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Appendix 10-3 – WFD Compliance Assessment – Lough Conn

Uisce Éireann

October 2026

BALLINA AND LOUGH TALT WATER SUPPLY UPGRADE

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Summary

In setting out to appraise the risk to Water Framework Directive (WFD) compliance of increasing abstraction (for both domestic and non-domestic use) from Lough Conn, this report brings together existing hydrological information that is currently available to assess the likely change to lough water level, downstream river flows and water quality. Lough Conn is a substantial water resource and based on the assessment subject to this report, we conclude that the risk to WFD compliance caused by the proposed increased abstraction is very low and no further investigation would be required. The existing Wherrew RWI&PS abstracts raw water and transfers to two WTPs, Wherrew WTP and Lisglennon WTP in accordance with the existing abstraction licence (Reference No. R00651-02).

There is a need to increase abstraction from Lough Conn to 38,120 m^3/day in response to increased future demand in the Ballina Water Resource Zone (WRZ) area and to allow for extension of Ballina WRZ to he current Lough Talt WRZ. Therefore, 40,000m^3/day is the upper limit of modelling used in this report. The current Lough Talt source is no longer sustainable as during periods of extended dry weather, water levels can decrease, which impacts the Lough Hoe Bog Special Area of Conservation (SAC), potentially endangering the qualifying feature, Geyer's whorl snail (*Vertigo geyeri*).

Lough Conn is located in the Moy catchment in north County Mayo. It is connected to Lough Cullin to the south by a narrow channel that passes under a regional road at Pontoon. As the water bodies are considered to have a strong hydrological linkage, Lough Conn and Lough Cullin are considered as a single body of water for the purpose of this assessment. The water bodies have a single outflow (approximately 1 km in length) that joins the River Moy upstream of the village of Foxford. The waterbodies associated with the proposed change in abstraction are located within the Moy and Killala Bay catchment (WFD catchment 34) and are associated with the River Moy SAC and the Lough Conn and Lough Cullin Special Protected Area (SPA). Most of Lough Conn and the River Moy is underlain by the Ballina groundwater body (GWB) with Lough Cullin associated with the Foxford GWB. Owing to the poor productivity of the aquifers in this body it is unlikely that any major groundwater-surface water interactions occur between the lakes and the GWBs, except for localised limestone karst features that exist in the vicinity of Crossmolina.

Screening identified a total of three (3) WFD water bodies to consider as part of any WFD compliance assessment. This included Lough Conn (IE_WE_34_406b), Lough Cullin (IE_WE_34_406a) and the Moy_100 (IE_WE_34M020800). For each of these water bodies, the following impact pathways were identified: changes in flow, and / or water level, changes in water quality and water quality processes, loss of habitat and changes in barrier porosity.

To determine the potential impacts on the hydrology and subsequently the WFD compliance risk, a phased approach has been adopted. This phased approach allows for an initial analysis of the potential environmental impacts associated with the change in abstraction at Lough Conn to determine the need for and the scope of any detailed modelling, monitoring and hydrological analyses given the understanding of risk at each phase. This report provides the outcomes of this Phase 1 assessment (initial hydrological assessment). The assessment considered the following scenario:

An increase in abstraction to 40,000 m^3/day The Water Environment (Abstractions and Associated Impoundments) Act 2022 (as amended) ensures that water abstractions and associated impoundments comply with the EU WFD. The act has been fully enacted and implemented by the EPA since August 2024. The risk-based regulation categorises abstractions into three bands based on the volume of water abstracted in one day. As the proposed abstractions exceed 2,000 m^3/day (2 MLD) they fall within Band 3 and require a full hydrological assessment. Therefore, environmental flow standards, outlined in EPA's Water Abstractions and Associated Impoundments Guidance (2025), are applied to set allowable flow reductions for waterbodies across High, Good, Moderate and Poor

status categories, in order to assess whether abstractions could risk failure of WFD objectives. It should be noted that Lough Conn, Lough Cullin and the River Moy do not have a “High” status objective under the WFD.

