the cooling water to flow over the surface of the ambient water and the increase in temperature to be confined to the surface. The depth of the thermal plume is not constant. The maximum depth of the thermal plume occurs at the discharge point and decreases with distance away from the discharge point. The gradient between the thermal plume and receiving waters is sharp in the vertical direction and sudden variations in temperature of 6°C can occur over a distance of 1-2 m below the surface. The gradients are considerably less in the horizontal direction.

The main factors which affect the thermal plume are:

- The quantity of heat discharged into the receiving waters. The maximum thermal load discharged occurs when the station is on full load.
- River conditions.
- Meteorological conditions.

It is noted for this assessment that temperature increases of less than 1.5°C are not considered part of the thermal plume.

3 Continuous Monitoring

Continuous temperature monitoring is being undertaken at seven fixed locations in the River Shannon in the vicinity of Lough Ree Power Generating Station at Lanesborough. At each location, between two and four temperature thermistors with loggers were deployed to measure and record temperatures at 0.3 m, 0.8 m and 1.5 m below the water surface. See Table 3-1 below for the number of loggers and depths at each location. It is to be noted that at location L2 there are only two data loggers deployed due to a shallow depth of water and at location L6 there are four data loggers deployed due to deeper depth of water in this location. Figure 3-1 below shows the locations of the continuous monitoring points, which are designated as points L1 to L7.



Figure 3-1: Continuous Monitoring Points

ID	Cross-section Location	Easting (m ITM)	Northing (m ITM)	Logger Depth T1 (m)	Logger Depth T2 (m)	Logger Depth T3 (m)	Logger Depth T4 (m)
L1	Intake	600798	769660	0.3	0.5	1.5	
L2	Outfall discharge	600609	769512	0.3	0.5		
L3	Discharge channel u/s of bridge	600548	769406	0.3	0.5	riverbed	
L4	Bridge pier	600476	769397	0.3	0.5	riverbed	
L5	Discharge channel d/s of bridge	600394	769194	0.3	0.5	1.5	
L6	Ballyleague Marina breakwater	600259	769206	0.3	0.5	1.5	3.0
L7	Bay leading to L. Ree	600255	768833	0.3	0.5	1.5	

Table 3-1: Continuous Monitoring Points Details

Lough Ree Power Generating Station Continuous Monitoring Summary Report –
Period 18: May 2018

One location is at the intake, designated as L1, and the remaining six are downstream of the outfall, designated L2 to L7.

The instruments were installed on the 11th and 12th July 2016. This report reviews the results of the monitoring for the eighteenth data download, between the 1st May 2018 and the 31st May 2018 inclusive, designated as Period 18. As noted above, the detailed results for the eighteenth period of continuous monitoring are presented in the IHD document in Appendix 1 of this report.

3.1 Station Load

Continuous records of station load at Lough Ree Power Generating Station in Megawatts (MW) for the period of monitoring were obtained from the station database, PI.

The station was on-load 100% of the time in Period 18. The average station load was 92 MW. Maximum output at Lough Ree Power Generating Station is 100 MW.

There is no continuous record of water levels in the River Shannon available at Lanesborough. For this assessment, water level data from the Office of Public Works (OPW) hydrometric gauge at Hodson's Bay (Gauge No. 26088) was used to represent conditions at Lanesborough. Water levels at Hodson's Bay for the period were obtained from the OPW website www.waterlevel.ie. The notes and warnings concerning the source, reliability and use of the data available on this website as set out in <http://www.waterlevel.ie/disclaimer/> are fully acknowledged.

Figure 3-2 below shows the Station Load for Lough Ree Power and water level at Hodson's Bay for Period 18.

Lough Ree Power Generating Station Continuous Monitoring Summary Report –
Period 18: May 2018

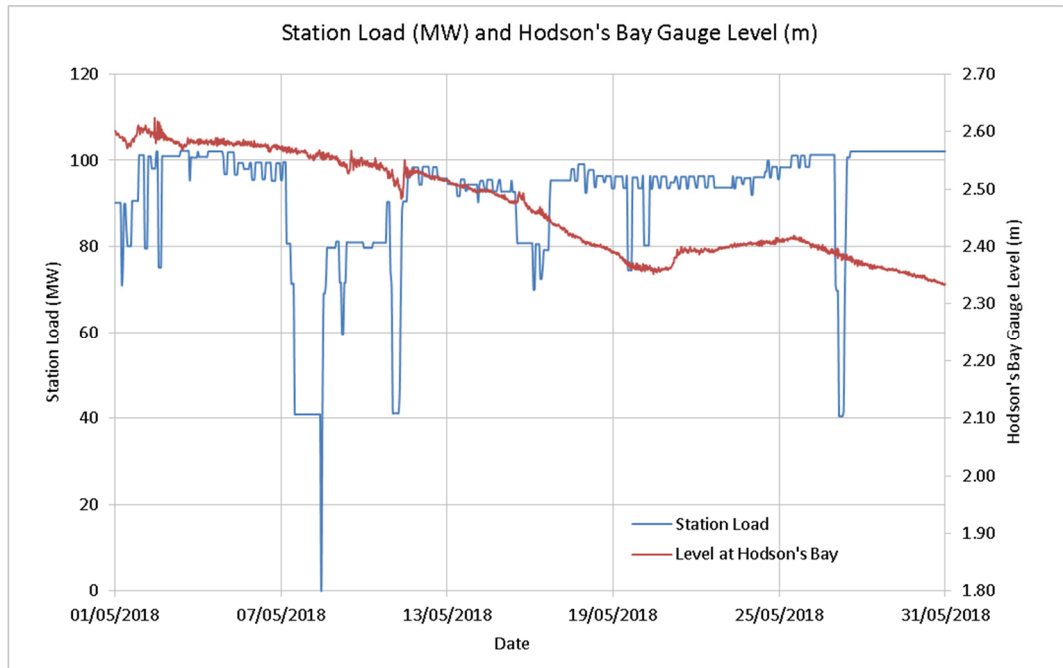


Figure 3-2: Station Load and Water Level at Hodson's Bay for Period 18

3.2 River Conditions

The water level at Hodson's Bay was highest on the 2nd May at 2.62 m and lowest on the 31st May at 2.31 m.

It is not possible to determine the flow at this gauge as there is no rating curve associated with this site. The closest location where flow in the River Shannon can be estimated is at Athlone Weir downstream of Lough Ree Power Generating Station. The estimated flow at Athlone during the period was between 44 m³/s and 68 m³/s. The average flow at Athlone for the period was 58 m³/s and flows greater than this occur 48 percent of the time. The long-term average flow in the River Shannon at Athlone is approximately 93 m³/s.

The relative locations of Lough Ree Power Generating Station, Hodson's Bay hydrometric gauge and Athlone Weir are shown in Figure 3-3.

