Curraghinalt Project
County Tyrone

Prepared for Dalradian Gold Limited

Environmental Statement - Volume 3

C2 Climate Baseline Report

November 2017

DALRADIAN
GOLD

CLIMATE BASELINE REPORT FOR THE CURRAGHINALT PROJECT, COUNTY TYRONE, NORTHERN IRELAND

Prepared For

Dalradian Gold Limited

Report Prepared by

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U6193

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CLIMATE BASELINE REPORT FOR THE CURRAGHINALT PROJECT, COUNTY TYRONE, NORTHERN IRELAND

1 INTRODUCTION

1.1 Purpose of Study

SRK Consulting UK (Ltd) has been commissioned by Dalradian Gold Limited (DGL) to undertake a climate baseline study for the Curraghinalt Project as part of the Environmental Impact Assessment (EIA) process for the project.

The purpose of the study is to determine site specific baseline information on meteorology and climate in the project area and collect sufficient information to inform baseline and impacts studies for the EIA. This report documents the baseline monitoring work undertaken at the proposed Curraghinalt Gold Project in Co. Tyrone, Northern Ireland. The report compares onsite data with other available data sets with the aim of establishing existing baseline climate conditions for the project site.

Onsite monitoring for the period January 2012 to August 2013 has been documented by SLR Consultants in a report entitled 'Environmental Baseline Study: Climate' prepared in September 2013 (SLR, 2013).

This report updates the analysis of the onsite field data to include data from 2014, 2015 and 2016. The report also compares the onsite data with information gathered from other sources, e.g. UK Meteorological Office ("Met Office") meteorological stations and standard methods of estimating key parameters of interest.

The meteorology of the site area is an important component of the environmental baseline study for the site and will feed into the environmental impact assessment process for the project.

Meteorological parameters will also be required by project engineers designing water management structures and other aspects of the mining operations.

Accordingly, initial assessments are made in this report to define key meteorological parameters that will be used in the environmental assessment and design processes.

1.2 General Description of Regional Climate

The Curraghinalt site is located in the Sperrin Mountains, an upland region in Northern Ireland with a maximum elevation of 678 m (Figure 1-1).

The study area for the climate baseline study focuses on the climatic conditions within the mine site area and the part of the Sperrin Mountains that sits between the Owenkillew River (to the north) and Owenreagh River (to the south). However, the assessment also considers data from locations distant from the mine site, but which can be extrapolated to provide information on climatic conditions at the mine. The locations of these more distant data sources are shown in Figure 1-2.

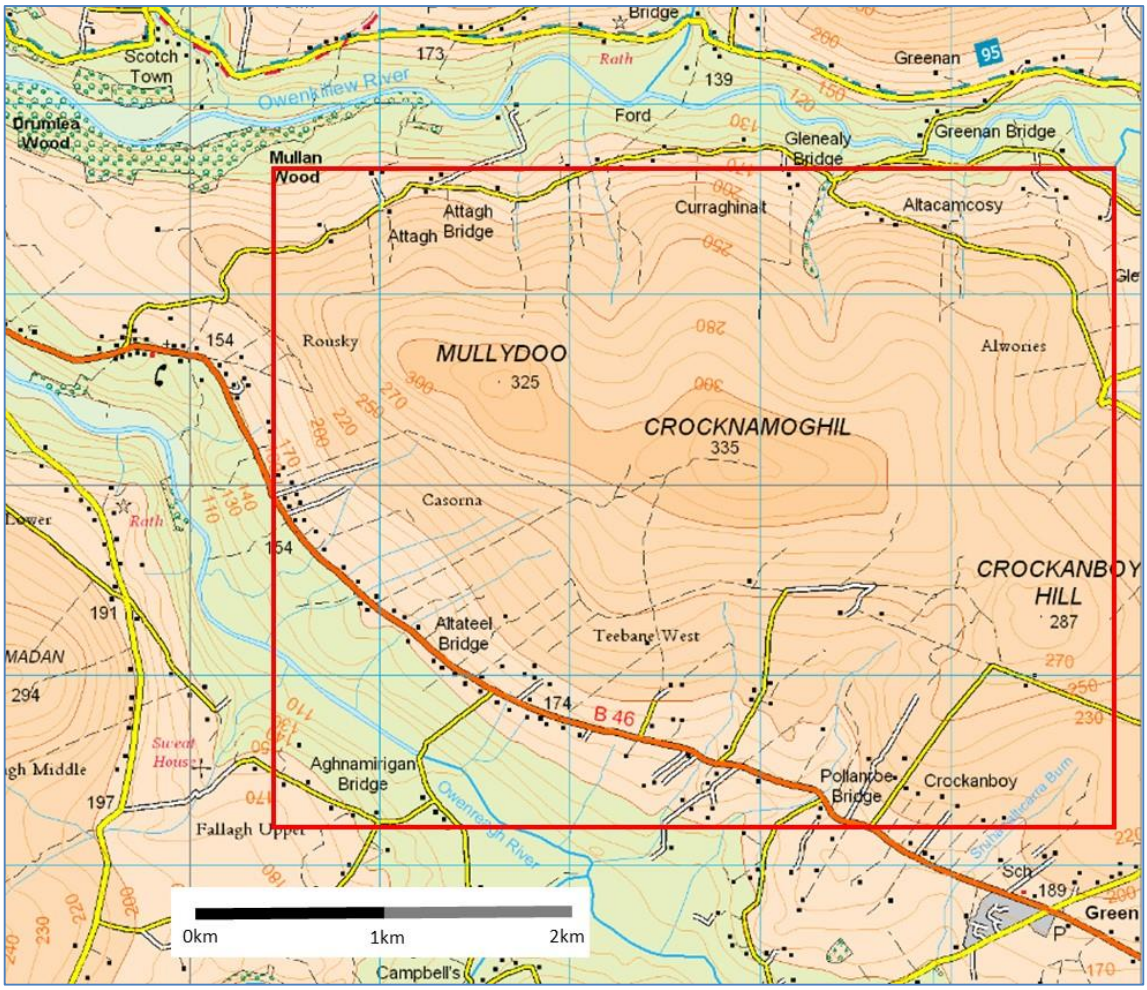


Figure 1-1: The main study area for the climate baseline report

(Note: The red box shows the study area)

The regional climate for Northern Ireland is summarised below in Table 1-1. The climate of Northern Ireland is moderated by its proximity to the Atlantic Ocean, being generally mild and wet. As a result, although there is seasonality in the climate (with winter months being colder, darker and wetter than summer months), the Atlantic tends to average out the seasonality, producing relatively cool summer temperatures and warm winters.

On average the region has a warm summer period (June to September) with an average maximum temperature of 18.5°C in July and a cooler winter period (December to January) with an average minimum temperature of 1.2°C in February (UK Meteorological Office data).

The average annual rainfall is 1,136 mm, with the wettest period between October and January and the driest period between April and July. On average October is the wettest month with 119.7 mm of rainfall (UK Meteorological Office data).

1.3 Climate Change

Information on climate change impacts on key meteorological variables is provided in Chapter 5.

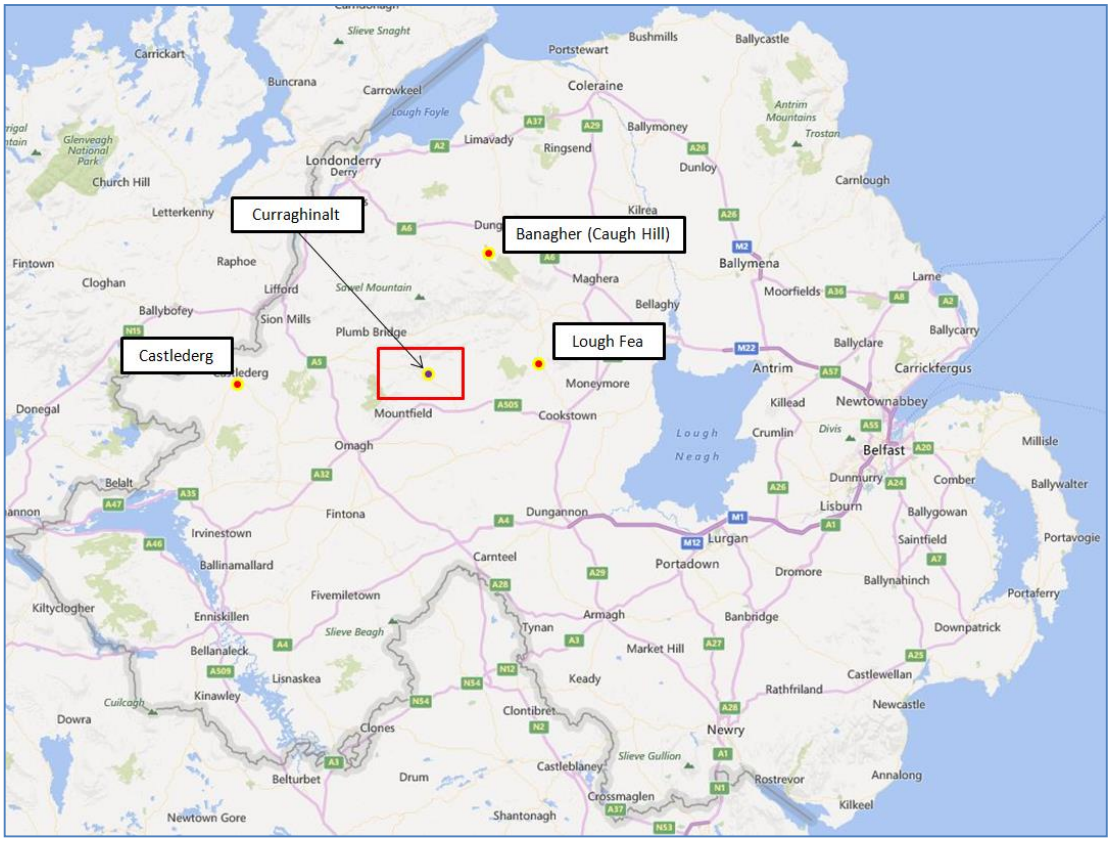


Figure 1-2: Locations of the site and the weather stations predominantly used in this report in relation to the whole Northern Ireland (Google Maps, 2015).

Note: The red box shows the study area

Table 1-1: Monthly climate summary for the Northern Ireland region for the period 1981 to 2010 (UK Meteorological Office data).

Month	Max. Temp (°C)	Min. Temp (°C)	Days of air frost (days)	Sunshine (hours)	Rainfall (mm)	Days of rainfall >= 1mm (days)
Jan	7	1.4	9.2	44.5	116.5	17.4
Feb	7.4	1.2	9.1	66.7	83.7	13.8
Mar	9.3	2.4	5.9	97.7	95.1	16.2
Apr	11.6	3.6	3.5	146.7	75	13
May	14.5	5.9	0.9	182.3	72.6	12.9
Jun	16.9	8.8	0.1	150.2	76.3	12.5
Jul	18.5	10.8	0	140.5	81.2	14
Aug	18.2	10.5	0	135.3	97.4	14.6
Sep	16.1	8.7	0.2	113.5	91.7	14.2
Oct	12.7	6.1	1.2	87.6	119.7	16.7
Nov	9.4	3.5	4.4	53.8	112.5	16.9
Dec	7.3	1.7	8.5	37.1	114.4	16.4
Annual	**12.4**	**5.4**	**42.8**	**1,255.8**	**1,136**	**178.6**

2 POLICY FRAMEWORK

2.1 European Union Policy: Climate Change

At the European Union level, the Directorate-General Climate Action (DG CLIMA) is responsible for developing and implements cost effective international and domestic climate change policies and strategies in order for the EU to meet its targets for 2020 and beyond, especially with regard to reducing its carbon emissions.

The DG CLIMA is responsible for:

- Developing and implementing international and domestic climate action policies and strategies;
- Leading international negotiations on climate;
- Implementation of the EU Emissions Trading System (EU ETS);
- Monitoring the implementation of Member States' emission reduction targets in the sectors outside the EU ETS; and
- Promoting low carbon and adaptation technologies.

2.2 UK and Northern Ireland Policy: Climate Change

UK legislation for climate change is covered by the UK Climate Change Act (2008) which identifies a target reduction of 80% of greenhouse gasses by 2015 based on 1990 levels. The Act is for the reduction in greenhouse gasses.

The Department for Agriculture, Environment and Rural Affairs (DAERA), through its climate Change Unit is the lead organisation responsible for Climate Change in Northern Ireland.

The Northern Ireland Executive's Programme for Government target is to work towards a reduction in greenhouse gas emissions by at least 35% on 1990, levels by 2025[1].

3 METHODS

There is data from an onsite project meteorological station at Curraghinalt for the time period 10 January 2012 until present. The onsite meteorological station monitors wind speed and direction, atmospheric pressure, humidity, temperature, dew point, rainfall, solar radiation, ground temperature and evaporation rates. The station is located in an elevated, relatively exposed position without any sheltering vegetation above the steep valley sides of the Owenkillew River valley.

In addition to the site meteorological data, climatic data was acquired from other sources including weather stations in relatively close proximity to the site from the UK Meteorological Office and catchment rainfall data from the National Rivers Flow Archive.

3.1 Project Site Data Collection

Meteorological parameters have been measured and recorded at the project meteorological station, the Curraghinalt Meteorological Station (CMS), which was set up in October 2011 and

[1] Programme for Government 2011-2015 http://www.northernireland.gov.uk/pfg (p.9) in "Climate Change Legislation and Targets" (Northern Ireland Assembly Research and Information Service Research Pater 135/13; 19 June 2013).

operational since January 2012 (Photo 1).

The meteorological equipment was supplied by Omni Instruments UK and established at the site by DGL. The details of the instrumentation are shown in Table 3-1 with the recorded data parameters in Table 3-2.

Table 3-3 and Table 3-4 show the data the meteorological station collects and the period it is recorded for.

Photo 1: Curraghinalt Meteorological Station (SLR, 2013)

In October 2012 additional instrumentation was added to the station by Omni Instruments UK to measure evaporation rates at the site. The instrumentation included a pyranometer, soil temperature probe and a Class A evaporation pan.

Photo 2: Curraghinalt Meteorological Station with evaporation pan, pyranometer and wind vane (SLR, 2013)

Table 3-1: Curraghinalt Meteorological Station (CMS) Details

Station ID	WS01	Additional instrumentation added to WS01
Commissioned Date	10/01/2012	24/10/2012
Make/Model	**Station:** MetPak ii **Rain Gauge:** Tipping Bucket TR-525i Rainfall Sensor **Logger:** dataTaker DT80	**Pyranometer:** KIPP Model CMP3 **Temperature:** Sensor **Evaporation Pan:** Class A
Meteorological station location	Curraghinalt, Co. Tyrone. **NGR:** E257413 N386222	
Altitude	239 mAOD	
Recording Interval	Hourly	Hourly
Parameters	Wind Direction (deg.) Wind Speed (m/s) Atmospheric pressure (Bar) Humidity (%RH) Temperature (Deg. C) Dew point (Deg. C) Rainfall (mm)	Solar Radiation (Wm2) Ground Temperature (Deg. C) Evaporation Pan surface water level (mm)

Table 3-2: Curraghinalt Meteorological Station Data

Data	Data Type
Rainfall (mm)	Hourly rainfall
Wind Speed (m/s)	Hourly wind speed
Wind Direction (%)	Hourly wind direction
Air Temperature (°C)	Hourly air temperature
Solar Radiation (Wm^2)	Hourly solar radiation
Evaporation Pan (mm)	Hourly evaporation pan surface water level
Ground Temperature (°C)	Hourly ground temperature
Humidity (%relative Humidity)	Hourly humidity
Dew Point (ºC)	Hourly dew point
Atmospheric Pressure (Bar)	Hourly atmospheric pressure

Table 3-3: Period of recorded data; Curraghinalt Meteorological Station

Data	Period of recorded data
Rainfall (mm)	10/1/2012 to 13/09/2016[1&2]
Wind Speed (m/s)	10/1/2012 to 13/10/2016[1&2]
Wind Direction (%)	10/1/2012 to 13/09/2016[1&2]
Air Temperature (°C)	10/1/2012 to 13/09/2016[1&2]
Solar Radiation (Wm^2)	24/10/2012 to 13/09/2016[2]
Evaporation Pan (mm)	24/10/2012 to 13/09/2016[2]
Ground Temperature (°C)	24/10/2012 to 13/09/2016[2]
Humidity (%relative Humidity)	10/1/2012 to 13/09/2016[1&2&3]
Dew Point (ºC)	10/1/2012 to 13/09/2016[1&2&3]
Atmospheric Pressure (Bar)	10/1/2012 to 13/09/2016[1&2]

[1]Data incomplete on 23/10/12 and 24/10/12 when extra recording equipment was added to the meteorological station.
[2]Data incomplete between 17/12/12 and 22/12/12. [3] Issues with data from February 2013 to present

3.2 Other Data Sources

3.2.1 UK Meteorological Office Data

The Met Office operates meteorological recording stations and synoptic meteorological stations in Northern Ireland. There are a number of meteorological stations in the area around the Curraghinalt site. The details of the recording stations in close proximity to the site are included in Table 3-4, with the station locations shown in Figure 1-2.

Table 3-4: Summary of Met Office monitoring stations used in the baseline study

Station Name	Date Opened	Station Altitude (mAOD)	Distance from site (km)	Station Type	Parameters Measured
Lough Fea	1965	225	20	Automatic	Rainfall (hourly) Wind Direction
Banagher (Caugh Hill)	na	214	28	Automatic	Rainfall (hourly) Wind Direction
Castlederg	na	49	22	Automatic	Rainfall (hourly) Wind Direction

The most comparable Met Office station to the onsite CMS is considered to be Lough Fea (54.721, -6.814), which is located approximately 20km west of the centre of the site, is positioned at a similar elevation to the site (225m above mean sea level) and is located in the Sperrin Mountains.

The Met Office station at Banagher (54.885, -6.966) is also within 30 km of the site at a similar elevation. However, it is located to the edge of the main body of the Sperrin upland area. The station at Castlederg (54.707, -7.577) is only 22 km from the site but is located at a significantly lower elevation.

There are two manually operated weather stations located at Strabane (Carricklee) and Edenfel (Omagh) located within a similar proximity to the site, however these were not considered for further analysis with the automatic meteorological stations preferred.

Data for all Met Office stations can be purchased from the Met Office. Daily rainfall data for the Lough Fea station was purchased for the period 1966 – 2016 and, in combination with freely available data, was used in the assessment; the Met Office data is outlined in Table 3-5. This data was then compared to information from the onsite station.

Table 3-5: Data available for Met Office monitoring stations used in the baseline study

Station Name	Data Availability	Data
Lough Fea	1966 - 2016	Daily rainfall totals (mm)
Lough Fea	1981 - 2010	Monthly average maximum temperature (°C) Monthly average minimum temperature (°C) Monthly average days of air frost (days) Monthly average rainfall (mm) Monthly average days of rainfall >= 1mm (days) Monthly mean wind speed at 10m (knots)
Banagher (Caugh Hill)	1981 - 2010	Monthly average maximum temperature (°C) Monthly average minimum temperature (°C) Monthly average days of air frost (days) Monthly average sunshine (hours) Monthly average rainfall (mm) Monthly average days of rainfall >= 1mm (days)

Station Name	Data Availability	Data
Castlederg	1981 - 2010	Monthly average maximum temperature (°C) Monthly average minimum temperature (°C) Monthly average days of air frost (days) Monthly average rainfall (mm) Monthly average days of rainfall >= 1mm (days) Monthly mean wind speed at 10m (knots)

3.2.2 National Rivers Flow Archive Data

The National Rivers Flow Archive (NRFA) has data from 1980 - 2014 that describes catchment monthly rainfall across the United Kingdom. It provides a free source of monthly precipitation data.

The NRFA has calculated monthly rainfall totals since January 1986, derived from a one kilometre square grid of rainfall values generated from all daily and monthly rainfall data available from the Met Office. The method employed conforms to that recommended in the British Standard Institution's Guide to the Acquisition and Management of Meteorological Precipitation Data, BS 7843-4:2012 (BSI, 2012).

Up to and including 1985, monthly catchment area rainfall totals were normally computed by first obtaining the long period (1941 - 1970) average annual rainfall for each catchment derived by the Met Office based on 1:250,000 isohyets; then, for a selected number of rain gauges chosen to represent the catchment, the monthly rainfall was expressed as a percentage of its annual average rainfall. The percentage values of rainfall for each rain gauge were calculated and their mean obtained to give a catchment percentage value for the month, which was then converted to monthly mean rainfall.

Accuracy depends largely on the reliability of the assessment of the areal annual average. However, the NRFA product is useful for catchment wide assessments as they take into account the impacts of elevation differences across the catchment.