To determine the risk to compliance with the proposed standards, the hydrological assessment approach considered Uisce Éireann’s Technical Guidance for Hydrological Estimation. This guidance sets out methods for undertaking flow estimates (including deriving river flow duration curves) for gauged and ungauged catchments and the appropriate reporting and documentation required in preparation of a flow estimate. Three separate approaches have been used to assess the impact of the proposed increased abstraction on downstream river flow, namely (1) the Environmental Protection Agency (EPA) HydroTool, (2) direct flow measurement and (3) donor transfer with lough routing. These approaches considered the scenario noted above. Use of differing approaches allows the sensitivity of WFD compliance thresholds to flow estimation methods to be understood and adds confidence to the overall results as outputs from individual approaches align. The routing model that was developed also provided a means to estimate the impact of an increased abstraction on the lough level regime. The flow and level estimates derived from these approaches were subsequently used for an initial impact assessment in view of the compliance as identified above.

The geology of the Lough Conn catchment is complex and consequently it is thought that rainfall-runoff response could vary substantially on a sub catchment basis. This has not been explored in this phase of the project. Instead, inflows have been estimated using donor transfer methods to generate a variety of plausible inflows and examine the impact of the potential abstraction increases under the above hydrological scenario. As above, this allows the sensitivity of WFD compliance thresholds to hydrological assumptions be understood and adds confidence to the overall results.

The routing model used in this assessment showed good agreement with the observed water level regime. It is also noticeable that the concave upward shape of some optimised rating curves (exponents smaller or equal to 1) suggest that water could be impeded from leaving Lough Cullin by high water levels in the Moy as anecdotal accounts suggest. Once calibration was completed, the routing model was re-run with zero abstraction and the proposed increased abstraction volumes over the same period of record used for calibration. This resulted in a set of naturalised, existing, and proposed outflow and water level data sets, which were used to estimate the impact of altered abstraction on the downstream flow and level regimes, relative to WFD standards.

The results of the hydrological assessment from the three separate approaches showed that flow standards at the outflow of Lough Cullin would typically achieve the standards for ‘high’ or ‘good’ WFD status depending on the flow estimation method applied following an increase in abstraction (both domestic alone and domestic and non-domestic increases combined). One of the flow estimates derived from the lough routing approach suggested a marginal failure of ‘good’ flow standards for the abstraction scenario considered. However, we do not believe this would be material in respect of the overall waterbody status given the very marginal nature of the failure and its limited spatial extent (i.e. the approx. 1 km reach between the Lough Cullin outfall and the confluence with the River Moy).

To give context to the size of the proposed domestic abstraction relative to the water stored in Lough Conn/Cullin it is useful to consider the depth of water that is equivalent to a 40,000 m^3/day abstraction. Given a total lough area of 54.1 km^2, an abstraction of 40,000 m^3/day is the equivalent to 0.7 mm over a 24-hour period of water depth from the two loughs assuming vertical sides. It therefore appears that changes in level due to the proposed abstraction increase will be very small relative to the existing level regime. For context, evaporative losses, which in summer can exceed 200,000 m^3/day (corresponding to around 4 mm/day of lake level reduction), which is more than 5 times the proposed abstraction rate of 40,000 m^3/day.

The lough routing approach shows that the change in level caused by increased abstraction in Loughs Conn and Cullin would be very small compared to their existing level regime. Changes in water level are estimated to typically fall between 11 and 31 mm for the change in abstraction. Furthermore, the increased abstraction would not exceed 10% of the natural Q50 outflow, which is the EPA-recommended threshold for lake risk assessment.

For the purpose of the WFD compliance assessment, water quality determinand data were also assessed against WFD classification standards used by the EPA in Ireland WFD classification standards used by the EPA in Ireland. Ten years' worth of data were reviewed and all determinands were identified as achieving at least 'good' WFD status in all waterbodies. Impacts on water quality as a result of this scheme are considered negligible.

In view of the potential impacts on lake levels and river flows its was concluded that the change in abstraction regime will not result in a deterioration in existing status of any of the WFD water bodies and will also not prevent the water bodies from attaining 'good' status where not currently achieved. Furthermore, the limited change in water level in both Lough Conn and Lough Cullin and flow within the River Moy will not result in any impacts on the designated habitats and species of the River Moy SAC or the habitats that support the designated bird communities of the Lough Conn and Lough Cullin SPA.

It is noted that some residual uncertainties have been identified in view of the available data. This includes:

- Limited gauged data available for the Lough Conn and Lough Cullin inflows.
- Limited information around the depth of the control at the outflow from Lough Cullin, its hydraulic characteristics, and the impact of high-water levels in the River Moy on outflows from the Lough Cullin catchment.
- Lack of a comprehensive bathymetry survey for both loughs.
- Uncertainties may exist within the climate data used within the lough routing model, particularly open water evaporation.