Lough Ree Power Generating Station Continuous Monitoring Summary Report –
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Figure 3-3: Locations of Lough Ree Power, Hodson’s Bay Gauge and Athlone Weir

Figure 3-4 below shows the recorded levels at Hodson’s Bay hydrometric gauge and calculated discharge at Athlone for Period 18. The estimated discharges at Athlone were derived from the hydrometric records in the ESB hydrological database.

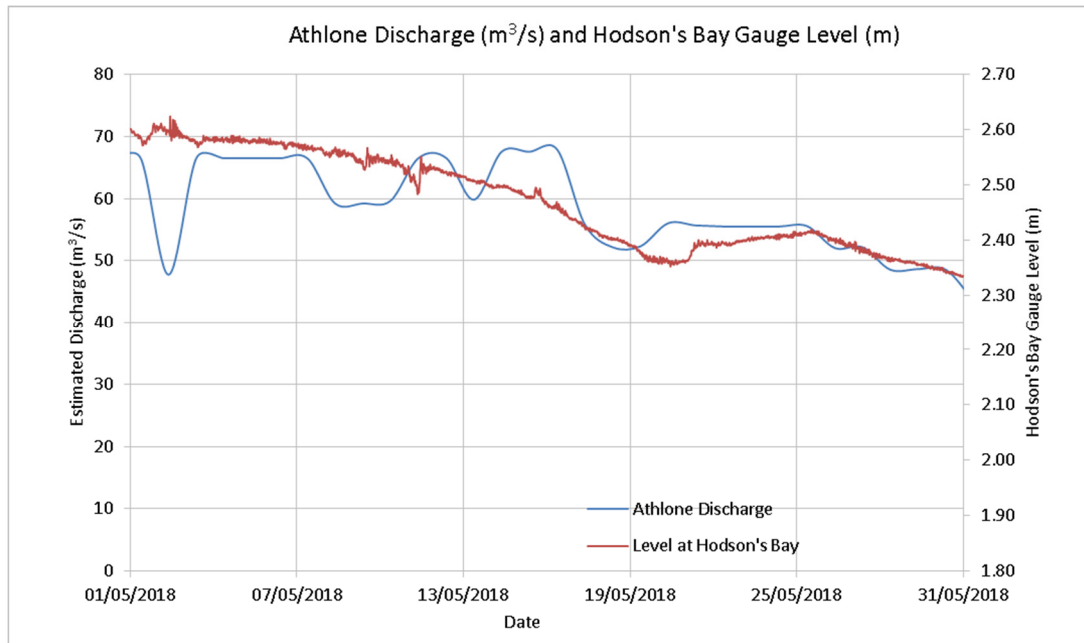


Figure 3-4: Hodson's Bay Level and Calculated Discharge at Athlone for Period 18

It should be noted that the operation of the gates at Athlone Weir influences the flow and level regimes in the River Shannon.

3.3 Meteorological Conditions

Meteorological conditions affect the thermal plume both directly and indirectly. Wind speed and direction can affect the size and shape of the plume by modifying the current profile in the receiving waters.

Records of wind direction and wind speed for the period of monitoring were obtained from the Met Éireann meteorological station at Mount Dillon, Co. Roscommon. The notes and warnings concerning the source, reliability and use of the data available on this website as set out in <http://www.met.ie/copyright/default.asp> are fully acknowledged.

During the period, the wind varied between north east and southern directions, shown in Figure 3-5. Wind speed generally varied between 1.9 km/hr to 31.5 km/hr, shown in Figure 3-6.

Lough Ree Power Generating Station Continuous Monitoring Summary Report –
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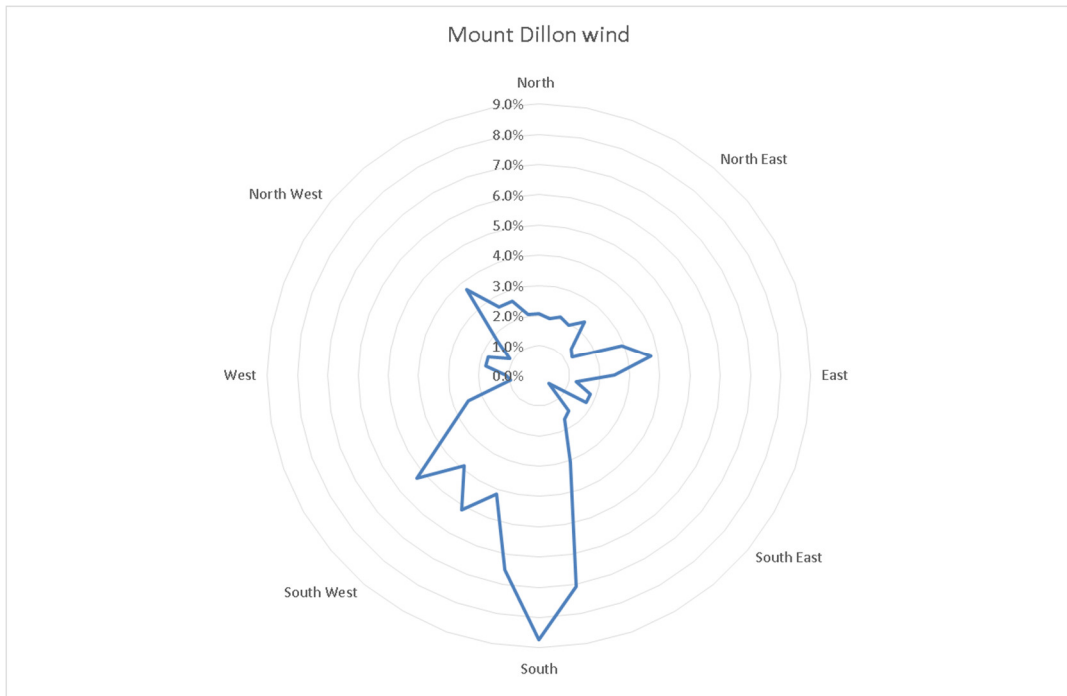