The site is located within the Owenkillew River catchment (Figure 3-1). The NRFA produces composite monthly rainfall data for a given catchment from surrounding Met Office stations and, for this study, a dataset for the Owenkillew catchment is presented. The Owenkillew has a catchment area of 440.1 km^2, a minimum altitude of 40 m AOD and a maximum altitude of 677 m AOD. The 50^{th} percentile altitude of the catchment is 215.4 m AOD, which is similar to the elevation of the onsite meteorological station.

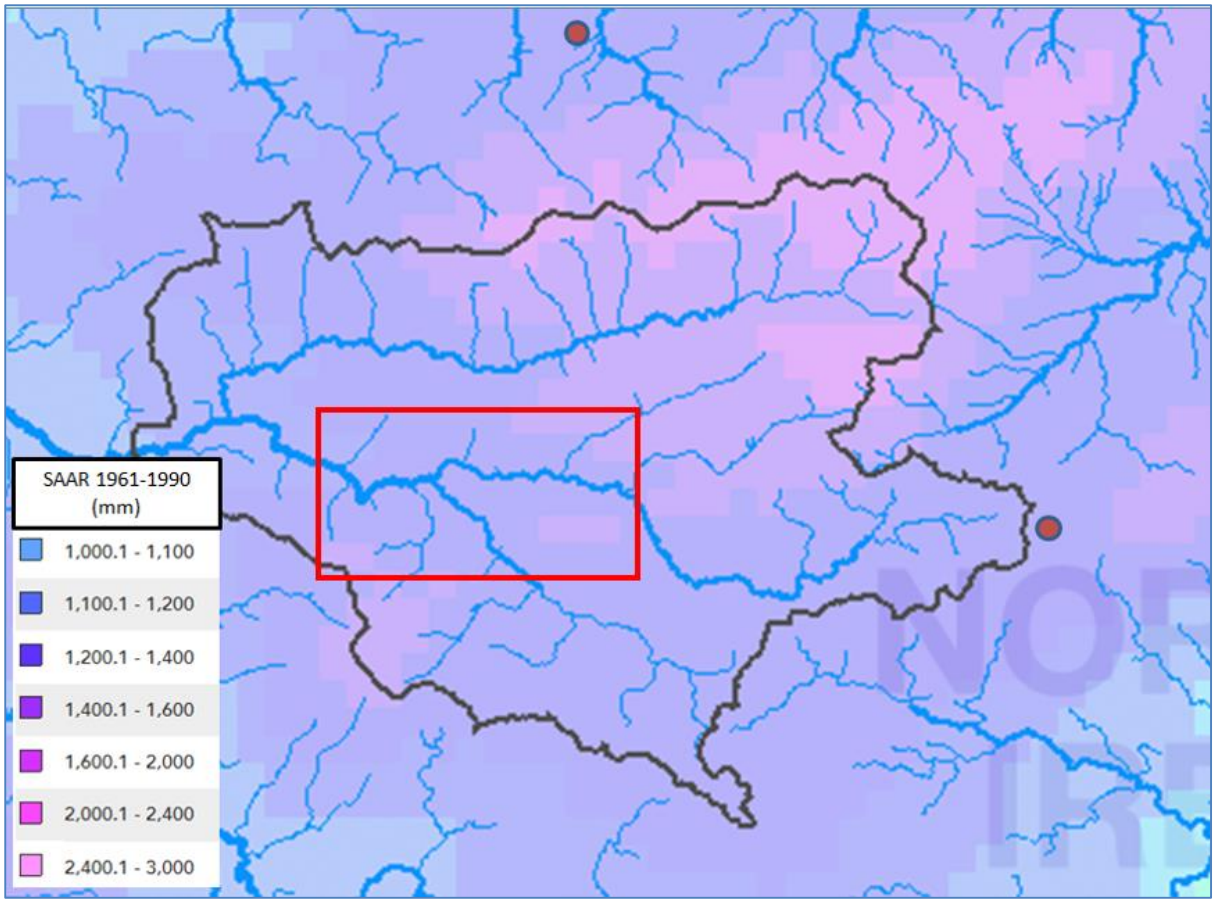


Figure 3-1: NRFA River Owenkillew catchment outline showing Met Office Standard Average Annual Rainfall (SAAR) for 1961-1990.

Note: The red box shows the study area and the red dots are the Lough Fea (east) and Banagher (north) Met Office station locations

3.2.3 Flood Estimation Handbook Data

The Flood Estimation Handbook (FEH) is the national standard method for calculation of flood flows in the United Kingdom. The methods include a tool for the extraction of rainfall Depth-Duration-Frequency (DDF) data for all locations in the United Kingdom, at a point, on a 1 km^2 square grid and averaged across catchments.

The method provides estimates of rainfall depth (mm) associated with a wide range of return period (e.g. 1 in 100 year) rainstorm events of different durations (e.g. 15 minute, 1 hour). The data is based on analysis and extrapolation of Met Office rainfall data with the process detailed in 'Volume 2: Rainfall frequency estimation' in the 'Flood Estimation Handbook' by the Institute of Hydrology (1999). The design rainfalls are a product of growth rates from Focused Rainfall Growth Curve Extension (FORGEX) and the median annual maximum rainfall (RMED).

The FEH provides DDF data for a range of durations and return periods. The design rainfall is available on a sliding scale for durations of 15 minutes to 192 hours for return periods of 0.5 years up to 10,000 years. Additionally, the design rainfall is available on a fixed scale for durations of 1 hour to 8 days for return periods of 0.5 years up to 10,000 years. For the purpose of this assessment data is extracted at the location (at-a-point data) of the infrastructure site.

DDF data can also be calculated directly from gauged rainfall data, typically based on 30 years of 15-minute rainfall data. However, as the FEH is the standard data source for estimating flood flows from rainfall events, use of the DDF data from the FEH would appear to be the most suitable source of data for baseline and engineering studies at the mine site.

4 RESULTS

Results for key meteorological parameters are presented and discussed in this chapter. Data collected from the onsite CMS is presented for each parameter and then compared to available regional data.

4.1 Air Temperature

The average hourly temperature recorded from the CMS between February 2012 and September 2016 was 8.6°C, with a high of 26.6°C (18/07/2013) and a low of -5.5°C (12/03/2013).

Average daily temperatures for February 2012 to September 2016 are presented in Annexes A to D with a monthly average minimum and maximum presented in Table 4-1 below.

There were 119 days with an hourly temperature below 0°C recorded between February 2012 and September 2016 (excluding December 2012). Of these days 13 had a daily average temperature of below 0°C and these are presented in Table 4-2. The coldest daily average temperature of -2.1°C was recorded on 11/03/2013.

Table 4-1: Monthly average daily minimum, mean and maximum temperatures recorded at the CMS for the period February 2012 to August 2016

		2012			2013			2014			2015			2016	
	Min	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.
Jan				2.0	4.2	7.2	1.9	3.9	6.5	0.9	3.8	9.1	2.2	4.6	7.4
Feb	4.2	5.9	8.0	1.1	3.2	5.8	1.9	4.3	8.6	1.2	3.8	7.2	0.8	3.2	6.1
Mar	4.7	7.5	10.7	0.0	2.0	4.4	3.0	5.6	9.2	1.8	4.7	8.5	2.4	5.2	8.4
Apr	2.5	5.4	8.7	2.4	5.3	8.6	5.4	8.7	12.5	3.6	7.3	12.1	2.3	5.3	8.5
May	6.3	9.8	13.5	5.4	8.4	11.7	7.7	10.2	13.3	5.0	7.9	11.1	6.7	10.5	14.7
Jun	8.6	11.1	13.9	9.0	12.3	15.8	9.7	12.9	16.4	7.8	11.3	14.9	10.4	13.2	16.7
Jul	9.8	12.5	15.5	12.7	16.3	20.6	11.5	14.7	18.0	9.3	12.2	15.2	10.6	13.1	16.3
Aug	11.3	14.0	17.4	10.9	13.6	16.6	9.5	12.0	15.3	9.7	12.5	15.6	10.7	13.8	16.8
Sep	7.9	10.8	13.7	9.0	11.6	14.5	9.8	12.9	16.2	8.1	10.8	14.0			
Oct	4.1	6.8	9.8	8.0	10.1	12.4	7.0	9.7	12.4	6.8	9.5	12.3			
Nov	3.1	5.1	7.0	3.4	5.3	7.7	4.7	6.9	8.9	4.4	6.9	9.6			
Dec				2.9	5.4	8.7	2.3	4.4	7.0	3.5	6.4	9.6			

Note: Blank spaces indicate missing or incomplete data.

Table 4-2: Days with an average temperature below 0°C recorded throughout the period February 2012 to September 2016.

Date	Average Daily Temperature (°C)		Date	Average Daily Temperature (°C)
02/02/2012	-1.32		25/03/2013	-0.03
03/02/2012	-0.55		26/03/2013	-0.40
20/01/2013	-0.26		27/03/2013	-0.60
22/01/2013	-0.07		28/03/2013	-0.55
23/02/2013	-0.14		19/01/2015	-1.30
11/03/2013	-2.12		02/02/2015	-0.39
12/03/2013	-0.61			

Note: December 2012 is excluded due to incomplete data.

Maximum and minimum hourly temperatures for the period of record are shown in Figure 4-1, with monthly average temperatures presented in Figure 4-2.

The seasonal pattern of temperature variations shown in Figure 4-2 is as would be expected, with the highest average temperatures in June and July, with the lowest average temperatures in January and February, although the coldest monthly average temperature at the site was recorded in March 2013 (1.9°C). The warmest month was July 2014 (16.3°C).

The average, maximum and minimum monthly temperatures for the period 1981 to 2010 for the Lough Fea, Banagher and Castlederg Met Office meteorological stations are presented in Figure 4-3. June to August is the warmest period and December to February is the coldest period on average. The lowest average minimum temperature is 0.7°C at Lough Fea in January and the highest average maximum temperature is 18.9°C at Castlederg in July.

The data for all three Met Office stations is reasonably consistent, with the Castlederg site recording slightly higher average temperatures throughout the year, as would be expected as this station is located at a lower elevation than the other two sites.

Figure 4-4 directly compares the monthly temperature data at Lough Fea with data from the CMS. There is a close match between data from the two sites, suggesting similar temperatures at the site and Lough Fea.

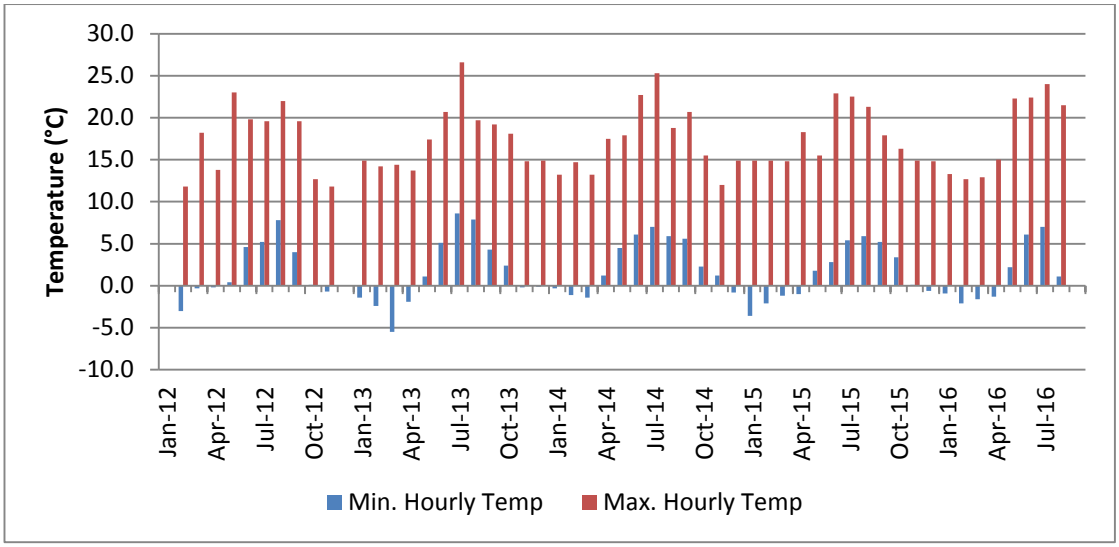
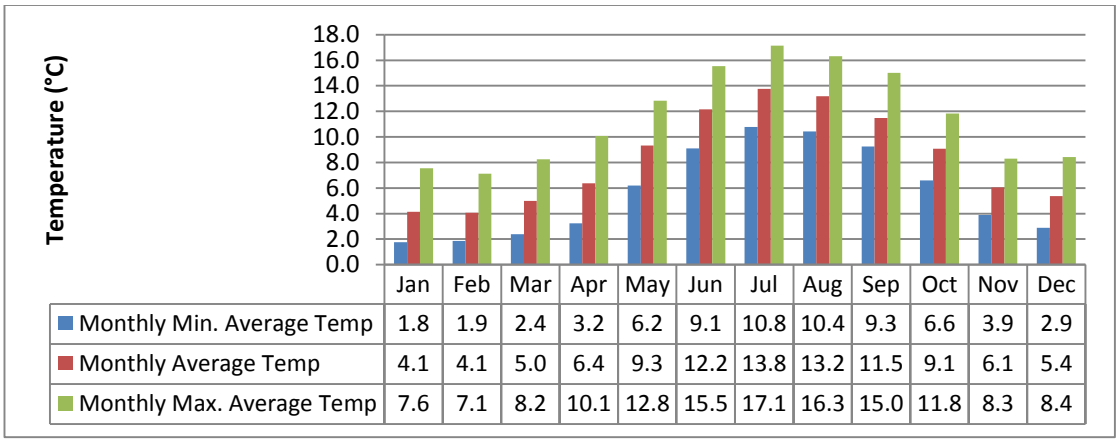


Figure 4-1: Maximum and minimum hourly temperature recorded at the project site (CMS) in each month between February 2012 and September 2016.

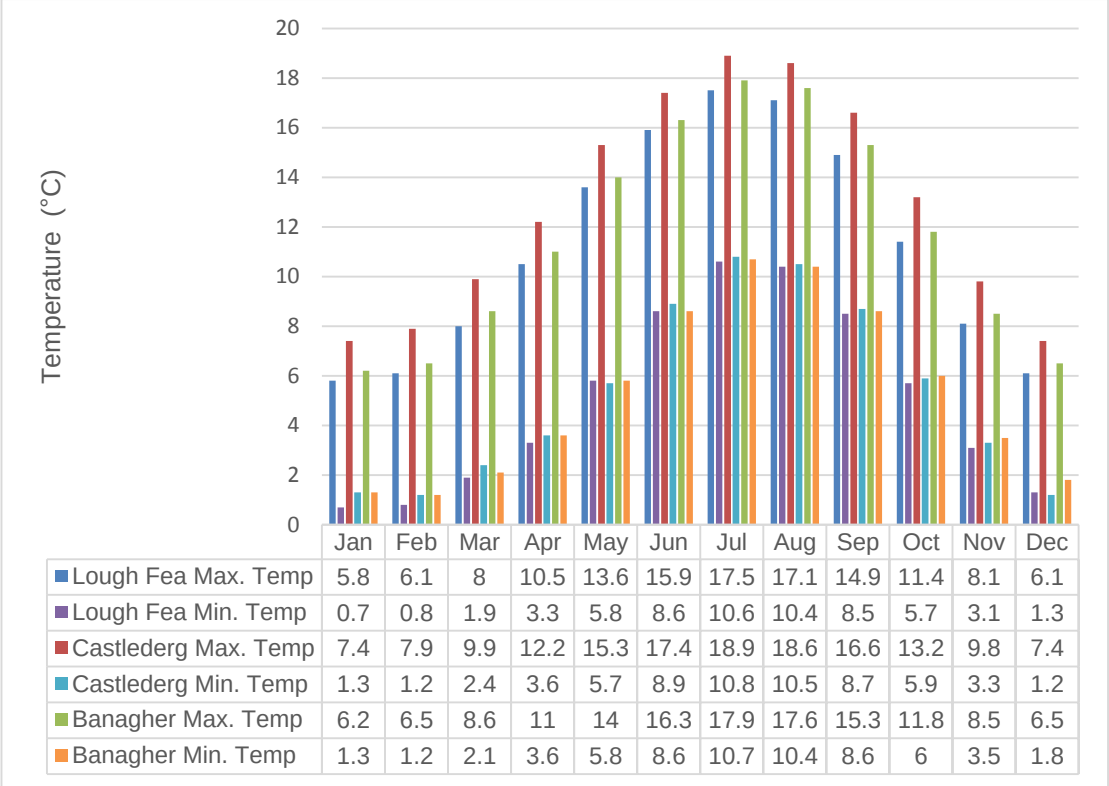
Note: December 2012 and September 2016 excluded due to incomplete data.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly Min. Average Temp	1.8	1.9	2.4	3.2	6.2	9.1	10.8	10.4	9.3	6.6	3.9	2.9
Monthly Average Temp	4.1	4.1	5.0	6.4	9.3	12.2	13.8	13.2	11.5	9.1	6.1	5.4
Monthly Max. Average Temp	7.6	7.1	8.2	10.1	12.8	15.5	17.1	16.3	15.0	11.8	8.3	8.4

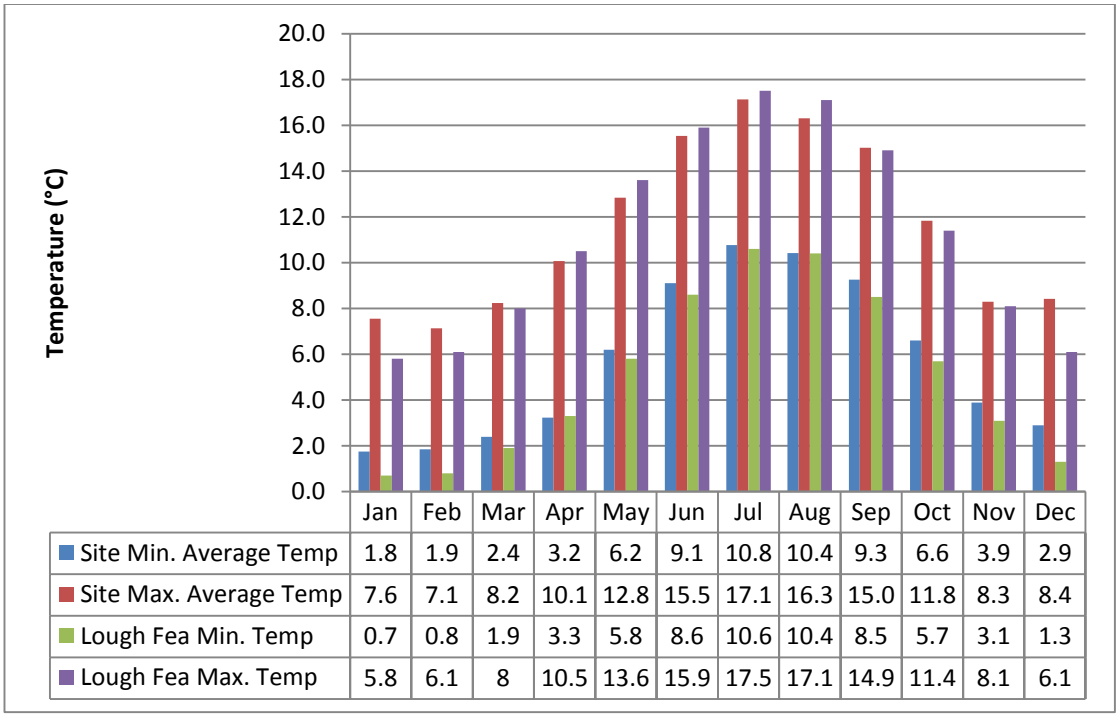
Figure 4-2: Monthly average temperature at the project site (CMS) for the period February 2012 to September 2016.

Note: December 2012 and September 2016are excluded due to incomplete data.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Lough Fea Max. Temp	5.8	6.1	8	10.5	13.6	15.9	17.5	17.1	14.9	11.4	8.1	6.1
Lough Fea Min. Temp	0.7	0.8	1.9	3.3	5.8	8.6	10.6	10.4	8.5	5.7	3.1	1.3
Castlederg Max. Temp	7.4	7.9	9.9	12.2	15.3	17.4	18.9	18.6	16.6	13.2	9.8	7.4
Castlederg Min. Temp	1.3	1.2	2.4	3.6	5.7	8.9	10.8	10.5	8.7	5.9	3.3	1.2
Banagher Max. Temp	6.2	6.5	8.6	11	14	16.3	17.9	17.6	15.3	11.8	8.5	6.5
Banagher Min. Temp	1.3	1.2	2.1	3.6	5.8	8.6	10.7	10.4	8.6	6	3.5	1.8

Figure 4-3: Average monthly maximum and minimum temperature throughout the period 1981 to 2010 at Lough Fea, Castlederg and Banagher.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Site Min. Average Temp	1.8	1.9	2.4	3.2	6.2	9.1	10.8	10.4	9.3	6.6	3.9	2.9
Site Max. Average Temp	7.6	7.1	8.2	10.1	12.8	15.5	17.1	16.3	15.0	11.8	8.3	8.4
Lough Fea Min. Temp	0.7	0.8	1.9	3.3	5.8	8.6	10.6	10.4	8.5	5.7	3.1	1.3
Lough Fea Max. Temp	5.8	6.1	8	10.5	13.6	15.9	17.5	17.1	14.9	11.4	8.1	6.1

Figure 4-4: A comparison of the average monthly maximum and minimum temperature at the CMS ("site") for February 2012 to September 2016 and Lough Fea (1981 to 2010).