Despite these residual uncertainties, it does not follow that the overall conclusions of this assessment are uncertain. The methods applied have assessed WFD compliance using a range of methods, and in the case of the lough routing approach, streamflow from four donor catchments were applied. In nearly all assessment methods, the change in river flow and lake levels caused by increased abstraction result in "Good" or "High" standards, with the exception of some marginal failure of "Good" standards at Q95. We do not to believe these deviations to be material in relation to overall water body status given the much higher uncertainty inherent in Q95 estimation. The estimated change in water level caused by additional abstraction (both domestic and domestic and non-domestic combined) is very small compared to the existing level regime and is consistent in magnitude for a range of inflows applied in the routing model.

Several actions that could be taken to improve the understanding of Lough Conn and Lough Cullin have been identified should Uisce Éireann continue with the subsequent phases of the project. These actions would result in a significant increase in the understanding of the Lough Conn/Cullin catchments but would also require a substantial amount of time and effort to complete. This is especially so of spot gauging activities needed to refine rating curves which could take several years to fully evolve. Despite the increase in hydrological understanding, it is likely that a subsequent detailed impact assessment in phase four would yield very similar results for the above scenario considered to that which is presented in this report.

We would not anticipate the range or magnitude of hydrological impacts on river flow and lough level to be substantially different to those established in phase one. For this reason, our recommendation is that further hydrological impact assessment work in phase 2, 3 and 4 is not pursued given the low risks of the proposal to WFD compliance..

INTRODUCTION

1. Introduction

1.1 Background

This report assesses in detail the effect of the increased abstraction on the hydrology of Lough Conn and associated habitats and water bodies and the resulting implications for compliance with the Water Framework Directive (WFD). The existing abstraction at Lough Conn is licenced and supplies Uisce Éireann's Ballina Water Resource Zone (WRZ) via a single abstraction point on the northern side of the lough which feeds Lisglennon Water Treatment Plant (WTP) and Wherrew WTP. The current hydrological yield is estimated at 559,230 m^3/day[1]. Lough Conn is hydrologically linked to Lough Cullin and the River Moy. There is a need to increase abstraction from Lough Conn to ~ 40,000 m^3/day. The potential changes in abstraction licence are related to the following:

- The replacement of the Lough Talt source, which currently supplies the Lough Talt RWS area. The current Lough Talt source is no longer sustainable as during periods of extended dry weather, water levels can decrease, which impacts the Lough Hoe Bog Special Area of Conservation (SAC), potentially endangering the qualifying feature, Geyer's whorl snail (*Vertigo geyeri*).
- Tourism, non-domestic growth and population growth is expected to increase demand in the Ballina WRZ requiring a potential increase in abstraction from Lough Conn.
- Rationalisation of the supply network within the Easkey Regional Water Supply Scheme (RWSS) is also required to address a potential deficit by 2044.

The Water Environment (Abstractions and Associated Impoundments) Act 2022 aims to align abstraction licencing with the requirements of the WFD. As such, any new abstraction or changes in existing abstraction should consider the risk to WFD compliance. A key component of the WFD compliance assessment is a review of the permitted abstraction as defined by relevant standards for achieving "Good" ecological status for river flows and/or lake levels.

To determine the potential impacts of increased abstraction on the hydrology and subsequently the WFD compliance risk, a phased/risk-based approach has been proposed. This phased approach consists of four (4) phases, the first of which (Phase 1) is an initial hydrological assessment of the change in abstraction at Lough Conn (including both future domestic and non-domestic increase in demand).

1.2 Source under investigation

As noted above, there are two WTPs associated with Lough Conn with a single abstraction point used for raw water abstraction to both plants. Details regarding the sources are presented in Table 1-1.

[1] As identified in the Water Available For Use (WAFU) for Uisce Éireann's National Water Resource Plan and assumed abstraction will be limited to 10% of the Q50 of the inflow for Lough Conn.