Figure 3-5: Wind Direction at Mount Dillon Meteorological Station for Period 18

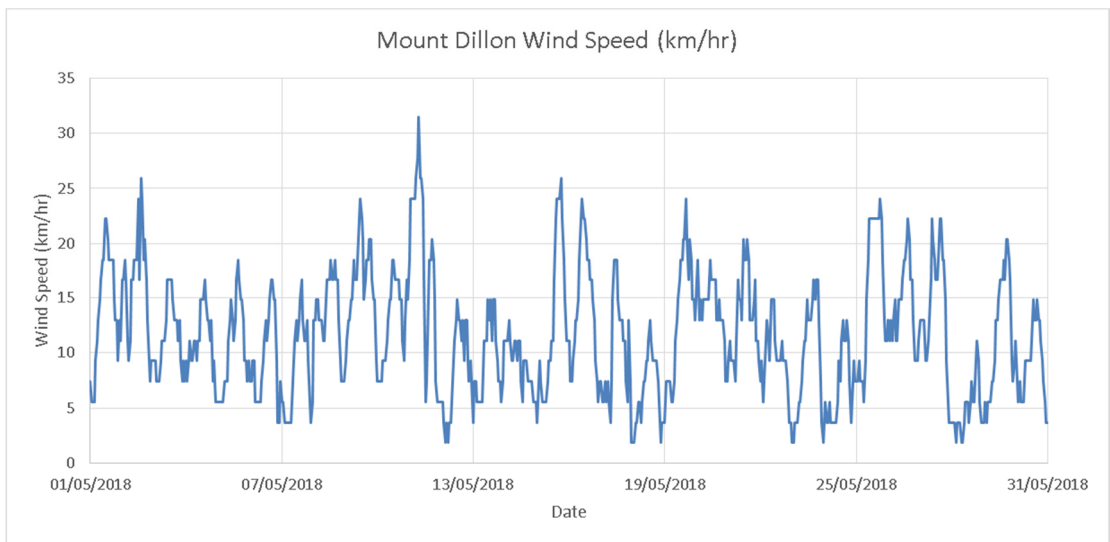


Figure 3-6: Wind Speed (km/hr) at Mount Dillon Meteorological Station for Period 18

4 Conclusions

From a review of the continuous temperature data from locations L1 to L7 for Period 18, in the light of station load, river flow and meteorological conditions and discounting periods when the station was off-load, the following conclusions are drawn:

- The station was on-load for 100% of the time in Period 18.
- At point L2, the maximum temperature rise is 9.61°C and the average temperature rise is 7.18°C. The thermal plume is observed at this location (which is within the distinct cooling water discharge channel), for 100% of the time during Period 18. See Figure 5.1 of the IHD report in Appendix 1.
- The maximum temperature rise at point L3 is 9.63°C and the average temperature rise is 7.28°C. The thermal plume is observed at this location (which is within the distinct cooling water discharge channel) for 100% of the time during Period 18. See Figure 5.2 of the IHD report in Appendix 1.
- At point L4, the average temperature rise is 0.14°C. Short spikes in water temperature occur throughout the month. The maximum temperature rise which occurs during this period is 7.12°C. The thermal plume is observed at this location for only 3% of the time during Period 18. Maximum temperatures occurred when the station was at or near full load, water levels were below 2.5 m and the wind was predominately from the south. See Figure 5.3 of the IHD report in Appendix 1.
- The maximum temperature rise at point L5, where the distinct channel into which the cooling water discharge occurs meets the bay leading to Lough Ree, is 7.74°C and the average temperature rise is 4.53°C. The thermal plume is observed at this location for 100% of the time. See Figure 5.4 of the IHD report in Appendix 1.
- At point L6, the maximum temperature rise is 5.09°C and the average temperature rise is 0.88°C. The thermal plume is observed at this location for 22% of the time during period 18. Maximum temperatures occurred when the station was at or near full load, water levels were low and wind was predominantly from the south east. See Figure 5.5 of the IHD report in Appendix 1.
- The maximum temperature rise at point L7 is 4.88°C and the average temperature rise is 1.06°C. Thermal plume is observed at this point (which is close to the east bank), for 33% of the time during Period 18. Maximum temperatures occurred when the station was at or near full load, wind speeds were low and the prevailing wind was from the north. See Figure 5.6 of the IHD report in Appendix 1.
- For approximately 22% of Period 18, thermal plume was observed simultaneously at both points L5 and L6.
- Lough Ree Power is not compliant with Condition 5.5 at times during Period 18.

The detailed results of the continuous monitoring are contained in Appendix 1.

Appendix 1

Irish Hydrodata Ltd Report

**“Lough Ree Power – Longterm Continuous Water Temperature
Measurements**

Monthly Report For May 2018

LOUGH REE POWER

**LONGTERM CONTINUOUS WATER
TEMPERATURE MEASUREMENTS**

MONTHLY REPORT

FOR

MAY 2018

Doc. Ref. 1245-16B-May18

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Prepared for:

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WHOLESALE MARKETS**



June 13th 2018

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1 Introduction

Irish Hydrodata Ltd (IHD) was contracted by ESB Generation & Wholesale Markets (ESBGWM) to deploy seven instrument strings containing a total of twenty-one temperature data loggers in the River Shannon in the vicinity of the cooling water discharge from the Lough Ree Power (LRP) plant. The data loggers were initially deployed on July 11th 2016 and were to remain in-situ for at least a 12-month period. Data is logged on-board the instruments and was to be downloaded on a regular basis (possibly monthly) during the course of the overall measurement period.

The reader is referred to the following documents for further information:

“1245-16-1-MS_LRP and WOP Longterm Temperature Measurements - Method Statement - June 23rd 2016”

“1245-16B-1-DR_LRP Longterm Temperature Measurements - Deployment of July 11th 2016 – Report”

Reporting was initially done on a download-by-download basis, i.e. each report would contain the data from a single data download, irrespective of its duration. This was later modified to provide reports on a monthly basis.

This report contains the data for the month of May 2018.

2 Instrumentation

For this project, Onset Hobo U22-001 Water Temp Pro V2 loggers units were chosen (Figure 2.1). These instruments are approximately 11.4cm in length and 3.0cm maximum diameter. They have off the shelf accuracies of +/-0.2°C and a resolution of 0.02°C. Instrument response time is 5 minutes. Memory capacity is 42,000 readings. There are up to 8 user-defined logging intervals and durations.

The instruments were set up to record at a 5 minute sampling interval. This is sufficient for approximately 145 days of logging before filling the available storage capacity. Battery life is of the order of 6 years, depending on operating conditions.



Figure 2.1 Hobo U22-001 Water Temp Pro V2 Logger

The instruments were calibrated by IHD prior to deployment according to the Method Statement document. Although the loggers have off the shelf accuracies of +/- 0.2°C and a resolution of 0.02°C, accuracies of about +/- 0.05°C were achieved during pre-deployment calibrations (Figure 2.2).