Note: December 2012 and September 2016 are excluded due to incomplete data.

4.2 Rainfall

To inform engineering design and on-site water balance calculations, three key precipitation data sets are considered;

- Annual precipitation totals;
- Monthly precipitation totals; and
- Extreme (daily or hourly) precipitation totals.

Regarding rainfall and snowfall totals, it is noted that the CMS contains a tipping bucket rain gauge which is not heated. As a result, there is a risk of undercounting of snow melt and sleet compared to Met Office stations.

4.2.1 Annual Rainfall Totals

The annual rainfall recorded from the CMS for 2012 was 845 mm (excluding January and December, due to data gaps for a significant period in each month), for 2013 it was 920 mm, for 2014 it was 1,202 mm and for 2015 it was 1,326 mm.

If the long-term average January and December rainfall totals (147 mm and 141 mm respectively from the Met Office Lough Fea data) are added to the 2012 February to November total this would give an approximate total annual rainfall of 1,131 mm for 2012 for the project site. If the long term average September, October, November and December rainfall totals (111 mm, 132 mm, 135 mm and 141 mm respectively) were added to the 2016 total this would give an approximate annual rainfall of 1,271 mm for 2016 at the project site.

The three nearby Met Office stations have an average annual rainfall for the period 1981 – 2010 calculated as 1,349 mm at Lough Fea, 1,144 mm at Castlederg and 1,350 mm at Banagher.

Met Office data for the period 1966 – 2015 for the Lough Fea station produced an average annual rainfall of 1,333 mm.

It is noted that all records at the CMS were lower than the long-term average at Lough Fea and also the annual rainfall totals for the period 2012 to 2015 measured at the Lough Fea station; 1,402 mm (2012), 1,275 mm (2013), 1,455 mm (2014), 1,509 mm (2015) and 1,482 mm (2016).

The NRFA Owenkillew catchment rainfall data had an annual average rainfall of 1,399 mm for the period 1980 to 2014.

Totals for 2012 to 2014 from the NRFA data were 1,408 mm for 2012; 1,351 mm for 2013 and 1,522 mm for 2014, i.e. higher than the project data set annual totals. The maximum annual rainfall for the Owenkillew catchment based on the NFRA dataset was 1,657 mm in 1990 and the minimum was 1,106 mm in 2001.

The Met Office Lough Fea station and NRFA Owenkillew catchment annual rainfall totals for the period 1980 to 2014 are shown in Figure 4-5. The annual totals for the CMS are included for comparison.

It is clear that the annual rainfall totals for the CMS are lower than the other datasets by around 20 to 30%.

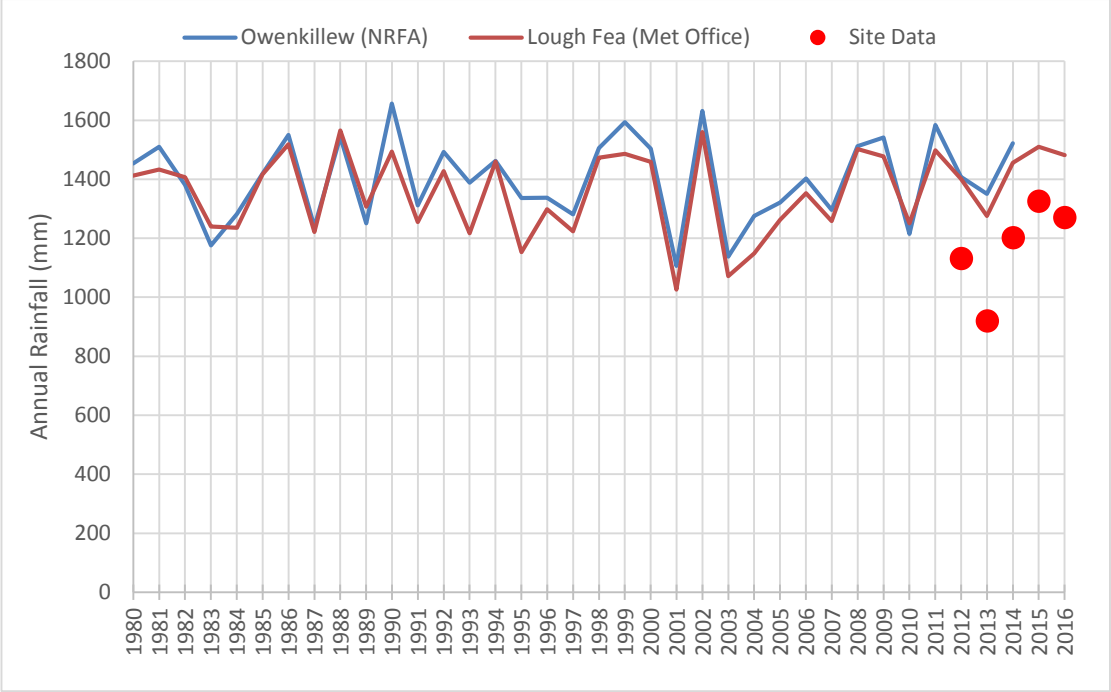


Figure 4-5: Annual rainfall (mm) for the period 1980 to 2016 for the Met Office Lough Fea meteorological data and Owenkillew catchment from NRFA data (up to 2014), compared to project site data from the CMS.

The reason for this apparent discrepancy in rainfall may be a result of the CMS rain gauge under-catching snow and sleet. However, this is not expected to cause a 20 to 30 % difference in annual precipitation totals.

In addition, given that the site is located at a similar elevation to two of the Met Office sites, and is consistent with the elevation of the NRFA data, elevation differences are also not expected to cause such a large discrepancy in precipitation totals.

Reasons for the differences between the project and other data sources are discussed in more detail in Section 4.2.2 below. In summary, the differences are considered to be caused by high winds at the CMS site.

Figure 4-5 illustrates that annual rainfall totals for Lough Fea and the NRFA Owenkillew catchment data are very similar. This is expected as the Lough Fea data will be a key input in the derivation of the NRFA values.

The Met Office Lough Fea data and NRFA data annual totals for the period 1966 – 2016 and 1980 – 2014 respectively have been fitted with a normal distribution (suitable for analysis of annual rainfall totals) and the distribution was used to calculate return period annual rainfall totals for the study area as summarised in Table 4-3.

The results for the data sets are very similar. Based on this analysis it is recommended that the Lough Fea data set, as it is observed data from a Met Office station, is used as the basis of water balance calculations at the site.

Table 4-3: Return period for annual rainfall totals for the Met Office Lough Fea meteorological station and the NRFA Owenkillew catchment data.

Return Period	Lough Fea Annual Rainfall (mm)	Owenkillew Annual Rainfall (mm)
1 in 100 wet year	1,693	1,733
1 in 50 wet year	1,651	1,694
1 in 25 wet year	1,605	1,650
1 in 10 wet year	1,533	1,583
1 in 5 wet year	1,465	1,520
1 in 2 wet year	**1,336**	**1,399**
1 in 5 dry year	1,207	1,279
1 in 10 dry year	1,139	1,216
1 in 25 dry year	1,067	1,148
1 in 50 dry year	1,021	1,105
1 in 100 dry year	979	1,066

4.2.2 Average Monthly Rainfall

The average monthly rainfall recorded from the CMS for the period February 2012 to August 2016 (excluding December 2012) was 95.0 mm with a maximum monthly rainfall of 232.7 mm (December 2015) and a minimum of 7.1 mm (December 2013).

The December 2013 rainfall total was considered too small by comparison with Met Office and NRFA data. If the observed December 2013 rainfall was accurately measured on site (7.1 mm) then this would have been the driest December on record, which is not borne out by weather summaries. December 2013 was also not a particularly cold, so the low rainfall total could not be explained by under-catching due to frost or snow.

Table 4-4 shows the total monthly rainfall for each month in the period February 2012 to September 2015; with the data graphically presented in Figure 4-6.

Table 4-4: Monthly rainfall totals for the CMS; February 2012 to September 2015

	2012	2013	2014	2015	2016
Jan		150.9	112.3	126.5	173.2
Feb	59.4	82.3	190.8	96.0	95.0
Mar	22.4	54.1	59.9	106.9	70.1
Apr	59.2	125.2	53.6	34.8	62.0
May	55.9	96.3	70.1	136.9	56.4
Jun	160.3	93.7	68.6	44.5	125.2
Jul	91.2	49.0	67.8	128.5	93.2
Aug	104.9	47.5	149.6	129.0	77.7
Sep	92.5	48.0	12.4	48.8	
Oct	124.0	109.7	121.9	57.7	
Nov	74.9	55.9	182.9	184.1	
Dec			112.5	232.7	

Note: January and December 2012 is excluded due to incomplete data. December 2013 is excluded due to erroneously low total.

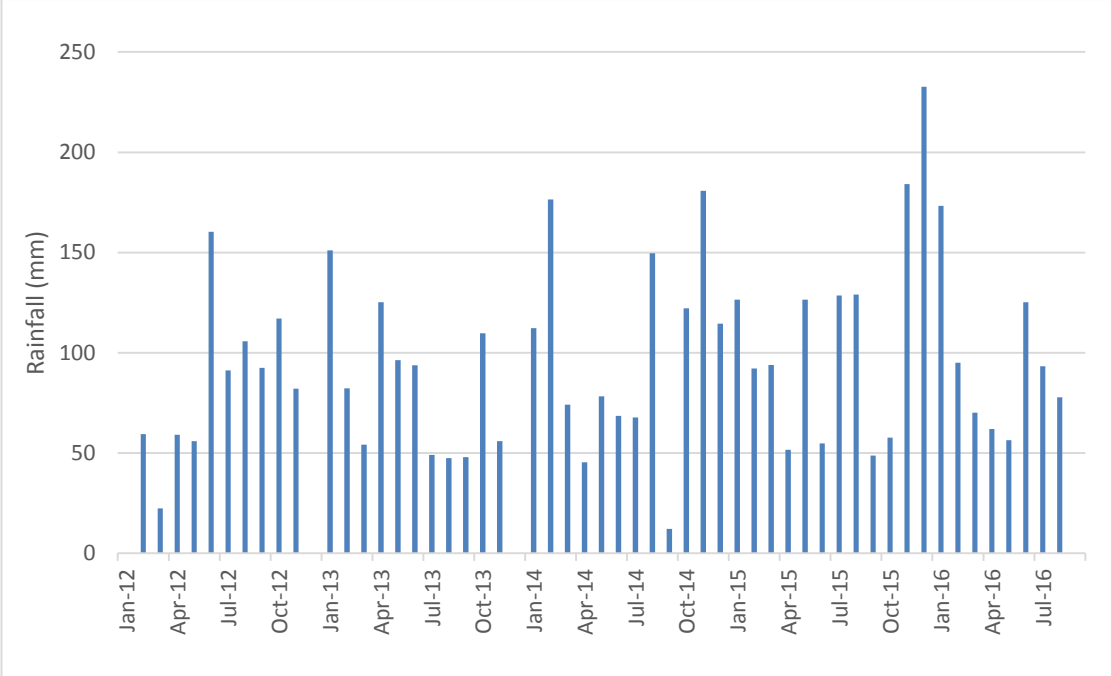


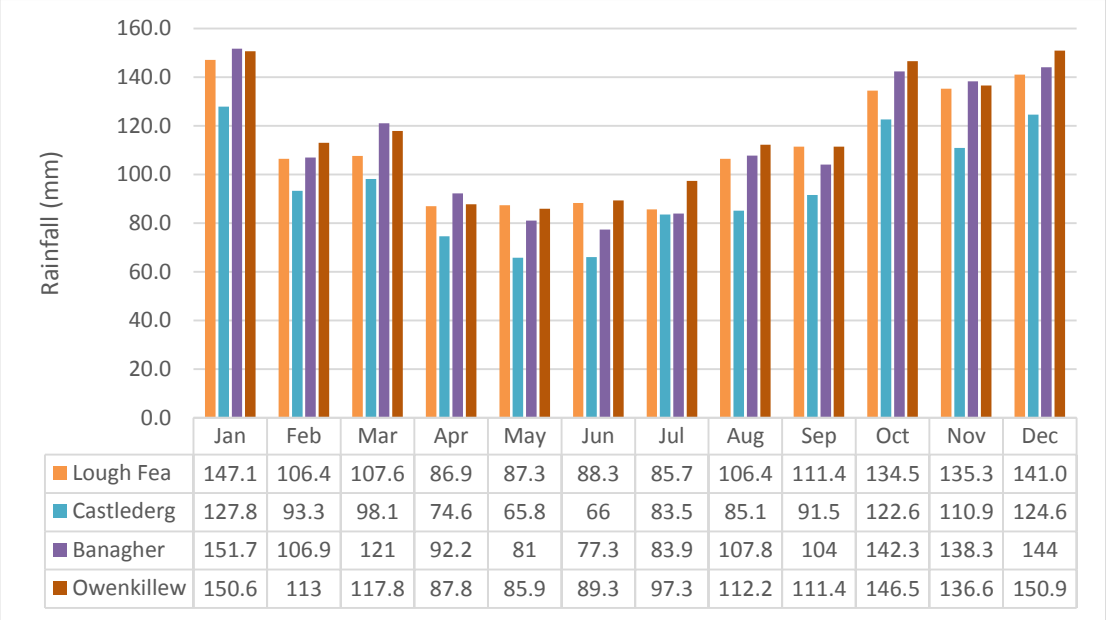
Figure 4-6: Monthly rainfall totals at the project site for the period February 2012 to September 2015.

Note: January and December 2012 is excluded due to incomplete data. December 2013 is excluded due to erroneously low total.

The average monthly rainfall data for the local Met Office stations are given in Figure 4-7 together with the NRFA Owenkillew catchment data. The latter appears to match well with the Met Office data for Lough Fea and Banagher. The average monthly rainfall totals for the Castlederg station are consistently lower than for the other data sets; this is consistent with the lower annual rainfall totals at this gauge.

For all four datasets the months with the most rainfall were January, October, November and December with May and June being the driest months:

- Lough Fea:
- highest average monthly rainfall; 145.3 mm (January)
- lowest average monthly rainfall; 85.4 mm (July)
- Castlederg:
- highest average monthly rainfall; 127.8 mm (January)
- lowest average monthly rainfall; 65.8 mm (May)
- Banagher:
- highest average monthly rainfall; 151.7 mm (January)
- lowest average monthly rainfall; 77.3 mm (June)
- Owenkillew (NRFA dataset):
- highest average monthly rainfall; 150.9 mm (December)
- lowest average monthly rainfall; 85.9 mm (May)



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Lough Fea	147.1	106.4	107.6	86.9	87.3	88.3	85.7	106.4	111.4	134.5	135.3	141.0
Castlederg	127.8	93.3	98.1	74.6	65.8	66	83.5	85.1	91.5	122.6	110.9	124.6
Banagher	151.7	106.9	121	92.2	81	77.3	83.9	107.8	104	142.3	138.3	144
Owenkillew	150.6	113	117.8	87.8	85.9	89.3	97.3	112.2	111.4	146.5	136.6	150.9

Figure 4-7: Monthly rainfall data for Lough Fea, Castlederg, Banagher Met Office stations and NRFA Owenkillew catchment

Average monthly rainfall for the project station, Met Office Lough Fea meteorological station and the NRFA Owenkillew catchment data for the period February 2012 to August 2016 (no 2015 data for the NFRA station was available at the time of writing) is presented in Figure 4-8.

It is clear from the figure that the project site data appears consistently lower than the Met Office and NFRA data.

The graph below (Figure 4-9) shows the percentage difference between the Met Office Lough Fea and NFRA Owenkillew catchment data, with the project data on average around 15% lower than the Met Office data and 20% lower than the NRFA catchment data.

There are two notable disparities in Figure 4-9:

- April 2013: the site data is approximately 40% higher than both the Met Office and NRFA data; and
- September 2014: the site data is 70% higher than the Met Office data.

The similarity of the April 2013 Met Office and NRFA data (86.6 mm and 91 mm) suggests that the recording at the Curraghinalt station is incorrect. The increase of 70% in September 2014 can be attributed to the low totals exaggerating the difference between the measurements; the Met Office measured 7.1 mm in September 2014 in comparison to 12.2 mm at the site and 13 mm from the NRFA data.

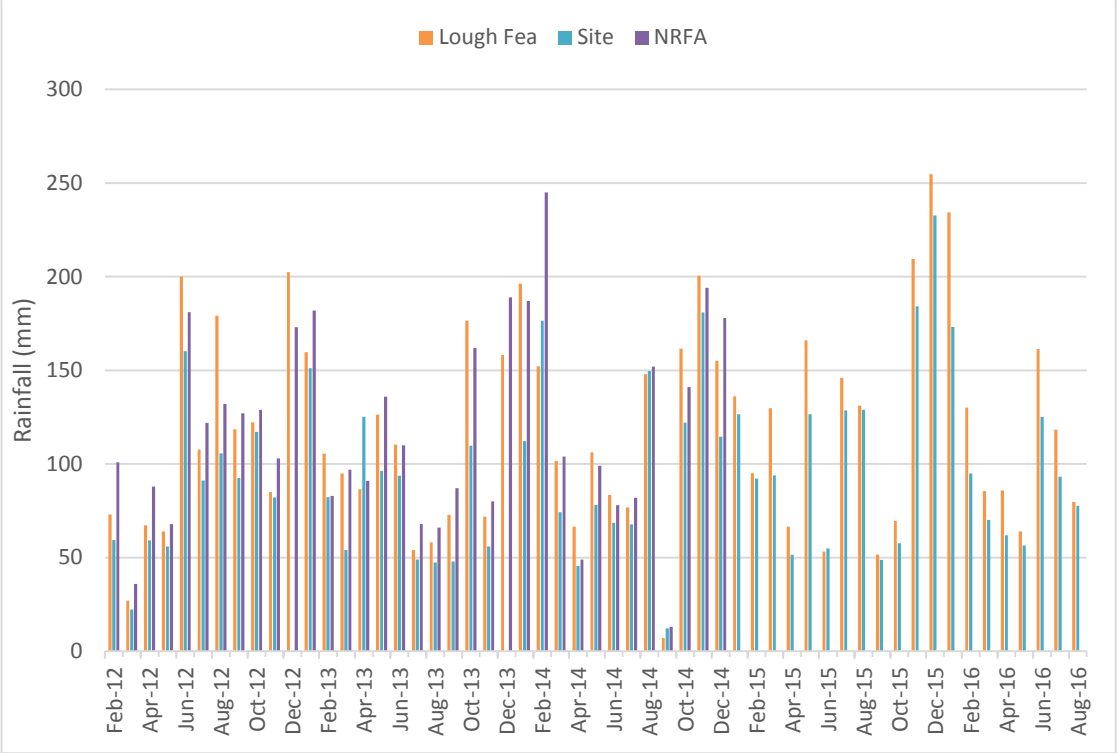


Figure 4-8: A comparison of the 2012 to 2016 monthly rainfall totals (mm) for the Met Office Lough Fea station, CMS "site" and NRFA Owenkillew catchment.