It is noted that existing maintenance issues at the intake (noted Table 1-1) will also need to be addressed as part of any proposals to increase abstraction from Lough Conn to assess the impacts associated with outages to accommodate manual silt removal and to improve the interface with the lakeshore. As Lough Conn forms part of the Lough Conn and Lough Cullin Special Protected Area (SPA) and the River Moy SAC, the maintenance works may require a range of mitigation measures to be put in place which consequently require planning permission. Any works required to address the maintenance issues are **not** subject to this assessment report but will need to be considered as part of the wider assessments (e.g. the EIA).

Table 1-1 – Summary of abstraction sources subject to this investigation

Name	Scheme	Coordinates*	Volumes	Notes
Wherrew	Ballina Water Resource Zone (Lisglennon WSZ, Ballina Town Mixed WSZ)	517368, 816742	4,550 m^3/day	• Silt/mud can accumulate in the intake channel and structures, which needs to be manually removed at intervals. • Timber, weeds, litter, and other debris can also build up at the intake and require manual removal. • Desilting within and at the mouth of the intake channel is necessary as required to remove deposited sand depending on occurrence of storms in the previous years.
Lisglennon	Ballina Water Resource Zone (Lisglennon WSZ, Ballina Town Mixed WSZ)	517368, 816742	9,100 m^3/day	• Water is pumped from Wherrew Raw Water Pump Station to Lisglennon Raw Water Pump Station. • The pumps have typically been operated during night hours to provide required volumes of raw water to the raw water storage tank and pump station near Lisglennon WTP.

** Irish Transverse Mercator (ITM) coordinates*

In addition to the abstraction noted in Table 1-1, a Group Water Scheme (GWS) abstraction is also located on the south-east of the lough (ITM coordinates: X - 522789, Y - 805960). There are 234 connections associated with this abstraction with an average daily demand of 150 m^3/day (0.15 MLD). This GWS abstraction has not been considered significant and has not been included in the WFD compliance assessment.

This assessment considers an increase in abstraction to 40,000 m^3/day. Notably, given the uncertainty in future demand, abstraction volumes have been rounded to the upper boundary of existing and expected future demand, thus providing a precautionary approach to impact assessment.

1.3 Purpose of this report

This report provides the outcomes of this Phase 1 assessment (initial hydrological assessment of the change in abstraction at Lough Conn, including both future domestic and non-domestic increase in demand) and includes the following sections in addition to this (introductory) section:

- **Section 2**: includes a summary of the characteristics the catchments associated with the water bodies under investigation.
- **Section 3**: includes a summary of the approach and details regarding the data used in the initial hydrological assessment and a WFD compliance risk.
- **Section 4**: Provides the outcomes of the initial hydrological assessment and the WFD compliance risk assessment.
- **Section 5**: Provides a summary of the conclusion of the assessment and recommendations regarding further monitoring, modelling and assessment (where required).

CATCHMENT CHARACTERISATION

2. Catchment characteristics

2.1 General description

Lough Conn is located in the Moy catchment in north County Mayo. It is connected to Lough Cullin to the south by a narrow channel that passes under a regional road at Pontoon village. There is no evidence of any hinderance to flow between Lough Conn and Lough Cullin. As such, there is an assumption that there is a strong hydrological link between these two water bodies (also confirmed based on available level data in Section 3.2.2.3.3). Lough Conn does not have any other outfall, other than into Lough Cullin and we assume that neither lough has significant losses to groundwater. As the waterbodies are considered to have a strong hydrological linkage, the catchments for both waterbodies are considered pertinent to this assessment. For these reasons, Lough Conn and Lough Cullin are considered as a single body of water for the purpose of this assessment. The Study Area is presented in Figure 2-1.

Current land use in the area surrounding the proposed works is comprised of mainly agricultural fields, local and regional roads with some dwellings along the roads. Much of the grassland is unimproved but improved grassland and silage fields are also present. Afforestation has occurred in the past around the shores of Loughs Conn and Cullin. Forestry is also present along many of the tributaries and in particular along the headwaters of the Deel. Drainage of the Moy in the 1960s lowered the level of the lakes, exposing wide areas of stony shoreline and wet grassland, which are liable to flooding in winter. This increased the habitat diversity of the shoreline and created a number of marginal wetlands, including fens and marshes which are not protected[2].