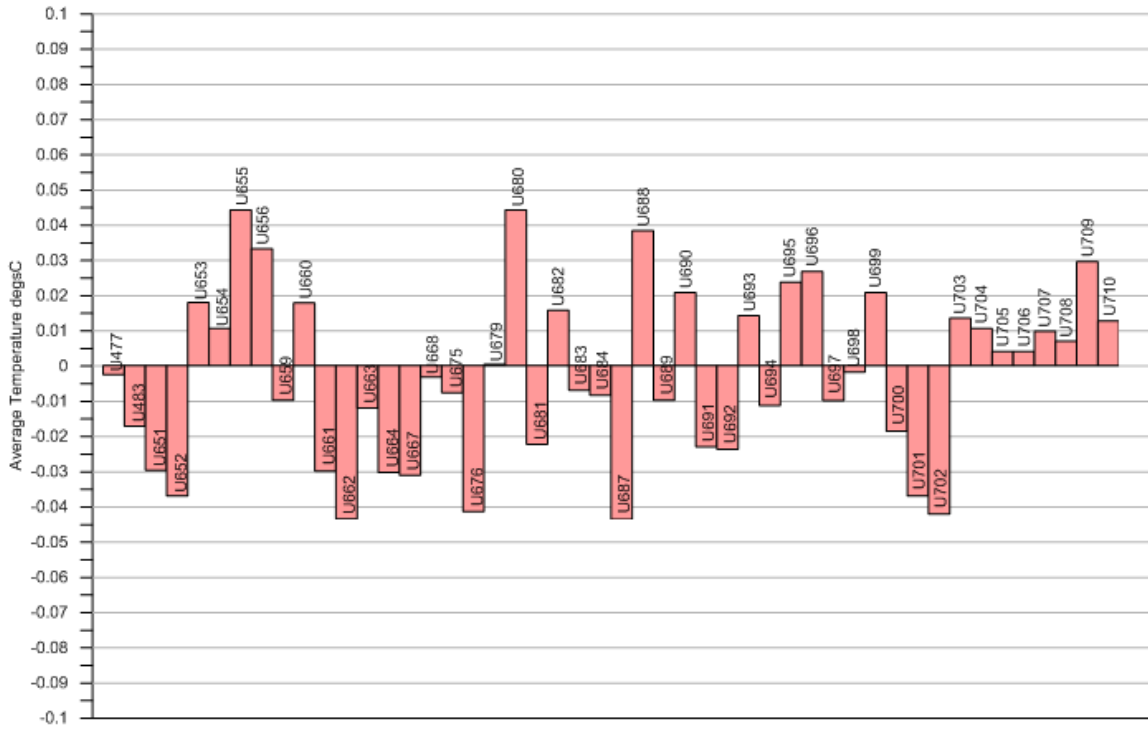


Figure 2.2 Instrument calibration

3 Deployment Locations

3.1 As-deployed locations

The as-deployed locations of the instrument strings are listed in Table 3.1 and shown in Figure 3.1. The table also shows the depth below water surface of each temperature data logger. Only two loggers were deployed at the outfall discharge location (L2) as it was quite shallow there. Four loggers were deployed at the marina breakwater at Ballyleague (L6) to avail of the opportunity to measure temperatures in the deeper waters there.

ID	Cross-section String Location	Easting (m ITM)	Northing (m ITM)	Logger Depth T1 (m)	Logger Depth T2 (m)	Logger Depth T3 (m)	Logger Depth T4 (m)
L1	Intake	600798	769660	0.3	0.5	1.5	
L2	Outfall discharge	600609	769512	0.3	0.5		
L3	Discharge channel u/s of bridge	600548	769406	0.3	0.5	riverbed	
L4	Bridge pier	600476	769397	0.3	0.5	riverbed	
L5	Discharge channel d/s of bridge	600394	769194	0.3	0.5	1.5	
L6	Ballyleague marina breakwater	600259	769206	0.3	0.5	1.5	3.0
L7	Lagoon	600255	768833	0.3	0.5	1.5	

Table 3.1 As-deployed instrument string locations

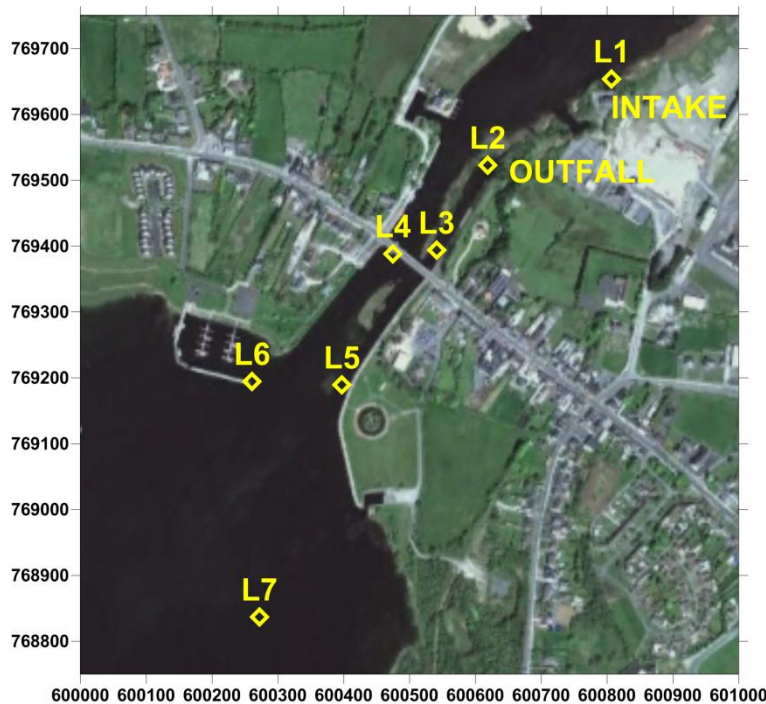


Figure 3.1 As-deployed instrument string locations

It should be noted that at low river water levels, the bottom logger and possibly the middle logger could lie on the river bed at some of the string locations, particularly in the discharge channel and at the bridge pier.

4 Data Downloads

4.1 Previous Deployment Periods

The instruments were initially deployed on July 11th and 12th 2016. The subsequent data download and instrument redeployment information is summarised in Table 4.1 below.

Deployment Number	Deployment	Data Download	Report
1	July 11 th & 12 th 2016	August 16 th 2016	1245-16B-DL1 Under separate cover
2	August 16 th 2016	October 26 th 2016	1245-16B-DL2 Under separate cover
3	October 26 th 2016	December 13 th 2016	1245-16B-DL3 Under separate cover
4	December 13 th 2016	January 25 th 2017	1245-16B-DL4 Under separate cover
5	January 25 th 2017	March 10 th 2017	1245-16B-DL5 Under separate cover
6	March 10 th 2017	April 28 th 2017	1245-16B-DL6 Under separate cover
7	April 28 th 2017	May 31 st 2017	1245-16B-DL7 Under separate cover
8	May 31 st 2017	June 28 th 2017	1245-16B-DL8 Under separate cover
9	June 28 th 2017	August 24 th 2017	1245-16B-DL9 Under separate cover
10	August 24 th 2017	October 6 th 2017	1245-16B-DL10 Under separate cover. And forms part of Monthly report 1245-16B-OCT17
11	October 6 th 2017	January 12 th 2018	Forms part of Monthly reports 1245-16B-OCT17 1245-16B-NOV17 1245-16B-DEC17 1245-16B-JAN18
12	January 12 th 2018	February 8 th 2018	Forms part of Monthly reports 1245-16B-JAN18 1245-16B-FEB18
13	February 8 th 2018	April 5 th 2018	Forms part of Monthly reports 1245-16B-FEB18 1245-16B-MAR18 1245-16B-APR18
14	April 5 th 2018	May 14 th 2018	Forms part of Monthly reports 1245-16B-APR18 1245-16B-MAY18

Deployment Number	Deployment	Data Download	Report
15	May 14 th 2018	June 12 th 2018	Forms part of Monthly reports 1245-16B-May18 1245-16B-Jun18

Table 4.1 Deployment & Data Downloads

4.2 Download & Redeployment Method

The instruments were recovered to the survey boat. They were cleaned and the data downloaded. All moorings were checked before the instruments were redeployed.