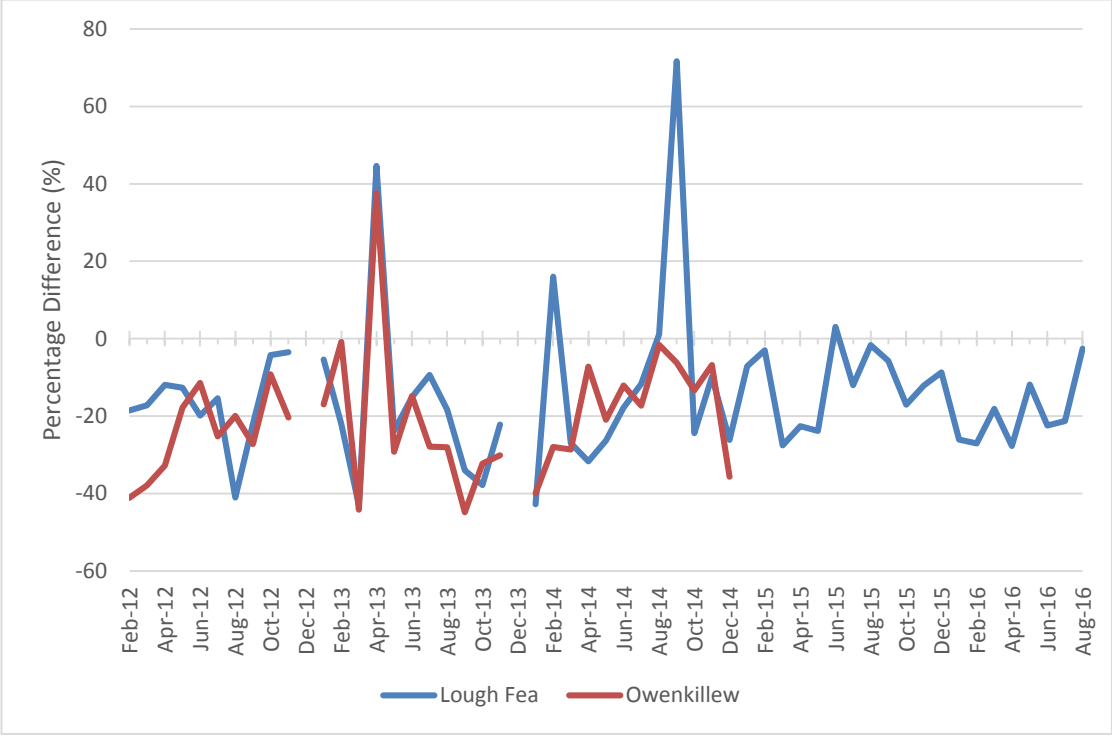


Figure 4-9: Percentage difference between the CMS project data and a. the Met Office Lough Fea (blue) and NRFA Owenkillew catchment (red) monthly rainfall totals.

To illustrate this further Figure 4-10 compares the average monthly rainfall for the CMS gauge ("Site") with: NRFA catchment data for the period 1980 to 2014 ("Owenkillew 1980 - 2014") and for the same period as the site data ("Owenkillew 2012 - 2014"); and Met Office Lough Fea data ("Lough Fea 1966 – 2016" and "Lough Fea 2012 – 2016") on the same basis.

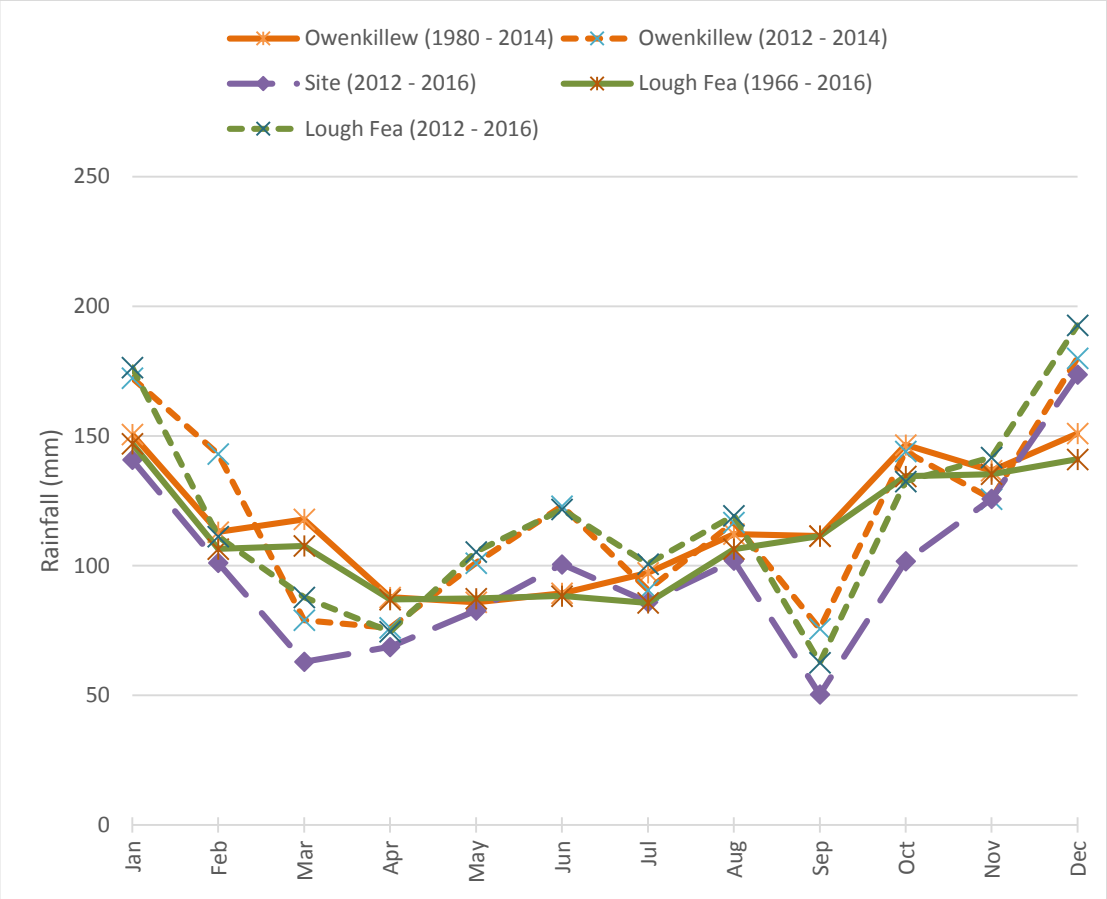


Figure 4-10: Average monthly rainfall for the NRFA Owenkillew catchment data and the Lough Fea data set compared with CMS ("site") monthly rainfall data

The results show;

- The CMS rain gauge data shows very similar trends in terms of months with high and low rainfall compared to the 2012 to 2016 Lough Fea and NRFA data, with the exception of March. This indicates that the overall pattern of rainfall (wet and dry months) appears consistent between the Lough Fea, NRFA data and the project data.
- The CMS data is consistently (apart from June and December) lower than the average of the Lough Fea and NRFA data for the period 2012 to 2014. This is the case in winter and summer, suggesting the reason for the discrepancy is not due to an under-catch during winter months.
- The period 2012 to 2016 deviates from the general trend of average rainfall totals for the full Lough Fea and NRFA data sets. The period 2012 to 2016 experienced a wetter spring and early summer conditions (May and June), as well as wetter winters (January and December). The period of record for the CMS gauge experienced a drier early spring (March and April) and September.

The difference between the CMS data and the Lough Fea and NRFA Curraghinalt catchment

data appears systematic and is not confined to certain periods of the year. It is possible that the project area has a lower rainfall than the Lough Fea and NRFA datasets, but this is considered unlikely.

A key factor appears to be the exposed location of the CMS. Pollock (2012) reports that, on an exposed upland UK site subject to high wind speeds, greater than 30% of the rainfall could fail to be recorded at a standard tipping bucket rain gauge. As will be shown in Section 4.4, wind speeds are relatively high at the project station and it is situated in an exposed location. Given the work by Pollock it is clear that an under-catch of up to 30% could result from wind effects. The impact of the under-catch could be mitigated by the use of a more aerodynamic tipping bucket rain gauge; however, some under-estimation of rainfall would still be expected to occur at the current location.

Providing a standard correction for wind effects is not possible as any correction factor will vary depending on wind speed and possibly wind direction (depending on site layout). Therefore, for project water balance calculations we would recommend basing monthly rainfall estimates on long-term data from the Met Office Lough Fea station.

Average monthly rainfall totals expressed as a percentage of the annual rainfall total for these three data sets are summarised in Figure 4-11.

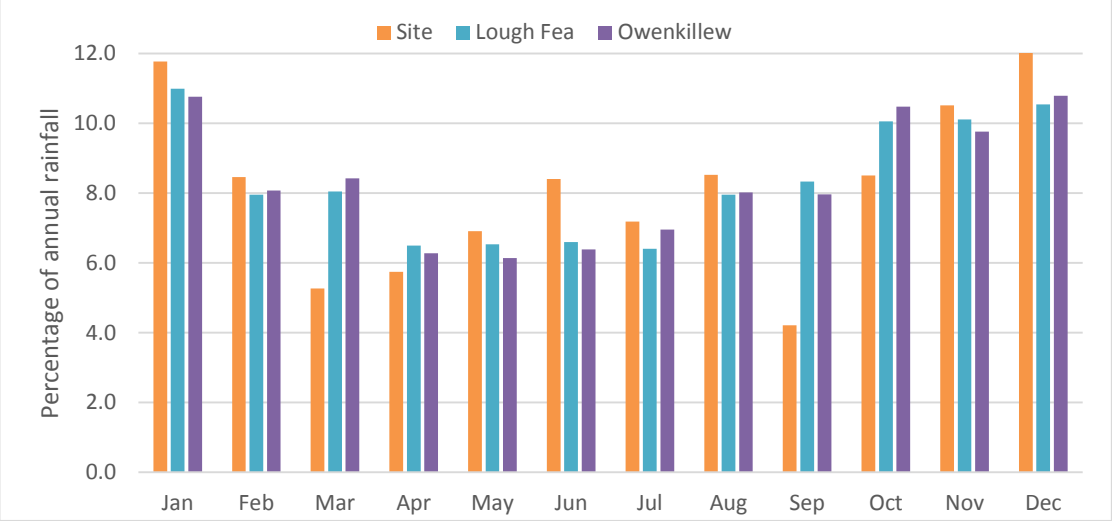


Figure 4-11: Average monthly rainfall total as a percentage of the average annual rainfall total for the CMS ("Site") data (2012 to 2016), the Lough Fea Met Office station (1966 - 2016), the NRFA Owenkillew catchment (1980 - 2014).

4.2.3 Daily Rainfall Totals

Daily rainfall totals for the complete CMS rain gauge data set are illustrated in Figure 4-12 and summarised in Appendices E to H.

At the CMS for the period February 2012 to September 2016 there were 150 days with greater than 10 mm of rainfall, 24 days with greater than 20 mm of rainfall and 5 days with greater than 30 mm of rainfall. The average daily rainfall for the period was 3.09 mm with a maximum recorded daily rainfall of 54.86 mm on 06/11/2014.

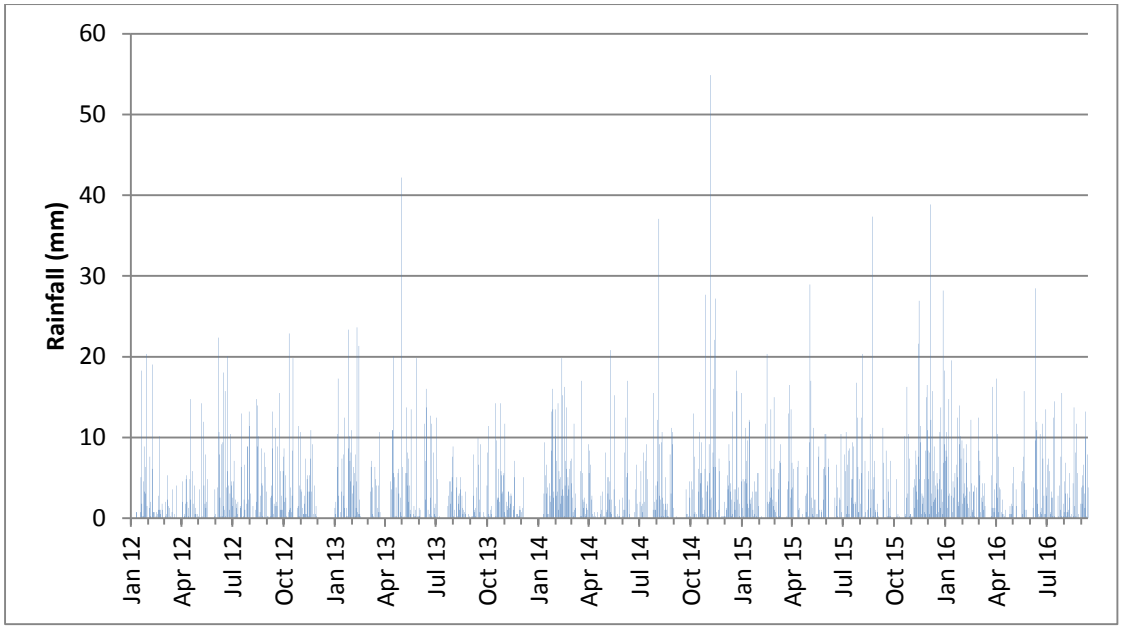


Figure 4-12: Daily rainfall totals (mm) recorded at the CMS rain gauge for the period February 2012 to September 2016.

Note: December 2012 is excluded due to incomplete data.

Daily rainfall data for Lough Fea Met Office station was acquired for the baseline. The NRFA data is not available on a daily time step.

During the period 1966 to 2016 at the Lough Fea station there were 9 days with rainfall totals of over 50 mm, which is higher than all but one of the daily totals observed at the project station. The days of rainfall over 50 mm occurred during both the winter and summer months and the latter are probably due to thunderstorm events which could be localised within the Sperrin's upland area (Table 4-5).

Table 4-5: Daily rainfall totals exceeding 50 mm at Lough Fea (1966 - 2015)

Date	Daily rainfall total (mm)
15/08/1970	87.6
21/11/1969	87.4
06/09/2010	63.0
01/11/1968	61.6
23/10/2005	55.2
02/05/2015	54.4
12/06/2007	53.6
11/08/2008	50.8
21/10/1987	50.2

4.2.4 Depth Duration Frequency Design Rainfall

A Depth-Duration-Frequency (DDF) curve provides estimates of rainfall depths associated with rain storms of different durations and with different probabilities of occurrence (return periods). They are required for flood flow estimation for watercourses and water management structures.

There is insufficient data from the CMS to allow the calculation of a DDF curve at the site, as around 30 years of data is normally required for the calculation of a DDF curve.

As outlined in Section 2.2.3, the FEH is the national method for flood estimation and the FEH Webservice provides calculated DDF curves for all locations in the United Kingdom. This data is based on Met Office rainfall data, with a 2013 update to the rainfall totals recently made available. The DDF curves for a range of return periods for the project site (point rainfall values) are shown in Figure 4-13, with rainfall depths for selected storm durations and return periods provided in Table 4-6.

There are only 4 years' data from the CMS. Maximum rainfall depths for selected storm durations within the CMS record are provided in Table 4-7 for comparison with Table 4-6. The onsite data suggests that there has been one storm (1 hour to 6 hours duration) which had a return period of around 20 to 50 years (30/04/2013).

Table 4-6: Estimated DDF curve data for the project site location

Duration	Rainfall Depth (mm) for each return period					
	10 year	20 year	50 year	100 year	200 year	500 year
15 min	12.1	14.9	19.2	23.1	27.7	35.3
30 min	16.5	20.4	26.4	31.9	38.4	49.2
1 hour	21.7	26.8	34.5	41.4	49.7	63.2
2 hours	26.7	32.4	40.9	48.7	57.9	72.8
6 hours	36.6	43.0	52.9	61.8	72.4	88.6
12 hours	44.7	51.7	62.4	72.1	83.3	100.1
24 hours	55.0	62.7	74.5	84.9	96.9	114.4
48 hours	75.2	85.5	101.0	114.4	129.5	152.6

Table 4-7: Largest rainfall depths within the CMS data set (February 2012 to September 2016)

Duration	Rainfall Depth (mm)
1 hour	31.8
2 hours	42.2
6 hours	42.2
12 hours	42.2
24 hours	56.4
48 hours	59.2

Note: December 2012 is excluded due to incomplete data.

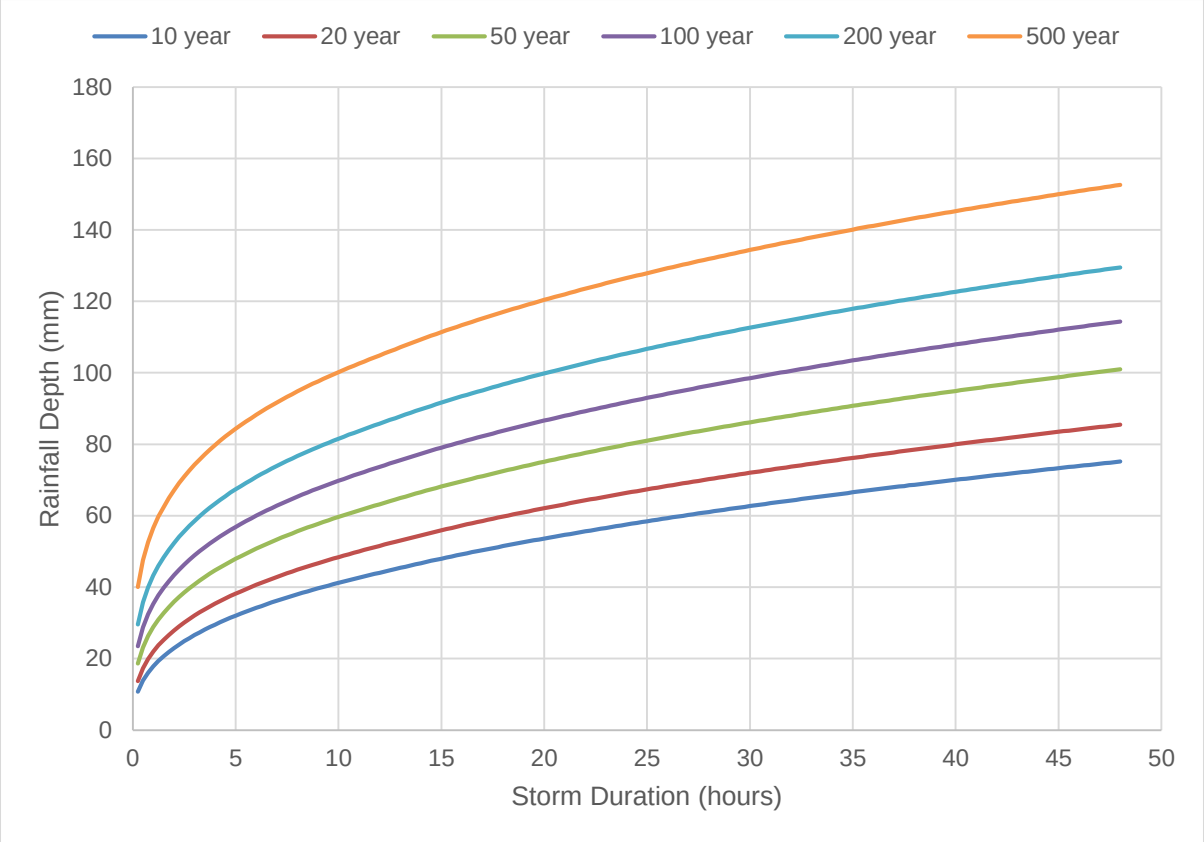


Figure 4-13: Estimated depth-duration-frequency curves for the project site location

4.3 Snow

Snowfall is not recorded at the CMS and the rain gauge is not heated. In addition, detailed information on snowfall has not been purchased for nearby Met Office stations. As a result, general information on typical snowfall is currently only available for Lough Fea.

At the Lough Fea meteorological station the majority of the sleet and snow falls in the winter (December, January and February), with a few days of snow recorded in early spring and autumn, and no days of snow in June, July, August and September on average. Snow rarely lies on the ground before December or after March and varies significantly from year to year. It can range from no snow throughout a winter to in excess of 30 days of snow lying during a severe winter.