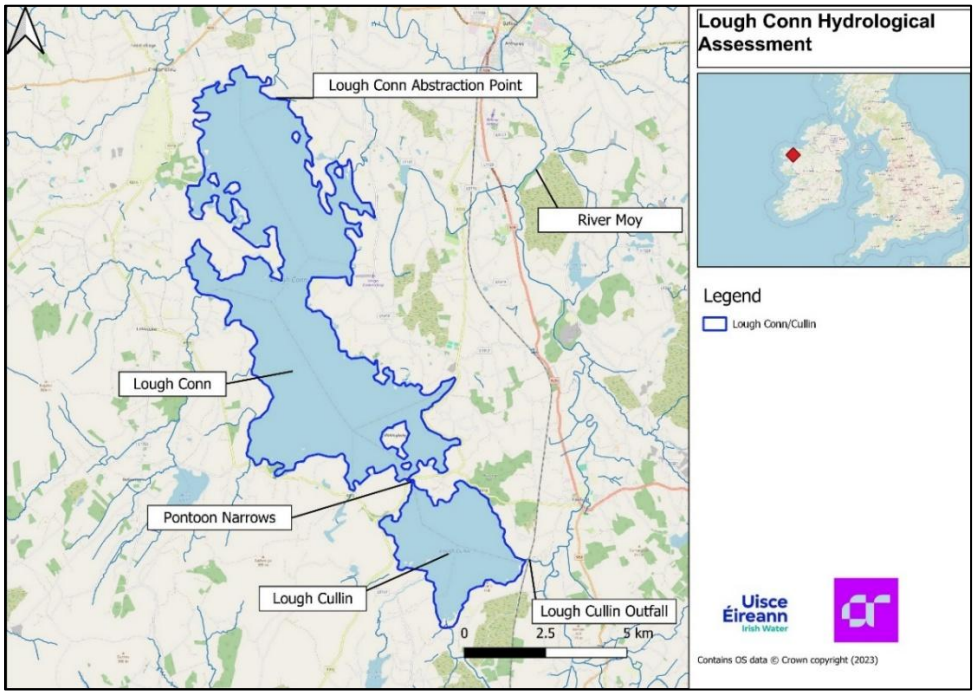


Figure 2-1 – Study Area overview

[2] https://www.npws.ie/sites/default/files/protected-sites/synopsis/SY002298.pdf

2.2 Water Framework Directive overview

The waterbodies associated with the proposed change in abstraction are located within the Moy and Killala Bay catchment (WFD catchment 34) (see Figure 2-2). The WFD catchment includes the area drained by the River Moy and all streams entering tidal water in Killala Bay between Benwee Head, County Mayo and Lenadoon Point, County Sligo, draining a total area of 2,345 km². The largest urban centre in the catchment is Castlebar. The other main urban centres in this catchment are Ballina, Tubbercurry, Kiltimagh, Swinford, Foxford, Enniscrone and Crossmolina. The total population of the catchment is approximately 77,262 with a population density of 33 people per km². The lowland parts of the catchment are underlain by various types of limestones while the upland areas from the Ox Mountains and Croaghmoyle are underlain by a band of igneous and metamorphic rocks. Much of the lowland area south of Lough Conn exhibits a drumlin topography. There are extensive sand and gravel aquifers lying between Swinford and Charlestown to as far south as Knock, to the east of Ballina and southwest of Crossmolina.

A total of 24 river water bodies has been identified as candidate Heavily Modified Water Bodies (HMWB). However, these designations are associated with arterial drainage within the Moy and Killala Bay catchment and are not relevant to public water supply[3]. Lough Conn (WFD water body ID: IE_WE_34_406b) and Lough Cullin (WFD water body ID: IE_WE_34_406a) are located within WFD sub-catchment Moy_SC_080. Based on the 2019-2024 data, the WFD risk for Lough Conn is classified as “Review” (noting that it returned to “Good” ecological status) with a downward trend in phosphate concentrations in recent years. Lough Cullin was considered “At Risk” as it returned to “Moderate” ecological status. Nutrient concentrations appear low in Lough Cullin, however, Environment Protection Agency (EPA) biologists determined that the presence of zebra mussels (*Dreissena polymorpha*) could be keeping phosphate and chlorophyll concentrations artificially low. The need for a detailed investigation, focusing on inputting river water bodies, agriculture and urban wastewater, was identified in River Basin Management Plan (RBMP) 2022. Other pressures identified include urban wastewater as well as agriculture. Abstraction has not been identified as a significant pressure in any of the assessed water bodies.