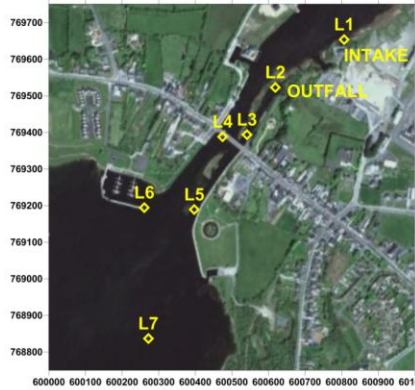
5 Data for May 2018

5.1 Data Timeseries

The calibration offsets are applied to the logged data during post-processing. The processed data is presented in the form of timeseries plots of absolute temperature. The data from L1 (intake) is generally taken to be background or ambient temperature. The data from L1 is shown on all plots along with the data from each of the other six instrument strings in turn. This allows for an immediate visual comparison of the background temperature at the intake with the temperature at the other locations. The effect of the thermal discharge, if any, can thus be clearly seen.

Figure 5.1 shows data from L1 and L2,
Figure 5.3 shows data from L1 and L4,
Figure 5.5 shows data from L1 and L6,

Figure 5.2 shows data from L1 and L3.
Figure 5.4 shows data from L1 and L5.
Figure 5.6 shows data from L1 and L7.



LOUGH REE POWER LONGTERM CONTINUOUS TEMPERATURE MEASUREMENTS MAY 2018

Absolute temperatures (°C) at L1 (intake) and L2 (outfall)

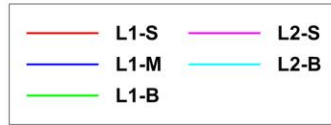
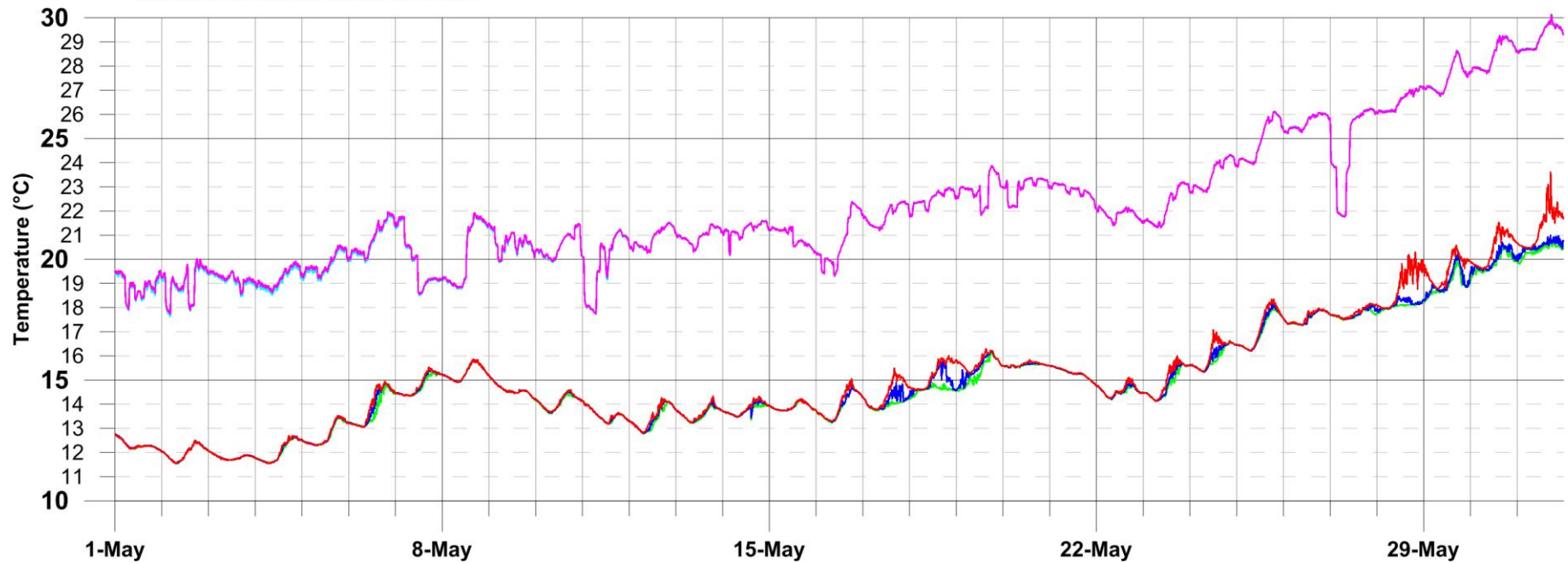
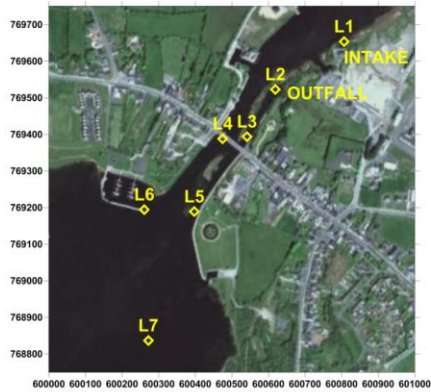