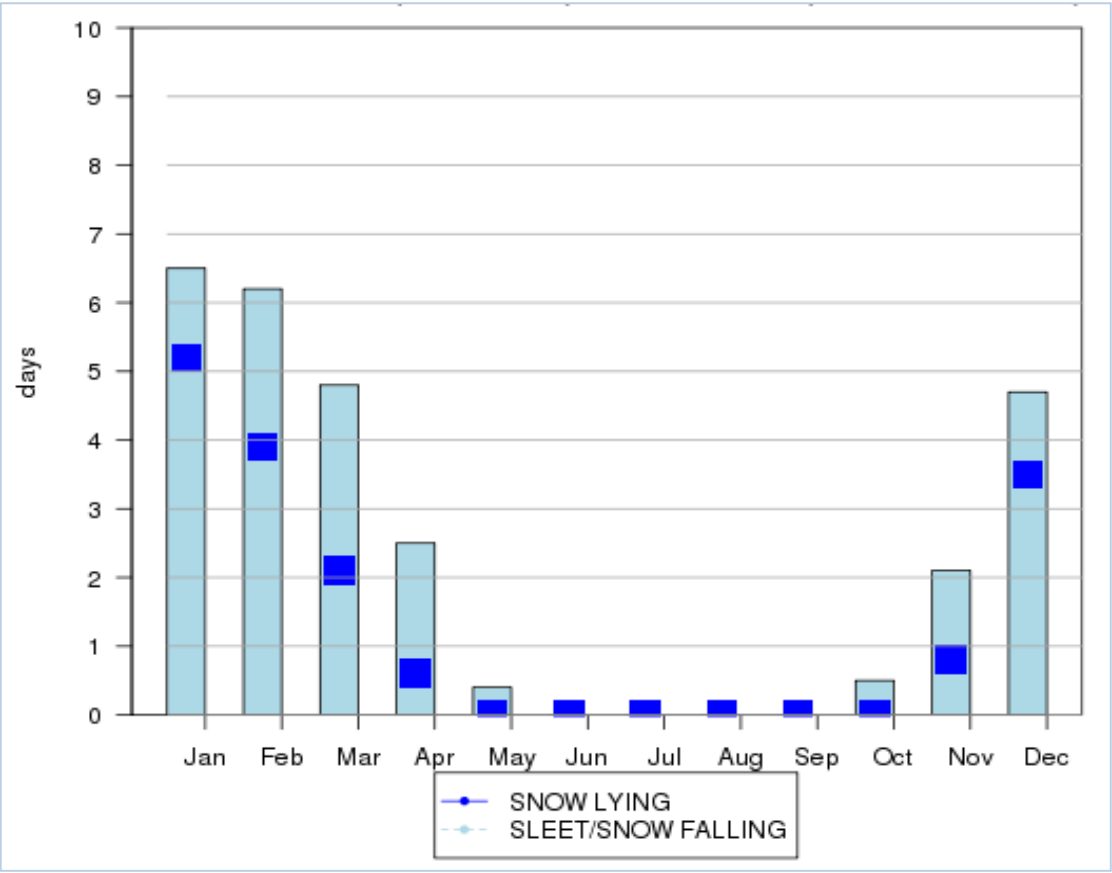


Figure 4-14: Average number of days per year of sleet/snow falling and snow lying at Lough Fea (1981-2010)
Note: A day of lying snow is counted if the ground is more than 50% covered at 0900

4.4 Wind Speed and Direction

The CMS wind speed recorder is mounted on a 2 m high tower. Met Office standard wind speeds are recorded from 10 m high towers; however, the Met Office accepts 2 m tower data for non-synoptic stations.

Wind speed increases with height from the ground with a power law generally used to extrapolate data from 10 m towers to higher elevations. However, there are difficulties associated with extrapolating data from a 2 m tower to a 10 m tower because at these lower heights local factors, such as land cover and nearby impediments, impact on ground friction effects. Therefore, for this assessment, data from the 2 m tower at the project station is compared with Met Office data from 10 m towers, with no adjustment. However, the differences in measurement tower height need to be considered when interpreting the data.

The maximum wind speed recorded at the CMS was 21.4 m/s (19/03/2014) with an average wind speed of 4.1 m/s over the period of record. The highest average monthly wind speed was January 2015 (6.02 m/s) with September 2014 having the lowest (2.57 m/s). The monthly averages are shown in Figure 4-15.

The wind data at the site is presented as a series of wind roses;

- Full period of record (Figure 4-16);
- Winter months (January, February and December) for full period of record (Figure 4-17);

- Spring months (March, April and May) for full period of record (Figure 4-18);
- Summer months (June, July and August) for full period of record (Figure 4-19); and
- Autumn months (September, October and November) for full period of record (Figure 4-20).

Based on this data the dominant wind directions are from the west and south-east at the project site.

As would be expected the highest wind speeds were recorded during the winter period, when wind came from the west and south-west for around 35% of the time at the site. In the summer (June to August) and autumn (September to November) periods there was more variation in the wind direction and generally lower wind speeds.

The seasonal variation in wind speed can be attributed to the frequency and strength of deep areas of low pressure passing over Northern Ireland. As Atlantic depressions pass the UK the wind typically starts to blow from the south and south west before turning more from the west and north west as the depression moves away. There are more frequent and stronger depressions occurring in the winter months between November and January, resulting in more westerly and south-westerly winds in winter compared to non-winter months.

The average annual wind speed at Lough Fea was 4.2 m/s and at Castlederg it was 3.6 m/s. The Banagher meteorological station did not record wind data. Between 1981 and 2010 the highest monthly average wind speed was 6.2 m/s for January at Lough Fea and the lowest was 2.9 m/s for August at Castlederg.

A comparison of monthly average wind speeds at Lough Fea, Castlederg and the CMS is provided in Figure 4-21.

It is notable that the wind speeds recorded at the project site are similar to those recorded at Lough Fea data for most months, and higher than the Castlederg data. The average wind speeds recorded at the CMS exceed those at Lough Fea for 6 months of the year and are only substantially smaller than the Lough Fea data for December.

Given the CMS data is measured from a 2 m height and the Lough Fea data from 10 m, the Lough Fea wind speeds might be expected to be higher than those at the site.

The fact that the site wind speeds are generally at least as high, or higher, than those at Lough Fea, emphasises the exposed location of the project meteorological station and backs up interpretations made regarding the onsite rainfall data in Section 4.2.

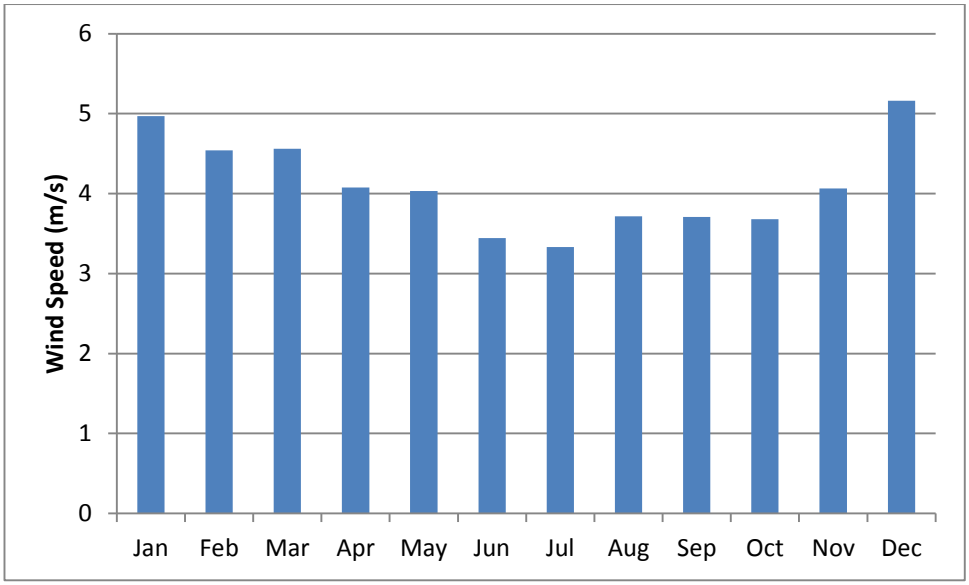


Figure 4-15: Average monthly wind speed recorded at the CMS for the period February 2012 to September 2016.

Note: December 2012 and September 2016 are excluded due to incomplete data.

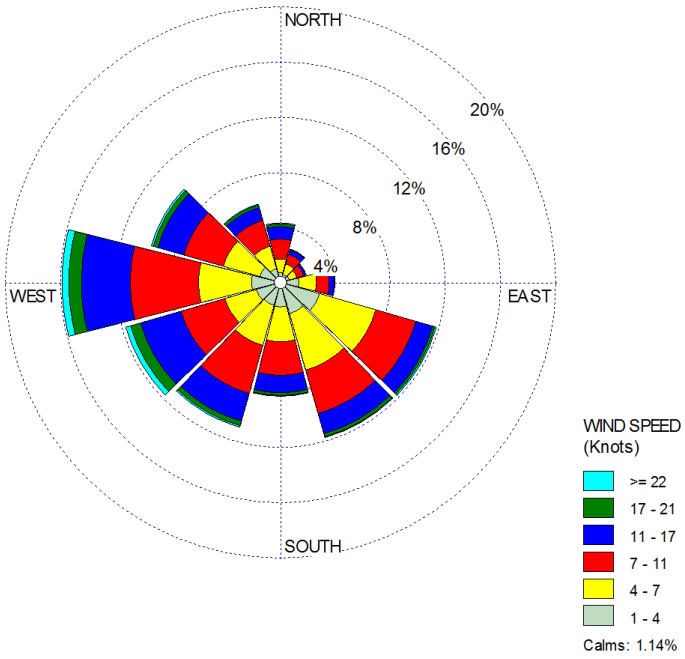


Figure 4-16: Wind Rose for the CMS for the period January 2012 to September 2016

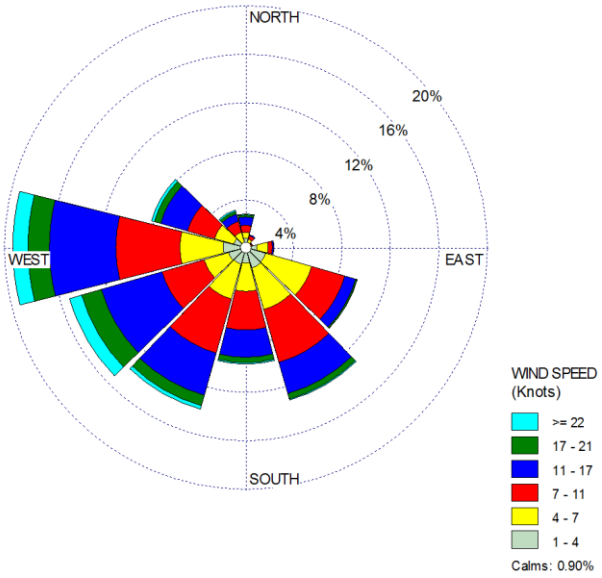


Figure 4-17: Wind Rose for the CMS for the months of January, February and December in the period January 2012 to September 2016

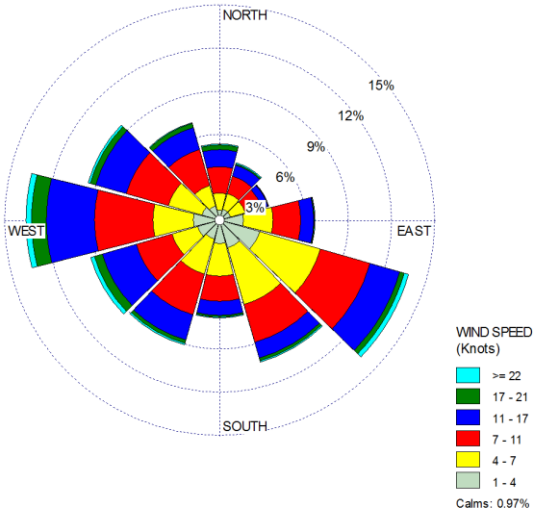


Figure 4-18: Percentage occurrence of hourly wind direction for the CMS for the months of March, April and May in the period January 2012 to September 2016

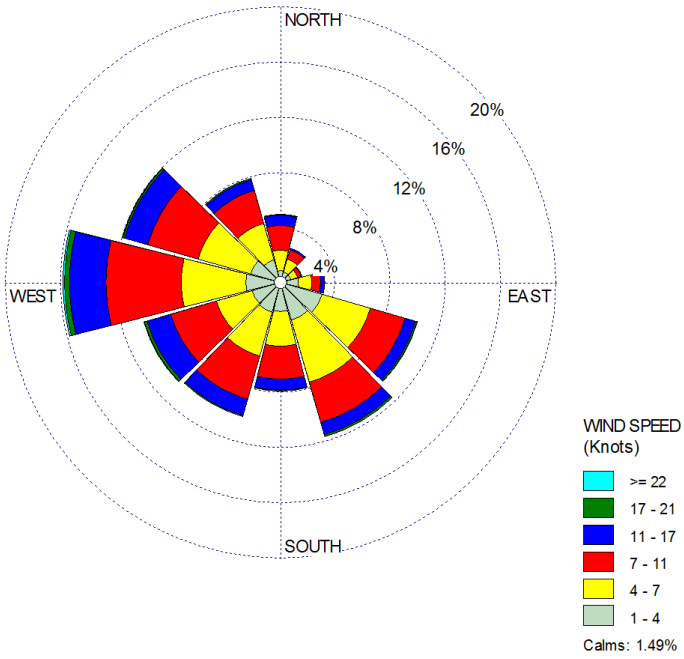


Figure 4-19: Percentage occurrence of hourly wind direction for the CMS for the months of June, July and August in the period January 2012 to September 2016

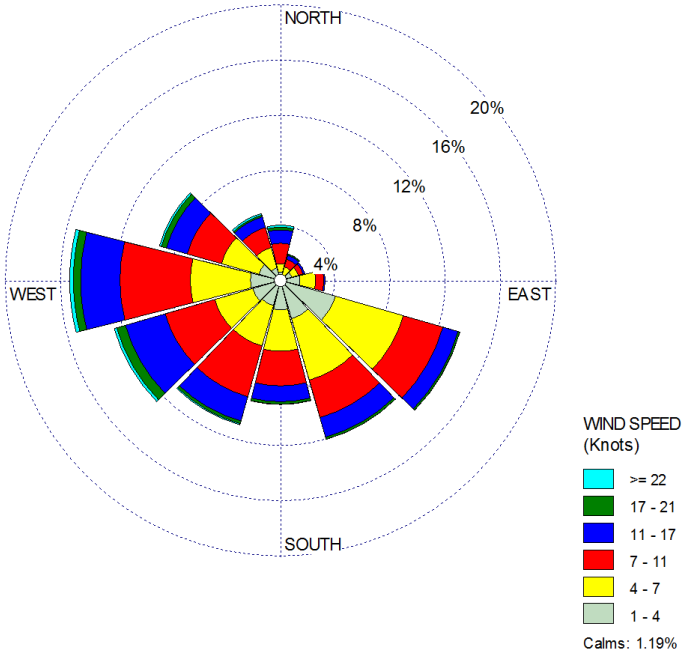
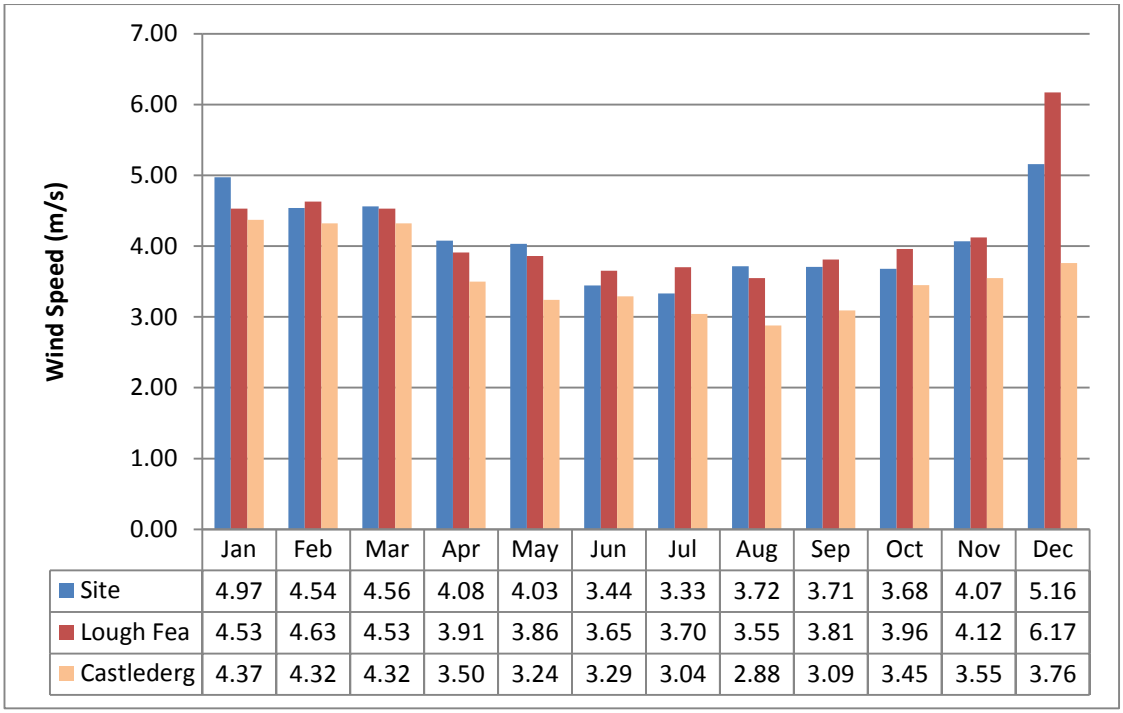


Figure 4-20: Percentage occurrence of hourly wind direction for the CMS for the months of September, October and November in the period January 2012 to September 2016



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Site	4.97	4.54	4.56	4.08	4.03	3.44	3.33	3.72	3.71	3.68	4.07	5.16
Lough Fea	4.53	4.63	4.53	3.91	3.86	3.65	3.70	3.55	3.81	3.96	4.12	6.17
Castlederg	4.37	4.32	4.32	3.50	3.24	3.29	3.04	2.88	3.09	3.45	3.55	3.76

Figure 4-21: A comparison of average monthly wind speed recorded at the CMS (February 2012 - September 2016) with Lough Fea (1981 - 2010) and Castlederg (1981 – 2010)

4.5 Solar Radiation

The solar radiation recordings at the CMS show the expected diurnal and seasonal variation in the data (Figure 4-22).

There was an average hourly solar radiation measurement of 98.1 Wm^2 with the highest hourly measurement of 1,322.19 Wm^2 on 21/05/2013 and the lowest hourly measurement of -31.22 Wm^2 on 18/02/2013. The consistently low levels recorded in February 2013 could be attributed to extended periods of heavy cloud coverage in the project area.

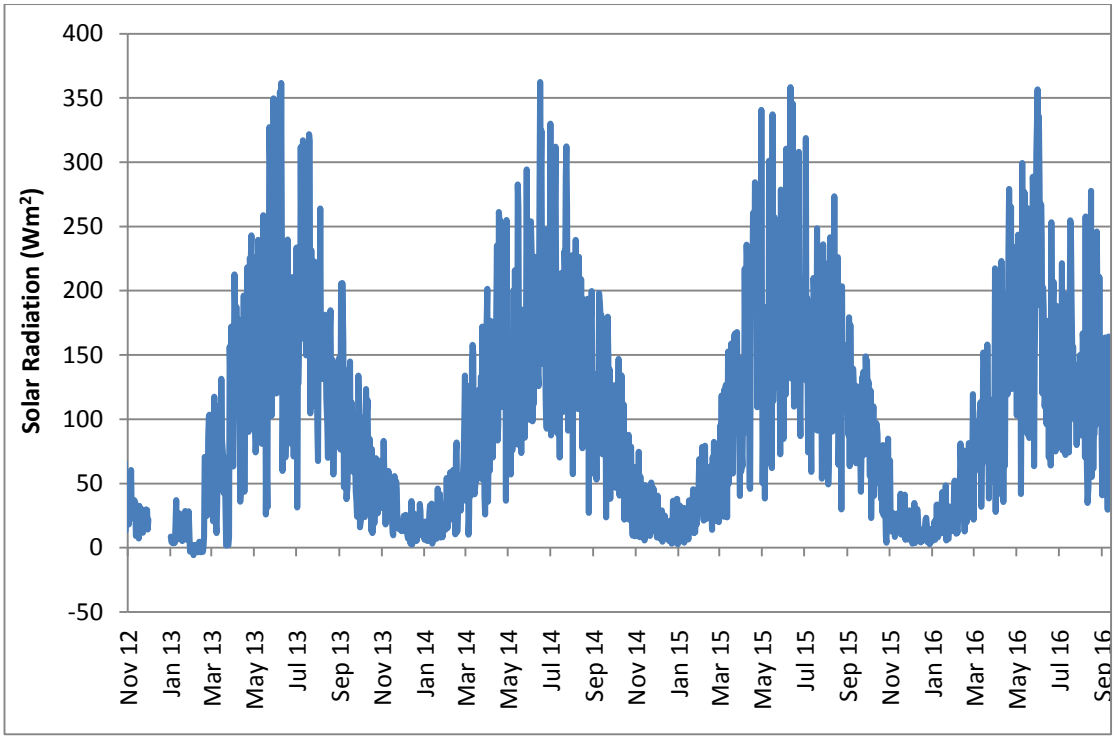


Figure 4-22: Daily average solar radiation (Wm^2) recorded at the CMS for the period November 2012 to September 2016.
Note: December 2012 is excluded due to incomplete data.

4.6 Ground Temperature

The ground temperature reflects the seasonality of the air temperature measurements (Section 3.1) with warmer ground temperatures during the summer months and colder ground temperatures during the winter. As evident in Figure 4-23, ground temperatures gradually rise between March and July and fall between August and February.

The average hourly ground temperature for the period January 2013 to February 2015 recorded at the CMS was 7.52°C with a maximum temperature of 17.71°C on 12/07/2013 and a minimum temperature of 0.76°C on 05/02/2015.