The downstream WFD water body is the River Moy (WFD water body ID: IE_WE_34M020800 and WFD water body ID: IE_WE_34M020850). The River Moy immediately downstream of Lough Cullin is in a “Moderate” ecological status, with the River Moy downstream of Foxford also considered in a “Moderate” ecological status based on 2019-2024 data.

2.3 Designated/protected sites and species

Both Lough Conn and Lough Cullin and the River Moy form part of the River Moy SAC (see Figure 2-2). The SAC was selected for the following habitats and species: Lowland Hay Meadows, Raised Bog (Active), Degraded Raised Bog, Rhynchosporion Vegetation, Alkaline Fens, Old Oak Woodlands, Alluvial Forests, white-clawed crayfish (*Austropotamobius pallipes*), sea lamprey (*Petromyzon marinus*) [1096] Brook Lamprey (*Lampetra planeri*), Atlantic salmon (*Salmo salar*) and otter (*Lutra lutra*). The Arctic char (*Salvelinus alpinus*), an interesting relict species from the last ice age has been recorded

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Cycle3-HMWB-candidates_Final.xlsx
https://www.npws.ie/sites/default/files/protected-sites/synopsis/SY002298.pdfCycle

from Lough Conn and in only a few other lakes in Ireland. The latest data suggests that it may now have disappeared from the site[4].

The loughs are also listed as a SPA under the EU Birds Directive (see Figure 2-2) and are considered of special conservation interest for the following species: Greenland white-fronted goose (*Anser albifrons flavirostris*), tufted duck (*Aythya fuligula*), common scoter (*Melanitta nigra*) and common gull (*Larus canus*). Lough Conn and Lough Cullin is of importance for wintering waterfowl and is also considered a breeding site for common and black-headed gull (*Chroicocephalus ridibundus*). The EU Birds Directive pays particular attention to wetlands and, as these form part of this SPA, the site and its associated waterbirds are of special conservation interest for Wetland & Waterbirds.

Other designations include:

- Lough Conn is designated as a drinking water body under the European Communities (Drinking Water) (No. 2) Regulations 2007 (SI no. 278/2007).
- Lough Conn is also protected as a WFD drinking water lake as defined under Article 7 of the WFD.
- The River Moy is designated as a salmonid watercourse under the European Communities (Quality of Salmonid Waters) Regulations, 1988.
- One abstraction (Sraheen, Foxford) is protected under the National Federation of Group Water Schemes (NFGWS)

[4] Inland Fisheries Ireland (2023) Appropriate Assessment – Screening. Fisheries Stock Management Plan (2023) for Loughs Conn and Cullin. Co. Mayo, Ireland. https://www.fisheriesireland.ie/sites/default/files/2023-02/l.conn_cullin_stock_management_aa_screening2023.pdf