Figure 5.1





LOUGH REE POWER LONGTERM CONTINUOUS TEMPERATURE MEASUREMENTS MAY 2018

Absolute temperatures (°C) at L1 (intake) and L3

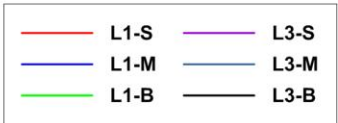
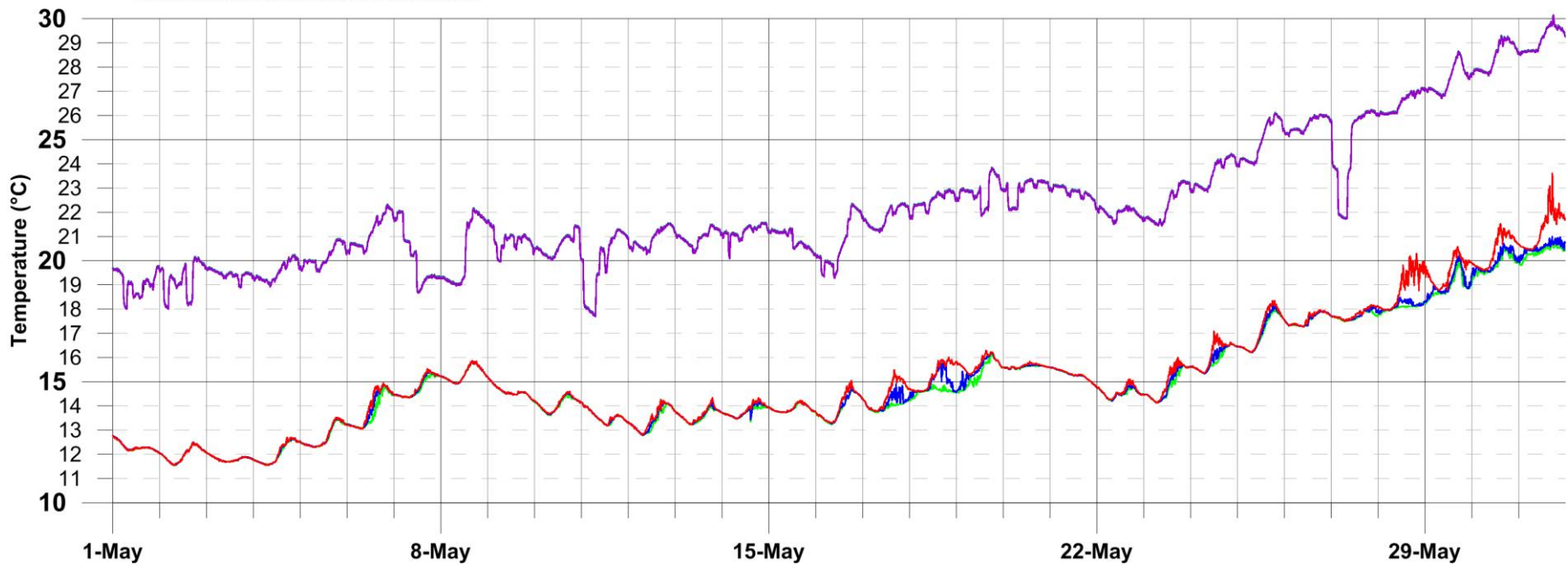
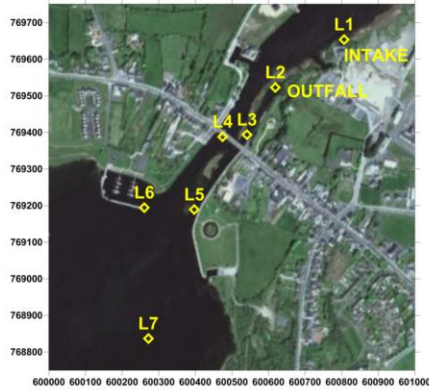