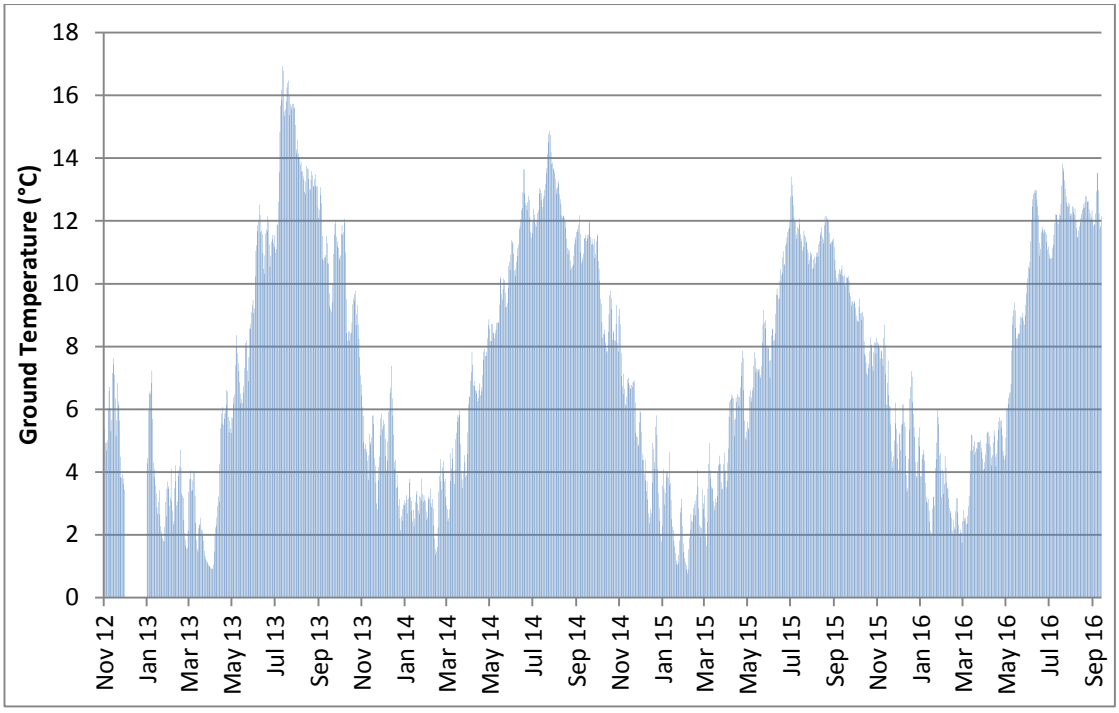


Figure 4-23: Daily average ground temperature recorded at the project site for the period November 2012 to September 2016.
Note: December 2012 is excluded due to incomplete data

4.7 Evaporation

Monthly evaporation recorded at the CMS is presented in Figure 4-24 with the data summarised in Table 4-8.

Figure 4-25 shows the evaporation pan surface water level data recorded at the project meteorological station. The average water level was 40.95 mm with a maximum recorded level of 198.04 mm (20/08/2014) and a minimum level of 0.50 m (17/01/2013).

The Northern Ireland Environment Agency (2008) evapotranspiration rates for Northern Ireland are shown in Figure 4-26; the area in which the project site is located exhibits annual evapotranspiration rates of 362 to 505 mm between 1971 and 2000. Environment Agency (2001) data for potential annual evaporation throughout mainland UK between 1961 and 1990 had an average total of 450 mm a year with an estimated 50 mm reduction for upland areas.

It is clear by comparison with the data in Table 4-8 and Figure 4-26 that there is a large discrepancy between the evaporation measurements recorded at the project station and the typical average data for Northern Ireland. As with the rainfall data, the discrepancy may be due to the high wind speeds and exposed position of the project meteorological station, with wind action increasing normal evaporation rates from the exposed evaporation pan.

Accurate evaporation measurement from evaporation pans can be difficult at exposed sites. An alternative method of calculating evaporation is to use standard equations, where evaporation can be calculated from first principles based on other meteorological data. Three methods were considered for this assessment;

- Aerodynamic method. Function of wind speed, humidity and air temperature. This is appropriate for sites where the limiting factor is the ability of evaporated water to be

removed from the site, i.e. wind limited. This is unlikely to be the case at the project meteorological station, but the method is included as it is the only method that can be applied in the first part of 2012.

- Energy Balance method. This is a function of net radiation and is appropriate for sites where the limiting factor is the supply of solar energy for evaporation, i.e. there is sufficient wind energy to remove water evaporated from close to where the evaporation occurred.
- Penman-Monteith Method. This is a standard approach for the calculation of potential evapotranspiration at the site based on meteorological data. The method provides a calculation of evapotranspiration for a reference crop (grassed field) with correction factors applied for other land use types. Koerselman and Beltman (1988) found that actual evapotranspiration from vegetated peatlands was 70 – 80% of the Penman-Monteith evapotranspiration. Therefore, the calculated Penman-Monteith values are multiplied by 75% to give evapotranspiration values for peat.

Evapotranspiration values are presented along with evaporation values in Table 4-9. Not all required meteorological data was available to allow calculation of evaporation/evapotranspiration for all three methods for the full data period. Until January 2013 there were no measurements of solar radiation and ground temperature required for methods 2, 3 and 4. After May 2013 there were issues with the humidity meter at the project station until January 2016 which precludes the application of empirical methods for these periods.

Monthly evaporation/evapotranspiration estimates for periods where they can be calculated and annual totals are provided in Table 4-8. An annual total is calculated for 2016, based on data from 2016 from January to September and values for October to December 2012. The estimated annual values are consistent with the expected regional averages.

Table 4-8: Monthly evaporation totals based on data recorded at the CMS for the period January 2013 to September 2016

	2013	2014	2015	2016
Jan	76.2	133.1	165.3	91.3
Feb	62.6	166.6	64.2	82.1
Mar	108.5	92.1	94.2	64.2
Apr	84.9	48.2	52.8	38.7
May	77.6	71.3	108.3	52.3
Jun	72.1	49.0	61.2	85.0
Jul	44.5	73.7	109.3	43.0
Aug	62.2	181.1	80.1	44.1
Sep	69.8	16.8	34.8	25.0
Oct	111.2	99.7	35.6	
Nov	80.2	37.0	106.7	
Dec	185.6	81.5	109.8	
Total	1,035.4	1,050.1	1,022.3	525.7 (9 months)

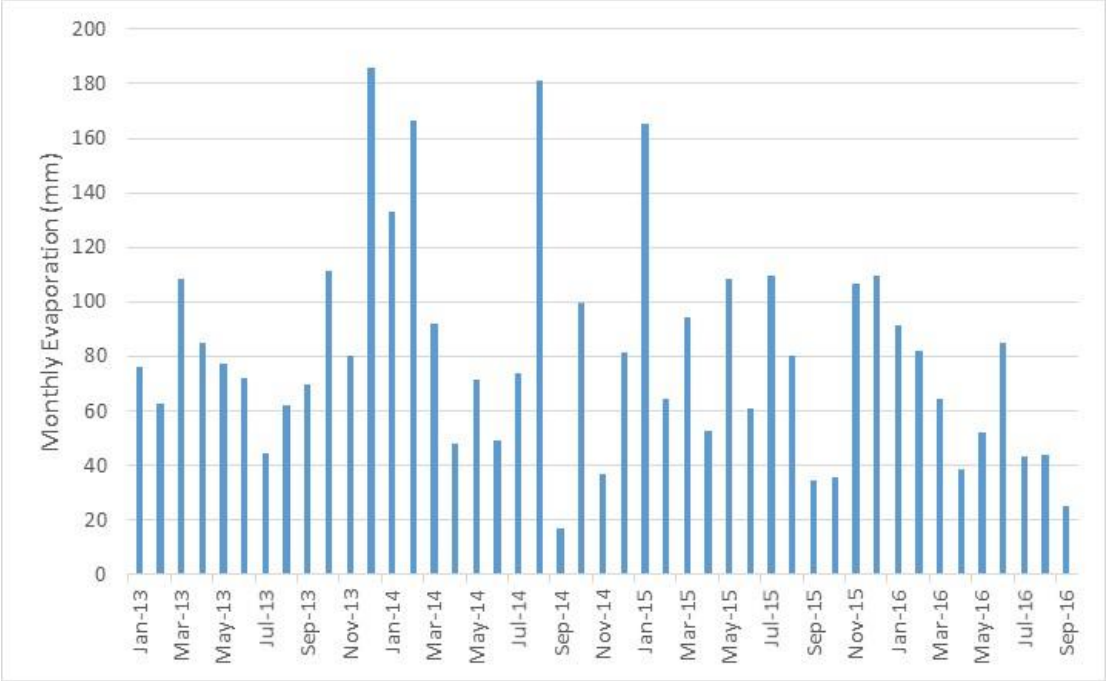


Figure 4-24: Monthly evaporation totals based on the CMS data for the period January 2013 to September 2016

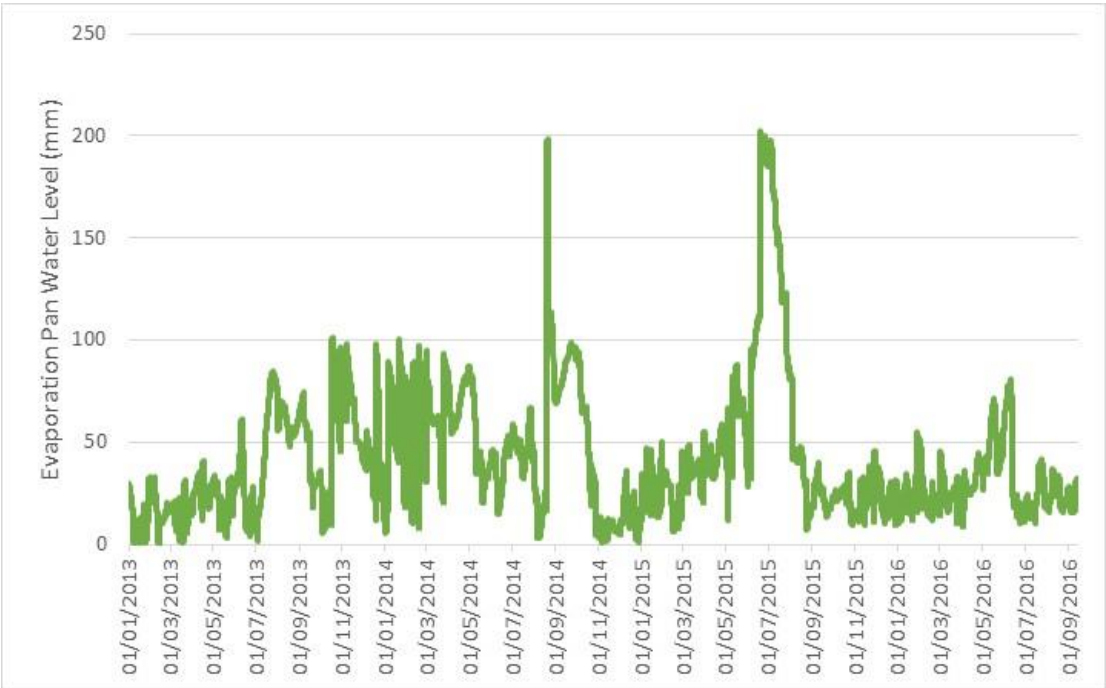


Figure 4-25: Hourly evaporation pan surface water level (mm) for the period January 2013 to February 2014 recorded at the CMS

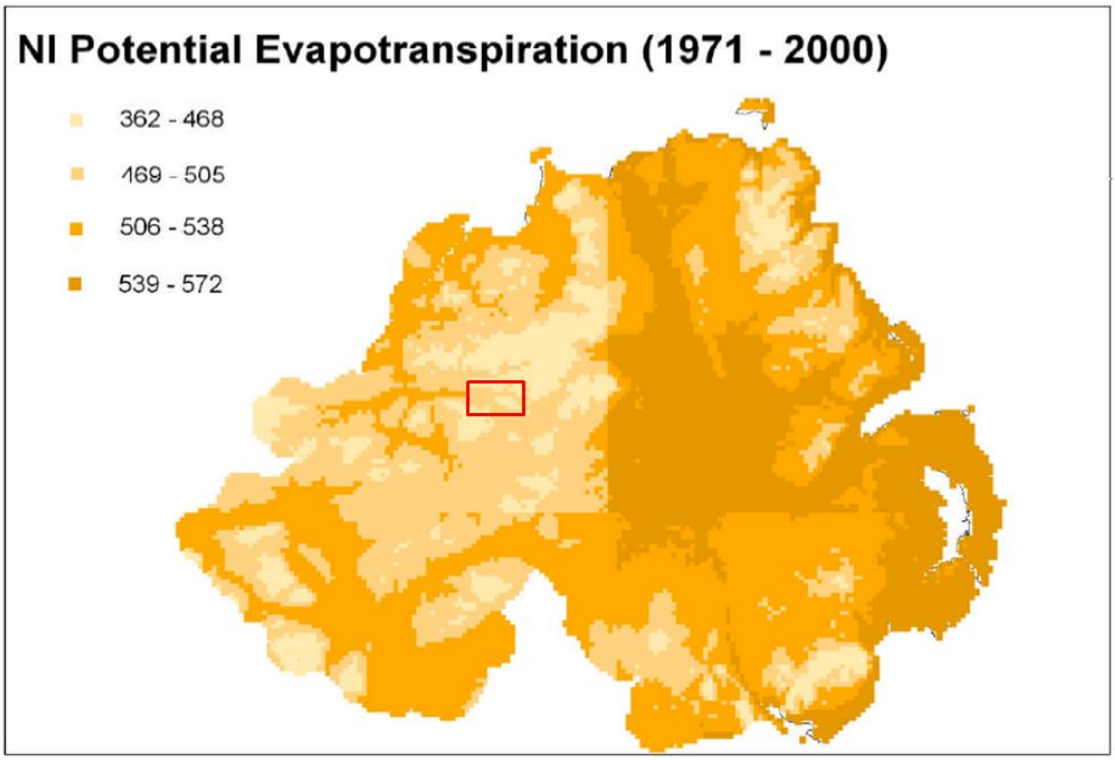


Figure 4-26: Regional annual average potential evapotranspiration in mm (red box = approximate site location) (source: Northern Ireland Environment Agency (2008))

It is recommended that as the project progresses evaporation data is obtained from the nearby Met Office stations and compared with the project station data. This will allow a more detailed review of the project data and the standard evaporation calculations, which could lead to updates to the estimates for the site.

Table 4-9: Monthly evaporation totals recorded at the project station calculated using standard equations

	Aerodynamic Method	Energy Balance Method	Penman-Monteith – 75% of potential evapotranspiration reference crop
Feb-12	13.6		
Mar-12	45.4		
Apr-12	40.5		
May-12	83.5		
Jun-12	32.3		
Jul-12	40.7		
Aug-12	50.4		
Sep-12	47.7		
Oct-12	15.0	4.3	5.9
Nov-12	10.8	11.3	7.0
Dec-12	7.2	5.2	10.5
Jan-13	6.1	5.5	17.8
Feb-13	15.6	9.7	11.8
Mar-13	21.6	27.9	21.4
Apr-13	38.4	62.1	41.6
TOTAL Oct 2012 to April 2013	**114.7**	**126**	**116.0**
Jan-16		8.6	19.5
Feb-16		19.3	13.8
Mar-16		41.8	25.2
Apr-16		64.8	37.3
May-16		87.4	65.6
June-16		70.8	55.8
July-16		66	52.7
Aug-16		56.8	49.3
Sep-16		16	14.7
TOTAL Jan 2016 to Sep 2016		**431.5**	**333.9**
Estimated annual total		**452.3**	**476.4**

5 CLIMATE CHANGE

The most up to date quantitative climate change predictions for the UK are provided within the UK Climate Projections (UKCP09) dataset (Murphy et al., 2007).

The UKCP09 data provides estimates of the effect of future climate change on a range of meteorological variables (e.g., temperature, rainfall). These are based on a range of climate model scenarios and a key aspect of the UKCP09 summary predictions are described below.

They are provided for three future carbon emissions scenarios; high, medium and low emissions scenarios, corresponding to the Intergovernmental Panel on Climate Change (IPCC) scenarios A1F1, A1B and B1 respectively. More information on the emission scenarios can be found in the IPCC's Special Report on Emissions Scenarios (SRES).

They are provided as probabilistic outputs, i.e. a single forecast is not made for each emissions scenario, but rather predictions are made that are assumed to represent values of change (e.g. increase in temperature) that are;

- Considered very likely to be exceeded (90% change of being exceeded)
- Considered to have a 50% change of being exceeded (central estimate)
- Considered very unlikely to be exceeded (10% chance of being exceeded).

UKCP09 results have been extracted for Northern Ireland as a whole and for a 25 km^2 grid cell at the project site. The results are presented in a table with nine values, corresponding to the nine combinations of emissions scenario and probabilities.

There is no clear guidance as to what would constitute a 'best estimate' of future predictions. However, a scenario with medium emissions and 50% change of exceedance might be considered a reasonably likely scenario and a scenario with high emissions and 10% chance of exceedance might be considered a reasonably conservative upper limit scenario.

5.1 Northern Ireland

5.1.1 Winter Mean Temperature

UKCP09 predicts an increase in winter temperatures in Northern Ireland by 2080.

The range of predictions is shown in Table 5-1, with a predicted increase of between 1.1ºC and 4.4ºC.

Table 5-1: Winter mean temperature change by 2080 in Northern Ireland

Emissions Scenario	Winter Mean Temperature (ºC)		
	10% probability	50% probability	90% probability
Low	+1.1	+2.0	+3.2
Medium	+1.3	+2.3	+3.6
High	+1.7	+2.9	+4.4

5.1.2 Summer Mean Temperature

UKCP09 predicts an increase in summer temperatures in Northern Ireland by 2080.

The range of predictions is shown in Table 5-2, with a predicted increase of between 1.1ºC and 6.2ºC.

Table 5-2: Summer mean temperature change by 2080 in Northern Ireland

Emissions Scenario	Summer Mean Temperature (ºC)		
	10% probability	50% probability	90% probability
Low	+1.1	+2.4	+3.9
Medium	+1.7	+3.2	+5.0
High	+2.2	+4.0	+6.2

5.1.3 Annual Mean Precipitation

UKCP09 predicts a change in annual mean precipitation in Northern Ireland by 2080.

The range of predictions is shown in Table 5-3, with a predicted change of between -6% and 5%.

Table 5-3: Annual mean precipitation change by 2080 in Northern Ireland

Emissions Scenario	Annual Mean Precipitation Change (%)		
	10% probability	50% probability	90% probability
Low	-3	0	+4
Medium	-4	0	+4
High	-6	-1	+5

5.1.4 Winter Mean Precipitation

UKCP09 predicts an increase in winter mean precipitation in Northern Ireland by 2080.

The range of predictions is shown in Table 5-4, with a predicted increase of between 2% and 34%.

Table 5-4: Winter mean precipitation change by 2080 in Northern Ireland

Emissions Scenario	Winter Mean Precipitation Change (%)		
	10% probability	50% probability	90% probability
Low	+3	+11	+21
Medium	+2	+11	+24
High	+2	+18	+34

5.1.5 Summer Mean Precipitation

UKCP09 predicts a change in summer mean precipitation in Northern Ireland by 2080.

The range of predictions is shown in Table 5-5, with a predicted change of between -39% and 6%. Most predictions are negative illustrating a general trend of drier summer months.

Table 5-5: Summer mean precipitation change by 2080 in Northern Ireland

Emissions Scenario	Summer Mean Precipitation Change (%)		
	10% probability	50% probability	90% probability
Low	-26	-11	+6
Medium	-33	-15	+3
High	-39	-19	+4

5.2 Site Location (UKCP09 Grid 873)

5.2.1 Winter Mean Temperature

UKCP09 predicts an increase in winter temperatures at the site by 2080. The range of predictions is shown in Table 5-6, with a predicted increase of between 1.1ºC and 4.5ºC. The predictions for the site are very similar to the regional predictions for Northern Ireland.

Table 5-6: Winter mean temperature change by 2080 at the site

Emissions Scenario	Mean Winter Temperature (ºC)		
	10% probability	50% probability	90% probability
Low	+1.1	+2.1	+3.3
Medium	+1.3	+2.4	+3.7
High	+1.8	+2.9	+4.5

5.2.2 Summer Mean Temperature

UKCP09 predicts an increase in summer temperatures at the site by 2080. The range of predictions is shown in Table 5-7, with a predicted increase of between 1.1ºC and 6.1ºC. The predictions for the site are very similar to the regional predictions for Northern Ireland.

Table 5-7: Summer mean temperature change by 2080 at the site

Emissions Scenario	Mean Summer Temperature (ºC)		
	10% probability	50% probability	90% probability
Low	+1.1	+2.3	+3.8
Medium	+1.6	+3.1	+4.9
High	+2.1	+3.9	+6.1

5.2.3 Annual Mean Precipitation

UKCP09 predicts a change in annual mean precipitation at the site by 2080. The range of predictions is shown in Table 5-8, with a predicted change of between -7% and 6%. The predictions for the site are very similar to the regional predictions for Northern Ireland.

Table 5-8: Annual mean precipitation by 2080 at the site

Emissions Scenario	Annual Mean Precipitation Change (%)		
	10% probability	50% probability	90% probability
Low	-4	0	+5
Medium	-6	-1	+5
High	-7	-1	+6

5.2.4 Winter Mean Precipitation

UKCP09 predicts an increase in winter mean precipitation at the site by 2080. The range of predictions is shown in Table 5-9, with a predicted change of between 3% and 41%. The predictions for the site show a larger percentage increase in winter mean precipitation than Northern Ireland as a whole.

Table 5-9: Winter mean precipitation change by 2080 at the site

Emissions Scenario	Winter Mean Precipitation Change (%)		
	10% probability	50% probability	90% probability
Low	+3	+12	+25
Medium	+3	+14	+31
High	+5	+19	+41

5.2.5 Summer Mean Precipitation

UKCP09 predicts a change in summer mean precipitation at the site by 2080. The range of predictions is shown in Table 5-10, with a predicted change of between -49% and 6%. The predictions for the site show a slightly greater percentage change in summer mean precipitation than Northern Ireland as a whole, with potentially drier summer conditions at the site.

Table 5-10: Summer mean precipitation change by 2080 at the site

Emissions Scenario	Summer Mean Precipitation Change (%)		
	10% probability	50% probability	90% probability
Low	-33	-13	+8
Medium	-40	-18	+7
High	-49	-24	+6

5.2.6 Change in precipitation on the wettest day

UKCP09 predicts a change in the amount of precipitation on the wettest day by 2080. The range of predictions for the winter period, the wettest period at the Curraghinalt site, is shown in Table 5-11. The predicted change is between -1% and 55%. The higher of this range suggests a very large increase in precipitation during the wettest winter day.

Table 5-11: Change in precipitation on the wettest winter day by 2080 at the site

Emissions Scenario	Change in precipitation on wettest winter day (%)		
	10% probability	50% probability	90% probability
Low	0	+13	+33
Medium	-1	+15	+39
High	+4	+24	+55

5.3 Summary of Climate Change Predictions

The climate change predictions provide an indication of the direction and quantity of potential changes in key climate variables by 2080.

6 SUMMARY AND RECOMMENDATIONS

This report summarises the baseline meteorological data obtained from the Curraghinalt meteorological station (CMS) at the project site. Where possible the onsite data has been compared with data from other sources (i.e. from nearby Met Office stations), with the aim of developing initial estimates of key meteorological parameters (e.g. monthly rainfall, DDF curve) required for the environmental assessment for the mine and to assist engineering design.

At Curraghinalt, the average hourly temperature recorded was 8.56°C with a high of 26.6°C (18/07/2013) and a low of -5.5°C (12/03/2013). The overall patterns of seasonal temperature variations are as would be expected for this part of Northern Ireland and the temperature data compares well with averages for the nearby Lough Fea and Baragher Met Office stations.

Analysis of rainfall data at the site suggests that there is an under catch of around 20 to 30% at the CMS, when compared with Met Office and NRFA data. It is concluded that relatively high wind speeds at the site and the exposed nature of the CMS result in the under catch. It is recommended that remedial measures are undertaken at the station to try and increase the catch of rainfall. We would recommend that the existing rain gauge is retained at the current location with the provision of wind baffles (or purchase of a more aerodynamic rain gauge) and that a second rain gauge is installed on site at a more sheltered location.

It is recommended that rainfall values (e.g. annual averages, monthly averages) used for water balance calculations and engineering work should be based on the Met Office data for the station at Lough Fea.

The maximum wind speed recorded at the onsite meteorological station was 21.4 m/s (19/03/2014) with an average wind speed of 4.2 m/s. The dominant wind directions recorded at Curraghinalt were westerly and south-easterly. The average annual wind direction at Lough Fea was 4.2 m/s and at Castlederg was 3.6 m/s. The onsite wind data is consistent with data for the nearby Met Office stations.

Solar radiation and ground temperature recordings at Curraghinalt displayed the expected seasonal variation; with low values in the winter period and higher values in the summer period.

Evaporation measurements at Curraghinalt were impacted by high winds, with the gauge recording erroneously high evaporation rates. However, rates calculated using standard methods and using other parameters measured at the station (e.g. humidity, wind speed), produced evaporation rates that were consistent with regional averages. It is recommended that the evaporation pan is moved to a more sheltered location and one where more regular maintenance (bi-daily or weekly) can be undertaken. This can be the same location as the new rain gauge, discussed above.

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ANNEX A DAILY TEMPERATURE (°C) RECORDED AT CURRAGHINALT IN 2012. BLANK SPACES INDICATE INCOMPLETE OR MISSING DATA

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1		0.33	9.28	5.69	9.68	13.22	10.99	14.25	14.12	8.86	2.67	
2		-1.32	6.08	7.01	9.08	11.61	14.80	13.38	13.53	7.63	3.83	
3		-0.55	5.89	3.20	11.04	9.15	14.23	13.51	14.73	7.27	2.48	
4		3.44	1.93	2.71	7.43	9.68	14.59	14.65	12.45	6.53	4.17	
5		3.90	3.57	4.15	4.05	8.83	15.38	12.20	11.73	7.50	4.08	
6		5.88	5.15	6.53	4.38	11.55	16.64	11.78	12.68	7.71	7.16	
7		3.74	4.62	8.02	4.84	10.88	14.48	13.43	15.69	7.25	8.09	
8		2.97	6.25	7.66	5.87	11.20	10.94	13.95	15.12	7.26	7.25	
9		6.69	9.35	5.33	6.11	9.86	10.90	15.17	13.21	7.33	6.50	
10		7.49	9.35	3.87	5.95	10.60	10.42	17.22	10.34	7.94	3.80	
11	8.83	6.73	8.15	5.15	5.59	12.09	9.73	15.38	8.16	9.65	4.53	
12	6.30	5.66	7.08	5.28	7.08	10.45	10.44	14.63	9.79	5.16	8.29	
13	3.34	5.58	7.03	3.53	7.26	10.13	11.98	16.20	11.65	5.45	10.41	
14	3.08	6.50	6.33	4.10	5.75	11.32	9.80	16.00	11.35	7.40	7.81	
15	3.37	6.49	7.05	4.00	5.32	9.91	11.14	15.05	11.31	5.78	7.49	
16	2.83	7.10	8.01	5.01	5.70	10.03	13.71	15.08	11.11	5.33	5.21	
17	6.03	3.64	4.64	5.65	6.48	8.66	13.75	16.15	9.35	7.55	3.39	
18	6.95	4.30	4.52	5.58	7.06	8.70	13.08	16.88	7.40	9.38	2.39	
19	3.61	6.96	6.62	6.39	7.42	10.45	10.86	15.53	8.19	8.99	9.47	
20	6.88	5.80	9.40	5.60	8.90	12.07	11.21	15.41	10.37	8.40	8.01	
21	5.70	8.85	7.55	5.44	11.54	10.67	12.51	13.52	7.69	9.34	5.15	
22	5.61	10.05	7.18	5.52	12.57	10.03	15.28	13.26	7.60	8.62	6.35	
23	3.13	10.41	8.42	5.95	14.55	11.35	14.27	12.39	8.35	9.68	3.08	
24	7.33	6.87	9.27	5.55	16.80	11.88	13.93	12.54	8.15	9.20	1.56	
25	6.73	5.84	12.15	5.65	18.76	10.96	13.60	12.72	9.24	7.60	2.67	
26	1.55	7.07	11.00	6.18	17.65	12.45	13.25	12.12	10.47	2.69	4.91	
27	2.81	9.67	12.22	4.69	17.05	16.49	11.60	14.55	9.05	3.71	3.89	
28	3.83	10.40	12.48	5.35	18.11	15.15	10.55	12.67	8.83	6.94	3.66	
29	5.19	10.40	8.22	5.40	14.68	13.10	9.87	12.45	9.06	5.43	2.57	
30	2.59		7.82	7.80	13.50	10.58	10.48	11.00	11.80	6.46	1.26	
31	1.61		7.12		13.20		11.71	11.22		4.62		

ANNEX B DAILY TEMPERATURE (°C) RECORDED AT CURRAGHINALT IN 2013. BLANK SPACES INDICATE INCOMPLETE OR MISSING DATA

Air Temperature: 2013 (^{0}C)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	3.07	3.42	6.44	0.61	6.70	9.04	10.62	16.98	12.55	11.61	5.61	7.70
2	8.46	2.27	4.54	1.70	7.10	10.85	11.00	15.76	15.83	13.63	5.07	5.95
3	9.75	7.24	5.25	2.15	8.53	13.59	12.68	13.23	15.04	14.90	4.60	6.47
4	8.57	4.25	2.97	2.67	6.22	14.84	13.18	14.23	13.68	12.56	3.46	2.90
5	8.38	2.07	3.69	2.96	10.55	14.79	14.25	12.90	10.04	12.58	4.25	4.43
6	7.78	2.81	4.45	3.64	11.20	15.39	14.86	13.35	8.43	15.01	4.83	3.95
7	9.19	1.27	5.12	2.49	11.78	16.15	17.63	13.58	8.73	15.26	4.60	6.14
8	7.38	4.48	4.62	3.45	9.81	15.10	20.30	14.39	9.90	11.39	3.78	9.44
9	2.44	6.45	3.01	3.01	6.88	15.58	20.90	12.89	10.12	7.88	2.42	8.99
10	2.06	4.41	0.35	3.56	7.04	13.21	18.05	12.48	11.03	7.24	3.69	9.56
11	2.66	1.42	-2.12	3.87	6.57	11.45	20.26	11.87	12.66	6.88	9.56	9.13
12	3.45	1.22	-0.61	4.12	6.91	12.73	21.38	11.68	13.23	8.29	5.70	11.56
13	1.70	5.87	1.92	4.93	4.98	10.00	14.85	13.13	9.03	8.96	5.87	8.38
14	2.73	5.37	2.38	9.82	5.72	10.15	14.47	14.82	9.65	9.64	5.94	6.30
15	1.36	4.61	3.37	8.78	5.47	9.22	15.45	15.51	10.01	8.52	7.89	4.91
16	1.82	6.60	1.84	7.88	5.71	11.16	17.62	13.82	7.05	9.13	9.02	3.77
17	4.11	5.67	2.15	8.36	8.32	12.31	18.43	14.35	7.63	9.83	5.95	2.90
18	8.08	3.11	1.85	6.74	8.31	13.28	19.13	11.94	8.05	11.15	3.86	7.20
19	5.73	2.39	0.72	6.25	11.42	11.86	20.85	13.22	9.58	12.15	2.41	2.92
20	-0.26	3.27	2.07	7.25	9.25	13.30	18.98	14.26	11.27	10.70	4.41	5.65
21	0.38	1.00	1.64	6.84	8.85	12.57	15.68	15.34	13.88	10.14	2.62	4.54
22	-0.07	0.23	4.93	7.94	7.56	10.93	17.17	14.73	15.73	12.87	2.77	3.92
23	0.07	-0.14	0.00	8.48	5.75	10.22	17.53	13.53	15.05	8.42	4.77	4.06
24	1.04	0.35	0.06	8.64	7.47	10.27	16.51	11.99	13.84	8.52	5.92	1.32
25	3.95	1.70	-0.03	5.54	10.11	11.86	16.14	13.78	13.27	11.84	5.13	2.81
26	4.19	2.30	-0.40	3.93	10.97	11.07	16.40	12.98	10.70	8.68	6.57	2.07
27	3.31	1.94	-0.60	5.63	8.41	11.56	15.67	13.59	13.21	8.53	8.22	5.05
28	4.14	4.64	-0.55	5.88	9.06	12.48	15.62	12.23	13.23	7.36	8.08	2.47
29	6.68		0.11	5.56	12.11	12.01	15.20	14.00	12.50	5.91	6.58	3.46
30	4.15		0.45	5.72	10.83	12.31	13.23	13.35	11.59	6.57	5.64	4.39
31	4.75		0.80		9.58		12.26	10.94		6.32		4.25

ANNEX C DAILY TEMPERATURE (°C) RECORDED AT CURRAGHINALT IN 2014. BLANK SPACES INDICATE INCOMPLETE OR MISSING DATA

Air Temperature: 2014 (^{0}C)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	3.29	5.90	2.72	9.40	8.40	13.37	15.63	13.78	12.70	10.64	9.31	5.88
2	4.34	4.54	3.33	7.32	7.88	11.70	14.22	12.15	12.86	9.90	7.23	2.35
3	4.83	5.41	1.65	8.70	9.61	10.98	13.15	12.96	13.73	10.74	4.08	4.62
4	1.62	2.66	4.43	9.35	11.45	9.56	13.32	13.72	15.45	7.56	6.70	4.38
5	4.15	4.80	5.37	10.33	9.11	9.66	10.90	14.55	12.96	9.24	5.51	2.48
6	6.05	4.33	9.58	10.64	8.72	11.50	11.16	14.40	10.26	8.66	8.98	6.05
7	5.90	2.39	5.11	5.92	8.10	13.28	12.08	12.21	10.17	6.95	7.07	3.11
8	4.83	4.53	7.51	5.88	9.11	12.14	12.52	13.50	10.33	7.89	4.63	2.40
9	2.86	3.71	5.54	9.12	8.88	12.75	13.15	13.13	12.00	8.61	5.99	5.23
10	3.77	2.09	4.68	7.13	9.02	11.99	14.71	11.28	12.94	8.28	6.03	2.26
11	4.04	1.20	4.75	6.18	9.13	13.12	14.28	12.20	14.61	8.49	8.75	4.53
12	4.01	2.26	4.92	7.43	7.86	14.55	14.95	12.05	14.22	8.45	8.38	7.26
13	2.28	2.36	7.05	7.18	8.40	14.15	12.75	12.48	13.33	8.53	7.06	1.08
14	1.48	4.14	7.40	7.09	9.76	13.83	12.73	11.73	12.47	8.20	8.07	4.83
15	6.63	3.55	7.96	8.51	13.13	13.37	13.59	11.74	13.08	10.18	8.02	2.65
16	3.92	2.52	7.90	9.04	12.85	14.52	15.08	12.05	13.23	11.80	7.69	4.19
17	4.24	6.55	7.10	7.46	11.00	16.30	15.13	10.92	13.53	12.37	8.83	9.48
18	2.90	6.36	7.28	7.65	9.15	15.26	16.07	10.18	14.29	13.64	7.91	8.35
19	2.27	8.03	8.55	7.59	10.58	13.17	16.60	9.27	14.90	11.29	8.50	3.85
20	3.29	5.22	5.45	8.38	12.62	12.57	15.38	9.77	12.63	10.37	8.21	5.09
21	4.92	3.30	2.65	11.20	11.15	13.11	15.95	10.93	12.38	7.48	7.43	8.78
22	4.88	5.58	2.10	9.93	9.42	12.79	19.53	9.46	12.68	9.29	8.00	9.10
23	3.05	7.72	3.70	9.96	8.46	13.70	19.07	9.23	11.11	11.00	3.39	6.24
24	6.15	4.94	3.79	8.89	9.70	13.66	19.93	10.62	10.79	7.68	4.15	3.03
25	4.94	4.43	6.65	8.26	10.08	14.36	20.15	11.48	13.90	9.08	5.23	2.17
26	3.08	4.96	5.91	9.56	10.44	13.26	15.34	13.07	11.73	10.85	4.73	1.34
27	4.56	3.81	3.58	10.83	11.83	11.82	13.03	12.12	10.89	13.35	4.10	1.03
28	3.96	2.75	4.18	9.88	13.26	11.62	14.45	13.63	14.26	8.92	7.46	1.62
29	4.13		5.98	12.35	10.32	11.71	13.65	13.39	14.11	5.93	8.37	0.89
30	2.20		8.05	8.83	11.96	13.37	14.50	12.61	14.00	12.40	7.04	3.78
31	2.79		8.80		13.75		13.91	12.64		13.35		7.28

ANNEX D DAILY TEMPERATURE (°C) RECORDED AT CURRAGHINALT IN 2015. BLANK SPACES INDICATE INCOMPLETE OR MISSING DATA.

Air Temperature: 2015 (^{0}C)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	8.85	0.23	2.58	3.53	5.80	5.81	18.39	10.63	10.07	10.85	9.42	7.93
2	3.41	-0.39	0.08	4.90	4.29	7.48	15.01	12.14	9.24	9.41	9.96	7.79
3	3.52	0.10	0.37	6.99	8.74	9.99	15.23	13.94	9.96	8.85	8.07	3.66
4	2.97	0.70	3.64	9.00	8.73	10.22	14.61	12.03	10.62	9.21	7.63	7.12
5	7.69	3.14	6.85	9.85	6.35	10.20	13.42	12.26	10.31	11.30	8.71	10.72
6	4.60	3.45	7.75	9.49	6.78	8.38	12.13	12.30	10.75	13.24	10.15	4.48
7	7.00	5.25	9.77	8.20	5.63	8.59	13.17	11.57	10.90	8.85	8.21	9.19
8	4.20	3.51	5.35	9.30	6.28	7.97	11.10	11.27	12.20	9.14	8.11	6.26
9	8.67	4.45	4.98	9.91	8.98	10.10	10.78	14.34	11.37	11.34	10.69	6.93
10	5.43	2.40	4.41	10.10	11.09	11.50	14.79	12.56	12.97	10.71	12.93	4.10
11	4.65	2.31	4.31	3.63	10.19	12.72	12.75	11.96	12.95	10.63	9.35	2.54
12	4.49	3.46	4.99	4.30	7.69	10.46	12.63	12.34	10.65	7.81	7.41	3.82
13	6.69	4.90	3.28	6.77	7.71	9.46	12.47	14.23	10.23	7.58	3.23	2.04
14	2.03	4.53	2.55	10.17	8.45	9.03	10.87	11.51	11.61	8.04	5.73	7.00
15	2.98	5.06	2.96	7.85	8.37	11.99	10.64	10.44	10.09	7.71	13.10	8.05
16	0.72	2.78	4.11	6.83	7.50	13.62	11.66	12.21	9.22	7.86	5.03	10.91
17	5.67	3.91	4.00	8.45	7.82	11.83	12.35	13.90	10.76	7.55	4.23	11.03
18	3.45	8.25	5.80	7.24	6.10	10.55	11.68	15.58	11.77	8.68	7.22	10.46
19	-1.30	5.00	7.06	7.38	6.13	10.96	12.29	13.00	10.95	8.97	5.73	11.32
20	0.43	1.93	6.84	8.31	7.60	13.45	12.21	14.45	11.90	8.77	2.48	6.65
21	0.53	6.60	6.41	10.31	9.76	9.34	12.00	14.45	10.17	12.36	2.55	5.59
22	1.08	3.51	5.98	10.88	10.92	10.28	11.35	13.14	9.02	9.43	4.07	7.08
23	3.10	6.18	5.30	12.58	11.05	12.09	11.00	13.83	9.67	9.76	4.60	4.92
24	2.51	2.63	2.95	8.19	8.79	14.19	10.04	12.40	8.74	7.15	6.23	4.63
25	6.28	7.12	4.15	5.50	9.45	13.90	10.33	10.29	9.45	6.52	7.59	1.37
26	4.56	5.97	4.74	2.75	8.78	14.43	10.55	11.58	11.41	9.90	9.80	3.80
27	5.43	3.09	4.85	2.16	7.44	13.38	11.95	11.58	11.15	10.90	6.14	3.62
28	2.31	5.99	7.48	3.38	6.79	13.80	10.55	12.14	11.64	9.76	3.24	9.51
29	0.21		4.52	3.87	6.28	13.70	9.93	12.56	11.79	9.00	4.75	6.56
30	3.06		4.45	6.38	7.14	18.51	10.55	12.21	10.85	9.99	1.66	6.14
31	1.73		3.76		6.99		10.63	11.13		11.75		1.90

ANNEX E DAILY TEMPERATURE (°C) RECORDED AT CURRAGHINALT IN 2016. BLANK SPACES INDICATE INCOMPLETE OR MISSING DATA.