Figure 5.2



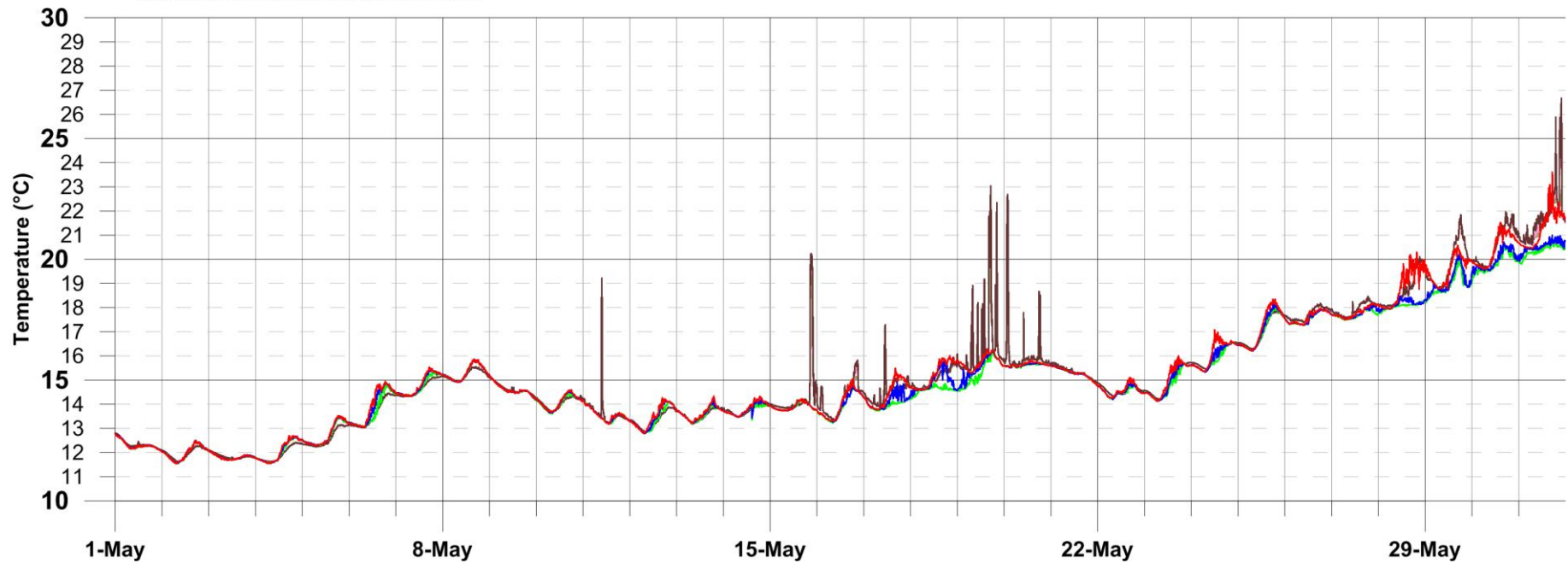


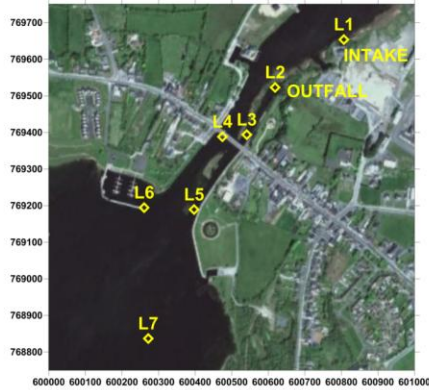
LOUGH REE POWER LONGTERM CONTINUOUS TEMPERATURE MEASUREMENTS MAY 2018

Absolute temperatures (°C) at L1 (intake) and L4



Figure 5.3





LOUGH REE POWER LONGTERM CONTINUOUS TEMPERATURE MEASUREMENTS MAY 2018

Absolute temperatures (°C) at L1 (intake) and L5

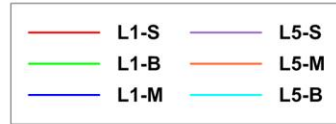
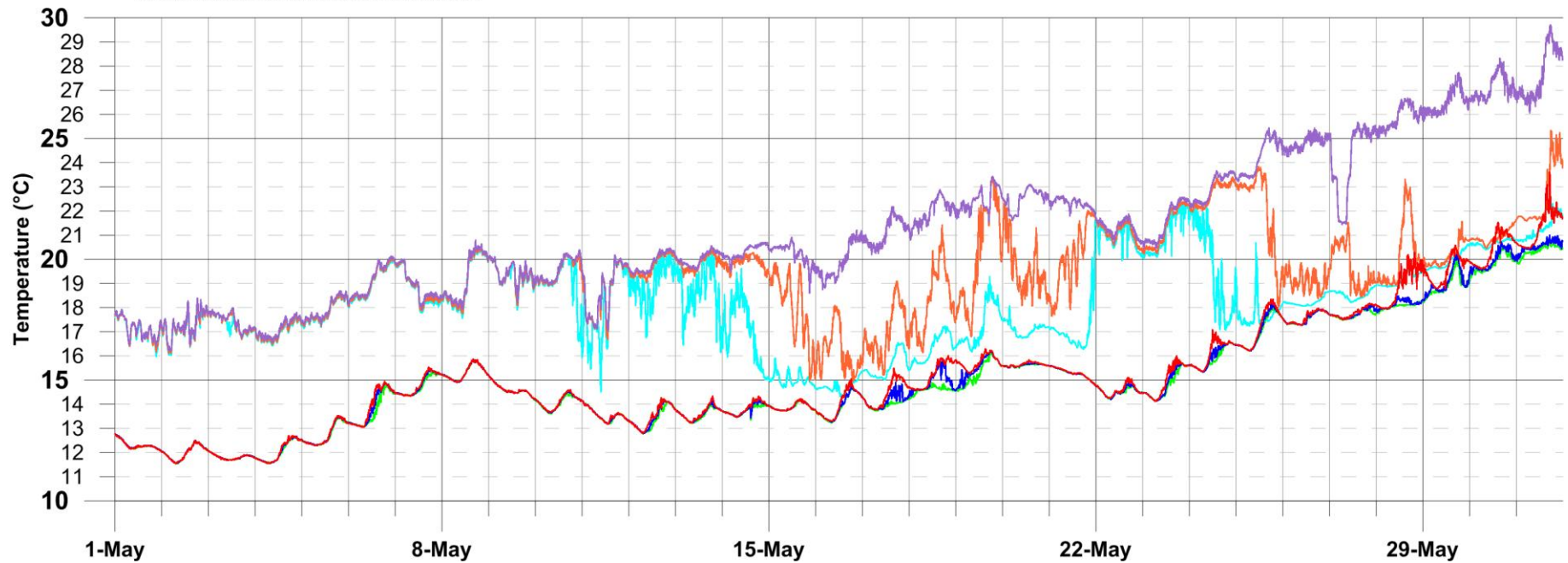
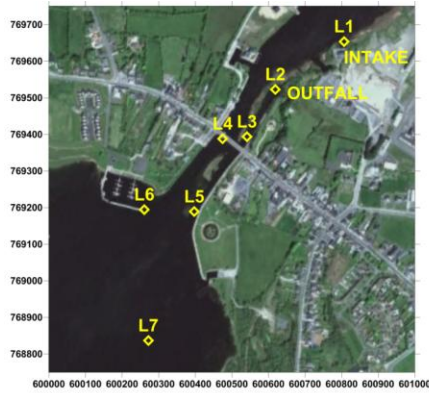


Figure 5.4





LOUGH REE POWER LONGTERM CONTINUOUS TEMPERATURE MEASUREMENTS

MAY 2018

Absolute temperatures (°C) at L1 (intake) and L6

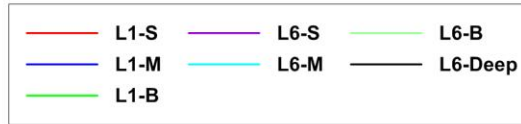
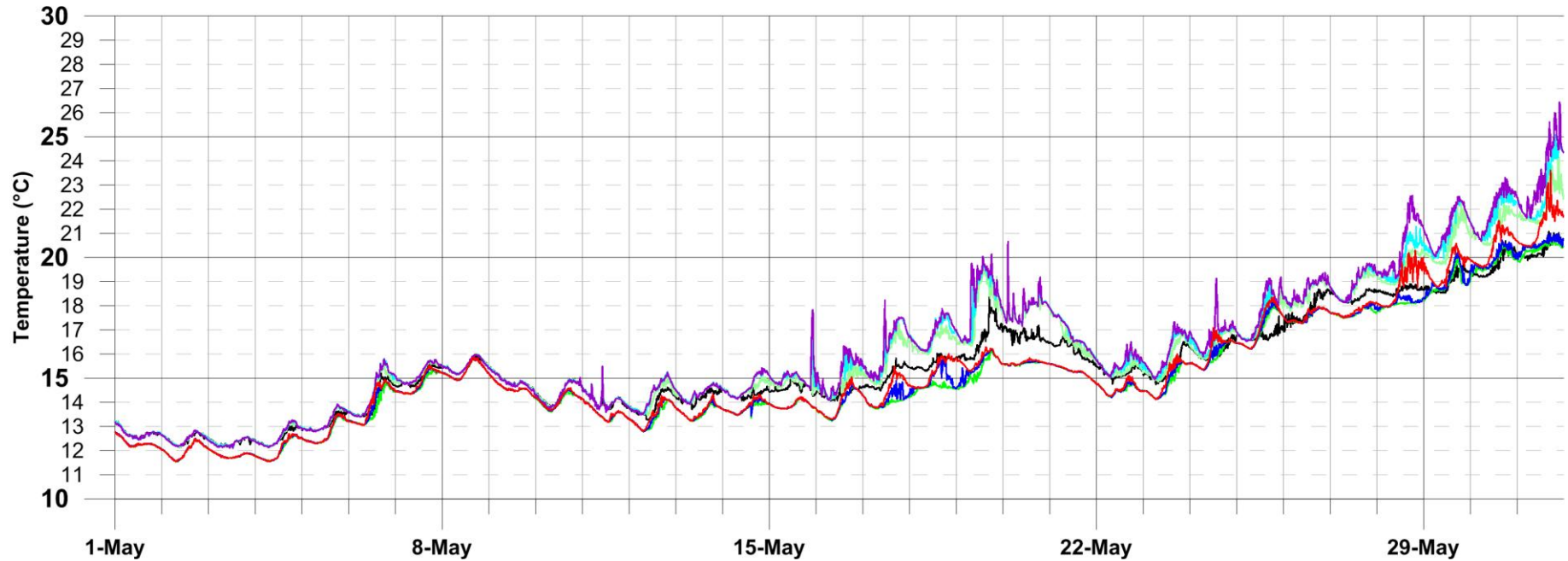
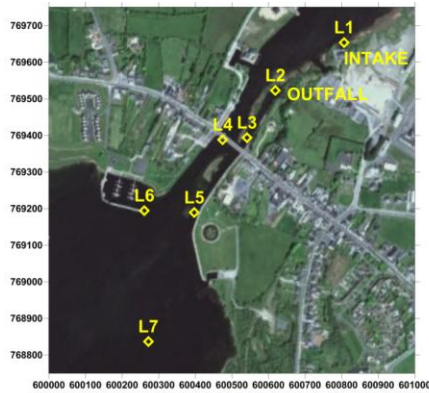