Air Temperature: 2016 (^{0}C)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	2.23	7.16	6.30	5.81	9.20	13.95	9.58	13.23	12.08			
2	6.73	3.01	6.82	5.91	7.70	13.81	10.25	14.72	12.91			
3	5.25	3.48	2.67	6.15	7.26	12.42	10.70	13.85	12.68			
4	5.89	8.33	2.81	7.08	8.59	15.18	10.49	13.53	13.91			
5	5.18	5.12	2.74	6.10	8.91	17.08	11.53	12.70	16.68			
6	4.83	3.61	1.52	3.98	7.88	17.94	12.21	15.18	17.95			
7	2.75	3.14	2.65	6.11	8.35	16.29	13.58	13.18	17.19			
8	1.37	4.26	4.27	4.64	12.74	16.55	13.99	12.12	13.91			
9	1.78	2.69	3.75	2.28	17.53	16.20	16.24	10.32	12.55			
10	2.49	2.27	6.40	3.81	15.20	15.58	13.98	11.30	11.18			
11	2.81	1.62	7.89	6.01	14.80	14.85	12.78	14.05	12.68			
12	2.93	2.27	9.17	6.21	15.37	13.83	11.04	14.36	14.90			
13	0.92	2.63	8.43	6.97	13.11	13.00	10.55	12.92	11.28			
14	4.33	1.60	6.49	6.50	8.01	12.95	12.14	13.17				
15	6.80	1.51	6.55	3.38	7.36	12.42	14.80	15.45				
16	2.05	4.15	6.08	2.79	7.93	10.00	12.53	16.08				
17	4.18	1.18	5.45	4.49	9.42	10.19	14.63	14.35				
18	5.36	1.30	4.36	6.62	9.05	10.66	19.19	15.47				
19	4.05	4.13	5.31	7.05	8.61	14.06	18.59	13.88				
20	2.63	4.89	5.88	8.44	10.02	12.49	16.21	14.10				
21	6.48	4.93	5.69	8.52	10.34	12.58	15.73	14.30				
22	8.87	2.53	5.95	7.06	8.22	12.98	14.01	15.43				
23	7.13	2.28	5.61	5.69	8.75	12.33	14.08	13.13				
24	11.79	0.58	5.91	5.79	11.38	11.69	13.28	13.45				
25	8.54	1.46	6.55	4.92	9.11	11.61	12.63	15.21				
26	7.68	2.04	5.65	2.78	8.80	12.05	12.63	12.94				
27	3.84	2.52	4.09	2.27	10.94	11.18	12.38	13.35				
28	4.50	2.20	4.26	2.00	11.60	10.94	13.13	13.74				
29	6.11	4.56	2.54	3.52	13.61	10.64	13.01	12.72				
30	0.54		3.52	5.33	13.11	10.71	11.90	15.66				
31	3.88		4.57		12.21		11.16	12.91				

ANNEX F DAILY RAINFALL TOTALS (MM) RECORDED AT CURRAGHINALT IN 2012. BLANK SPACES INDICATE INCOMPLETE OR MISSING DATA.

Rainfall: 2012 (mm)

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1		0.00	0.00	0.00	0.25	0.51	1.52	11.43	0.00	7.62	3.56	
2		0.00	0.00	2.03	0.00	0.00	2.54	0.00	0.25	8.64	3.30	
3		1.27	2.03	4.57	0.00	0.00	4.57	3.05	0.25	2.03	0.00	
4		7.62	0.25	0.00	3.56	0.00	7.11	0.00	0.00	5.33	1.27	
5		2.03	0.51	0.00	0.00	3.81	0.00	0.00	0.00	2.54	0.51	
6		0.25	2.29	0.25	0.00	22.35	0.25	0.00	0.00	0.25	0.51	
7		0.00	5.33	0.51	14.22	10.67	2.29	1.52	2.54	0.00	1.78	
8		6.10	0.00	1.78	0.25	7.87	1.27	0.00	0.25	0.00	2.79	
9		19.05	1.52	4.83	0.00	2.54	1.78	0.00	4.06	0.00	7.37	
10		0.76	1.27	5.33	11.94	0.00	0.51	0.00	2.79	0.76	0.51	
11	0.76	0.76	0.00	2.03	4.06	0.25	2.03	0.00	8.64	22.86	0.51	
12	0.76	0.00	0.25	0.00	0.00	9.14	0.00	1.02	13.21	1.02	4.83	
13	0.00	0.76	0.00	1.27	1.78	0.25	0.00	14.73	0.51	1.27	5.33	
14	0.00	0.00	0.00	0.25	7.87	9.40	0.00	2.03	1.78	3.81	3.30	
15	0.00	0.25	0.76	0.00	1.27	18.03	1.27	13.97	0.00	0.76	0.25	
16	0.00	0.76	3.56	4.83	2.03	1.52	1.52	8.89	1.52	2.79	3.30	
17	0.00	0.00	0.00	14.73	4.83	1.02	6.35	10.16	11.18	8.38	5.33	
18	0.76	0.51	0.00	2.29	0.00	15.75	12.95	0.25	2.03	19.81	7.37	
19	5.08	1.02	0.51	0.00	0.00	0.25	0.00	0.00	1.52	0.00	10.92	
20	18.29	2.79	0.00	0.00	0.00	0.00	0.00	0.76	8.89	0.00	3.30	
21	1.78	1.02	0.00	5.84	0.00	3.81	0.25	2.79	0.00	0.00	0.00	
22	0.25	10.16	0.00	1.78	0.00	20.07	2.29	8.64	0.00	0.00	9.14	
23	0.25	1.02	4.06	0.00	0.00	5.84	6.60	4.32	0.00	0.00	0.51	
24	4.57	0.51	0.00	4.06	0.00	4.06	1.02	4.06	15.49	0.00	0.00	
25	8.89	0.00	0.00	0.51	0.00	0.00	0.00	0.25	5.84	0.00	0.00	
26	3.30	1.78	0.00	1.27	0.00	1.02	0.00	0.00	1.02	1.27	4.06	
27	6.35	1.02	0.00	0.51	0.00	3.05	1.78	8.13	1.02	1.52	0.51	
28	3.05	0.00	0.00	0.00	0.00	10.41	8.89	0.00	2.79	11.43	1.52	
29	20.32	0.00	0.00	0.00	0.00	4.57	8.89	6.35	1.02	0.25	0.25	
30	1.52		0.00	0.51	0.25	4.06	2.29	0.00	5.84	4.06		
31	0.00		0.00		3.56		13.21	3.30		10.67		

ANNEX G DAILY RAINFALL TOTALS (MM) RECORDED AT CURRAGHINALT IN 2013. BLANK SPACES INDICATE INCOMPLETE OR MISSING DATA.

Rainfall: 2013 (mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	1.27	3.05	0.00	0.00	0.25	1.27	0.25	8.89	0.00	4.06	0.76	0.76
2	0.51	0.00	0.00	0.00	0.00	0.25	12.45	0.25	0.00	8.13	11.68	0.00
3	2.03	6.35	0.00	0.00	6.35	1.02	0.00	1.02	0.00	11.43	0.25	1.27
4	0.00	4.06	0.00	0.00	0.00	0.00	4.83	0.00	0.25	0.51	0.00	0.00
5	6.35	5.59	0.00	0.00	0.25	0.00	0.00	0.00	0.25	0.00	2.03	5.08
6	10.41	0.25	3.30	0.00	0.00	0.00	0.00	0.00	2.79	0.25	1.52	0.00
7	17.27	7.87	6.35	0.00	0.00	0.00	0.25	3.81	7.87	1.02	1.02	0.00
8	2.79	1.27	7.11	0.00	5.59	0.00	0.00	5.08	0.76	0.51	3.30	0.00
9	0.00	4.57	3.81	0.00	13.72	0.00	0.00	0.25	1.02	1.52	3.30	0.00
10	0.00	23.62	0.51	0.00	5.59	0.00	0.00	1.78	0.25	0.00	1.27	0.00
11	0.76	0.76	0.25	4.57	8.13	11.68	0.00	2.79	1.27	0.00	2.79	0.00
12	0.00	0.51	0.00	0.00	4.06	2.29	0.00	3.05	3.81	0.00	1.78	0.00
13	3.30	21.34	0.00	3.56	7.37	7.11	0.00	1.02	0.00	0.00	3.05	0.00
14	7.37	2.29	6.35	10.92	2.03	16.00	0.00	3.56	0.00	0.00	2.79	0.00
15	0.00	0.51	4.83	10.92	4.06	13.72	0.00	5.08	9.91	0.00	0.00	0.00
16	7.87	0.25	0.00	5.59	1.02	0.00	0.00	0.00	6.60	14.22	0.00	0.00
17	2.79	0.00	4.06	20.07	0.51	1.02	0.00	2.79	2.29	0.25	1.52	0.00
18	12.45	0.00	1.27	5.08	13.46	0.00	0.00	1.27	0.76	9.65	1.02	0.00
19	1.27	0.00	0.00	0.25	0.00	0.00	0.00	0.51	9.14	2.29	5.08	0.00
20	0.00	0.00	4.06	0.00	0.00	0.51	0.00	1.02	0.00	2.54	7.11	0.00
21	0.25	0.00	0.76	3.81	0.00	2.54	0.00	0.76	0.00	6.10	0.00	0.00
22	1.27	0.00	10.67	0.25	0.51	12.70	0.00	0.00	0.00	2.54	0.00	0.00
23	0.00	0.00	0.76	0.00	1.52	11.68	1.52	3.30	0.00	2.03	0.51	0.00
24	0.25	0.00	0.00	5.59	0.25	0.25	2.79	0.51	0.00	0.00	0.51	0.00
25	23.37	0.00	0.00	6.10	0.25	0.00	4.57	0.00	0.76	14.22	0.51	0.00
26	8.64	0.00	0.00	3.05	1.02	0.00	0.00	0.00	0.25	5.84	0.25	0.00
27	10.16	0.00	0.00	0.00	19.81	8.13	4.57	0.00	0.00	5.33	0.25	0.00
28	7.11	0.00	0.00	2.54	0.00	1.27	1.78	0.00	0.00	3.05	1.02	0.00
29	4.57		0.00	0.76	0.25	0.51	3.30	0.51	0.00	3.30	1.52	0.00
30	8.13		0.00	42.16	0.00	1.78	5.08	0.25	0.00	5.33	1.02	0.00
31	10.92		0.00		0.25		7.62	0.00		5.59		0.00

ANNEX H DAILY RAINFALL TOTALS (MM) RECORDED AT CURRAGHINALT IN 2014. BLANK SPACES INDICATE INCOMPLETE OR MISSING DATA.

Rainfall: 2014 (mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0.00	10.16	7.37	9.14	8.13	2.54	0.00	2.29	0.00	0.25	4.06	2.03
2	0.00	2.79	4.32	5.59	0.00	0.25	2.03	12.19	0.00	0.00	0.25	0.25
3	0.00	7.11	2.54	8.38	0.76	1.02	0.00	4.57	0.00	4.57	9.14	0.00
4	0.00	3.30	0.76	0.00	1.02	8.13	5.84	0.00	0.00	0.00	5.59	1.02
5	0.00	14.22	0.25	6.60	5.08	1.02	1.52	37.08	0.25	3.56	2.29	1.27
6	0.00	1.02	11.68	2.29	3.05	0.00	0.76	2.79	0.00	12.95	54.86	5.33
7	0.00	5.84	1.02	2.79	5.08	12.45	1.78	9.14	0.00	0.51	2.54	3.56
8	0.00	4.83	1.27	0.51	2.29	5.08	8.13	2.29	0.00	7.62	0.00	4.06
9	0.00	5.08	3.05	0.00	4.57	17.02	0.00	0.25	0.00	0.76	0.00	9.14
10	0.51	1.78	0.00	0.25	20.83	5.59	2.03	9.40	0.00	0.00	8.13	7.11
11	3.05	2.79	0.00	0.00	0.76	0.00	0.00	10.67	0.00	0.51	16.00	4.32
12	9.40	19.81	0.00	0.76	2.29	0.00	7.11	2.54	0.00	0.00	6.35	3.30
13	0.00	3.56	0.00	0.25	0.51	2.29	0.00	1.78	0.00	0.00	22.10	0.25
14	5.33	15.24	0.00	0.00	0.00	0.51	9.14	0.25	0.00	0.00	27.18	2.29
15	6.60	2.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.10	6.35	0.51
16	3.05	0.25	0.00	0.00	0.00	0.00	4.83	1.02	0.00	3.30	0.00	13.21
17	0.51	16.26	0.25	0.76	3.56	0.00	0.00	5.08	0.00	10.67	0.76	0.00
18	3.81	4.06	5.84	0.00	15.24	0.00	0.00	1.78	0.00	5.59	0.00	3.56
19	0.51	7.11	0.25	0.00	1.52	0.00	0.00	1.02	0.00	4.32	0.00	2.03
20	0.00	13.72	17.02	0.00	0.25	0.00	0.00	0.25	0.00	5.59	1.02	1.02
21	4.32	6.10	5.59	0.00	0.00	0.00	0.00	1.78	0.00	9.40	7.37	3.56
22	2.79	2.79	2.29	0.51	0.00	0.00	0.00	0.00	0.00	0.51	5.84	18.29
23	2.03	5.08	1.27	2.79	0.51	0.76	0.00	0.25	3.56	2.54	0.00	15.75
24	13.21	4.06	2.03	1.02	0.00	0.00	0.00	0.00	0.51	0.51	0.00	2.29
25	8.38	3.56	2.54	0.00	0.25	3.56	0.00	7.87	0.51	0.25	0.25	0.00
26	16.00	6.10	0.51	3.30	2.29	6.60	1.02	0.00	0.00	1.02	0.00	3.81
27	13.46	7.11	0.25	0.00	0.25	1.78	15.49	3.05	0.25	6.10	0.25	1.78
28	2.54	0.00	1.78	0.25	0.00	0.00	2.03	11.18	0.00	27.69	0.00	0.25
29	3.30		1.27	0.00	0.00	0.00	1.02	10.67	4.57	0.00	0.25	0.00
30	0.00		1.02	0.25	0.00	0.00	1.02	9.14	2.54	3.30	0.25	0.00
31	13.46		0.00		0.00		4.06	1.27		4.57		4.57

ANNEX I DAILY RAINFALL TOTALS (MM) RECORDED AT CURRAGHINALT IN 2015. BLANK SPACES INDICATE INCOMPLETE OR MISSING DATA.

Rainfall: 2015 (mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	15.49	0.00	1.02	6.86	0.00	10.41	0.00	0.00	1.78	0.00	0.00	8.38
2	1.27	0.00	0.76	3.81	9.40	0.00	0.00	1.78	0.76	0.00	0.25	4.83
3	4.83	0.00	2.03	6.10	28.96	0.00	0.00	5.59	0.25	0.00	0.00	0.51
4	0.25	0.00	0.25	0.00	0.00	0.00	7.87	12.45	0.00	0.00	0.00	8.13
5	0.00	0.25	0.00	0.00	17.02	7.37	0.00	20.32	0.00	4.83	3.81	38.86
6	4.57	0.00	0.00	0.00	2.54	6.35	5.84	0.00	0.00	0.25	1.27	12.19
7	11.18	0.00	3.56	0.00	0.51	0.00	10.67	0.00	0.00	0.00	4.83	3.05
8	4.83	0.00	5.59	0.00	1.27	0.00	0.51	0.25	0.00	0.51	4.06	1.52
9	7.11	0.00	7.11	0.00	0.25	0.00	6.60	0.00	0.00	0.00	8.38	15.75
10	4.32	0.00	0.25	0.00	11.18	0.00	1.52	7.11	0.00	0.00	6.60	2.03
11	1.78	0.00	6.86	6.35	2.29	0.00	8.38	0.76	11.18	0.25	3.30	5.84
12	9.65	0.00	9.14	7.11	2.29	0.00	0.51	0.00	6.86	0.00	2.29	8.89
13	1.27	11.68	0.00	1.02	0.00	0.00	8.64	0.00	2.29	0.00	7.62	2.29
14	12.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	21.59	2.54
15	11.94	20.32	0.00	1.27	0.51	0.00	0.00	1.02	0.00	0.00	26.92	4.06
16	2.29	2.03	0.00	0.00	0.00	0.00	4.83	3.56	0.00	0.00	4.83	0.51
17	1.78	0.00	0.00	0.00	0.51	2.54	2.54	5.84	8.38	0.00	11.43	5.59
18	2.54	1.78	0.00	0.00	7.62	0.00	9.40	0.00	0.00	0.00	9.40	4.32
19	0.00	3.30	0.00	0.00	8.89	6.60	4.83	10.41	0.25	0.00	0.51	3.56
20	3.30	2.03	0.00	0.51	1.02	1.52	8.89	1.27	4.83	10.16	3.05	0.76
21	1.02	2.54	0.00	0.00	0.00	3.81	1.78	3.56	3.30	0.51	1.78	4.83
22	0.25	13.46	0.00	0.00	0.00	0.25	0.00	0.00	0.25	0.25	2.79	10.67
23	4.57	3.81	0.25	0.00	1.02	0.00	2.03	37.34	1.27	2.54	2.54	1.27
24	0.51	6.10	3.56	0.00	0.76	0.00	1.78	0.25	7.11	16.26	4.83	13.72
25	3.30	2.29	4.57	2.79	0.00	2.54	0.00	3.56	0.25	0.00	0.76	3.56
26	0.00	6.10	12.95	0.76	0.00	2.29	16.76	5.08	0.00	3.05	0.51	2.03
27	0.25	1.52	0.00	3.05	6.10	0.00	12.45	7.11	0.00	10.41	8.38	0.51
28	3.30	14.99	16.51	6.35	2.29	10.41	6.35	1.02	0.00	0.25	14.99	28.19
29	5.59		2.54	5.33	6.35	0.76	0.76	0.76	0.00	7.37	16.51	6.86
30	5.59		13.46	0.25	10.41	0.00	0.76	0.00	0.00	0.51	10.92	18.29
31	1.52		3.56		5.33		4.83	0.00		0.51		9.14

ANNEX J DAILY RAINFALL TOTALS (MM) RECORDED AT CURRAGHINALT IN 2016. BLANK SPACES INDICATE INCOMPLETE OR MISSING DATA.

Rainfall: 2016 (mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	7.11	1.78	8.38	17.27	4.32	0.00	2.79	0.76	3.81			
2	8.38	3.05	5.33	4.32	6.35	0.00	6.60	4.57	1.78			
3	10.67	8.64	7.11	10.41	0.00	0.00	0.00	6.86	5.33			
4	7.62	2.54	0.76	2.54	0.00	0.00	7.37	3.05	4.06			
5	1.27	4.32	2.54	0.76	0.00	0.00	0.00	0.25	6.60			
6	2.79	2.79	0.00	7.62	0.00	1.27	5.84	0.76	3.05			
7	14.73	9.14	2.03	3.81	3.56	3.81	0.51	3.05	1.27			
8	0.00	6.86	4.32	3.56	1.52	0.00	0.76	0.76	13.21			
9	3.05	3.81	2.79	0.00	0.00	0.00	3.30	1.02	9.91			
10	0.00	1.78	1.02	0.00	0.00	9.65	2.54	5.59	0.25			
11	2.79	0.00	4.32	0.76	0.00	28.45	2.54	2.54	0.00			
12	19.56	1.27	1.52	2.29	0.00	10.92	0.25	0.25	7.87			
13	0.00	3.30	0.00	0.51	0.00	11.94	12.45	0.00	3.81			
14	0.76	0.00	0.00	0.00	0.00	3.56	0.25	0.51				
15	4.57	0.25	0.00	0.51	0.00	1.78	14.48	0.00				
16	2.54	12.19	0.00	0.25	0.00	0.51	0.00	0.00				
17	3.81	4.32	0.00	0.00	4.57	0.00	0.00	4.32				
18	5.59	0.76	0.00	1.02	0.51	0.25	0.00	0.25				
19	0.00	1.02	0.00	0.00	5.84	10.41	0.00	13.72				
20	0.00	3.30	0.00	0.00	7.62	0.76	0.00	1.52				
21	6.60	3.30	0.00	0.00	15.75	1.27	2.79	8.13				
22	12.45	4.06	0.00	0.00	4.32	0.51	0.25	0.25				
23	5.08	0.25	0.25	0.00	1.02	11.68	0.00	11.68				
24	2.03	0.00	5.33	0.00	0.00	7.37	4.06	0.00				
25	1.52	0.00	1.27	0.51	0.00	0.00	1.02	5.59				
26	13.97	3.81	16.26	1.52	1.02	2.79	7.62	0.51				
27	9.14	0.00	1.27	0.51	0.00	0.51	0.25	0.00				
28	10.16	0.00	0.76	1.78	0.00	0.51	15.49	0.00				
29	7.37	12.45	3.56	0.51	0.00	13.46	0.00	0.00				
30	0.00		1.27	1.52	0.00	3.81	0.25	0.00				
31	9.65		0.00		0.00		1.78	1.78				