Figure 5.5





LOUGH REE POWER LONGTERM CONTINUOUS TEMPERATURE MEASUREMENTS

MAY 2018

Absolute temperatures (°C) at L1 (intake) and L7

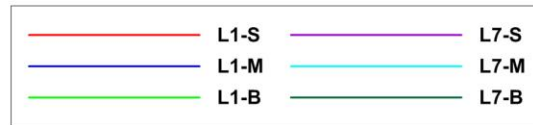
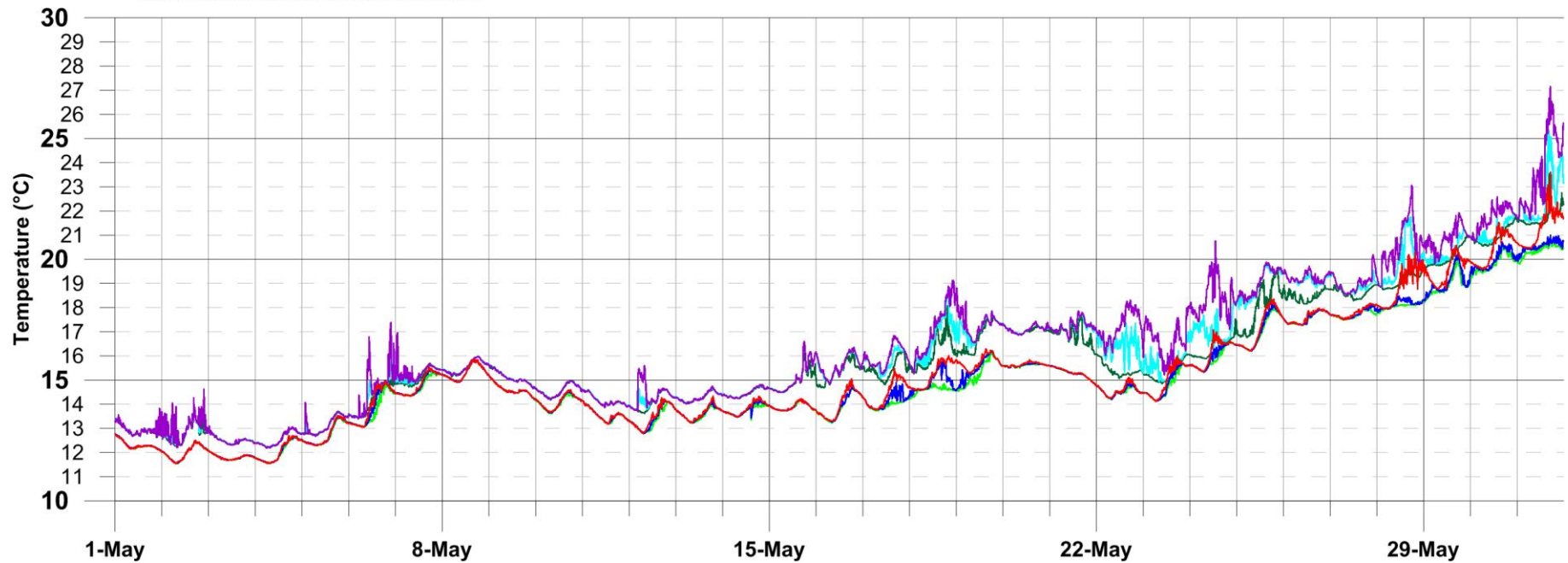


Figure 5.6



6 Water Levels

6.1 OPW water level data from gauge at Hodson’s Bay

Water level data was acquired from the OPW water level gauge at Hodson’s Bay in Lough Ree (Figure 6.1). Data for the month of May 2018 is plotted in Figure 6.2.



Figure 6.1 Hodson’s Bay, Lough Ree

**LOUGH REE POWER
LONGTERM CONTINUOUS TEMPERATURE MEASUREMENTS**

May 2018

Water Level at Hodson's Bay (OPW Station 26088)

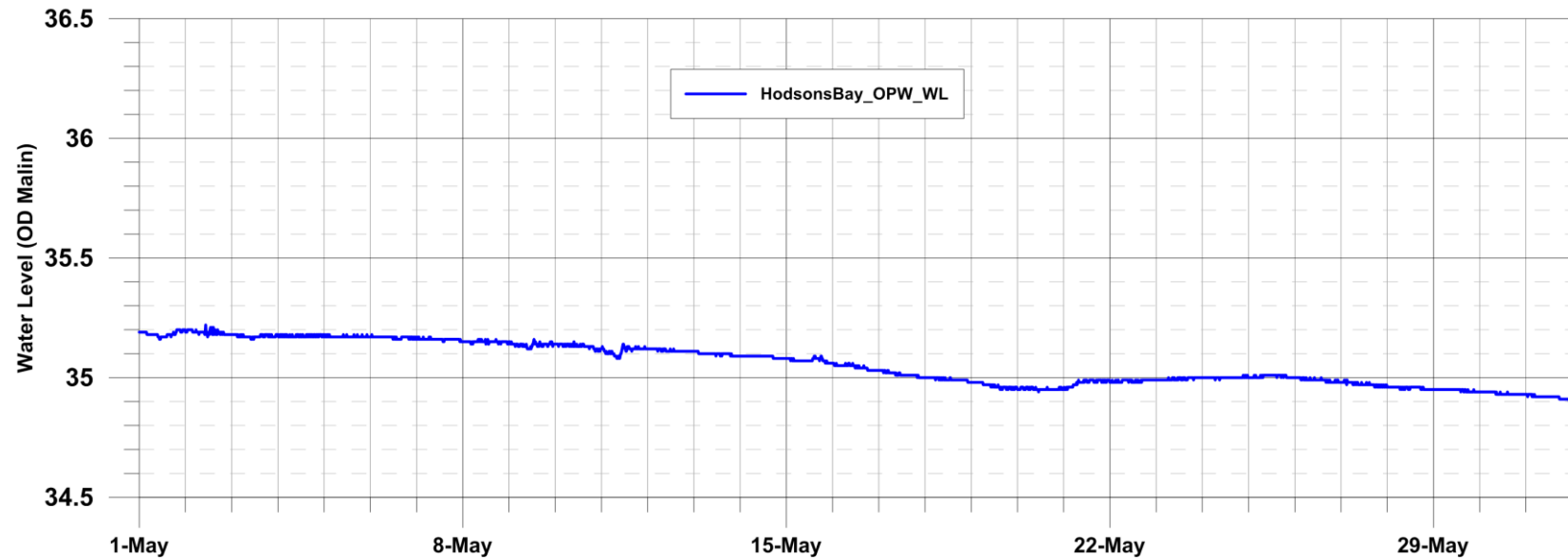


Figure 6.2 Water Level at Hodson's Bay