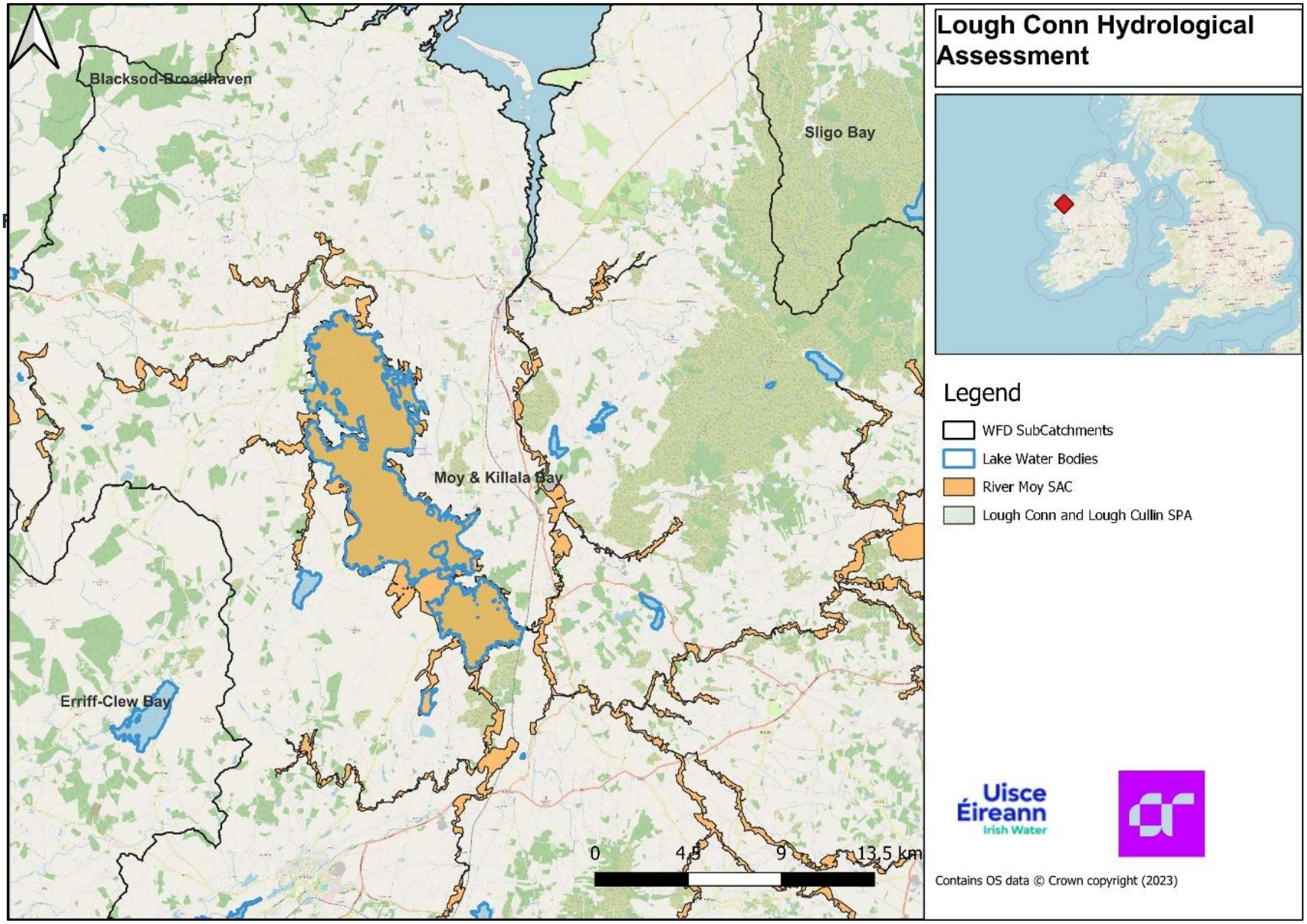


Figure 2-2 – Map showing the WFD Sub catchments and the extent of the SAC and SPA habitats

2.4 Hydrological characteristics

The total catchment area for Lough Conn and Lough Cullin is 819.38 km^2 (including the area of open water). The catchment characteristics are summarised in Table 2-1. The main watercourse draining into Lough Conn is the River Deel which has a total catchment of 233.88 km^2 and drains the catchment to the North of Lough Conn. The main watercourse draining the west of the catchment is the River Addergate with a catchment of 40.8 km^2. (see Figure 2-3). Limestone Karst features are present in the northwest catchment, between Crossmolina and Castlehill. The southern catchment mostly drains into Lough Cullin and includes the River Clydagh which has a catchment of approximately 355 km^2. The outflow of Lough Cullin drains into the River Moy upstream of the village of Foxford (Figure 2-4).

Table 2-1 – Summary of catchment characteristics

Catchment	Catchment area (km^2)	Standard Annual average Rainfall (mm/yr)	Potential Evaporation (mm/yr)	Baseflow Index Soils (BFISOIL)	Flood Attenuation by Reservoirs and Lakes (FARL)	Drainage Density km/km^2	Slope m/km
Lough Cullin Outflow	819.38	1419	530	0.7825	0.673	1.395	1.067
River Deel	233.88	1513	478	0.369	0.98	1.663	3.032
River Addergate	40.80	1615	467	0.66	0.86	1.686	5.052
River Clydagh	355.04	1266	465	0.457	0.86	1.355	0.855

The Pontoon Bridge narrows (Figure 2-5) are not thought to have any hydraulic influence on levels in Lough Conn. The outflow control is thought to be just upstream of the rail bridge that crosses the outflow of Lough Cullin (Figure 2-6). It is possible in high flow conditions that water levels in the Moy cause water to back up in Lough Cullin. During high flows, anecdotal accounts also suggest high water levels in the River Moy result in water from the River Moy flowing into Louch Cullin.

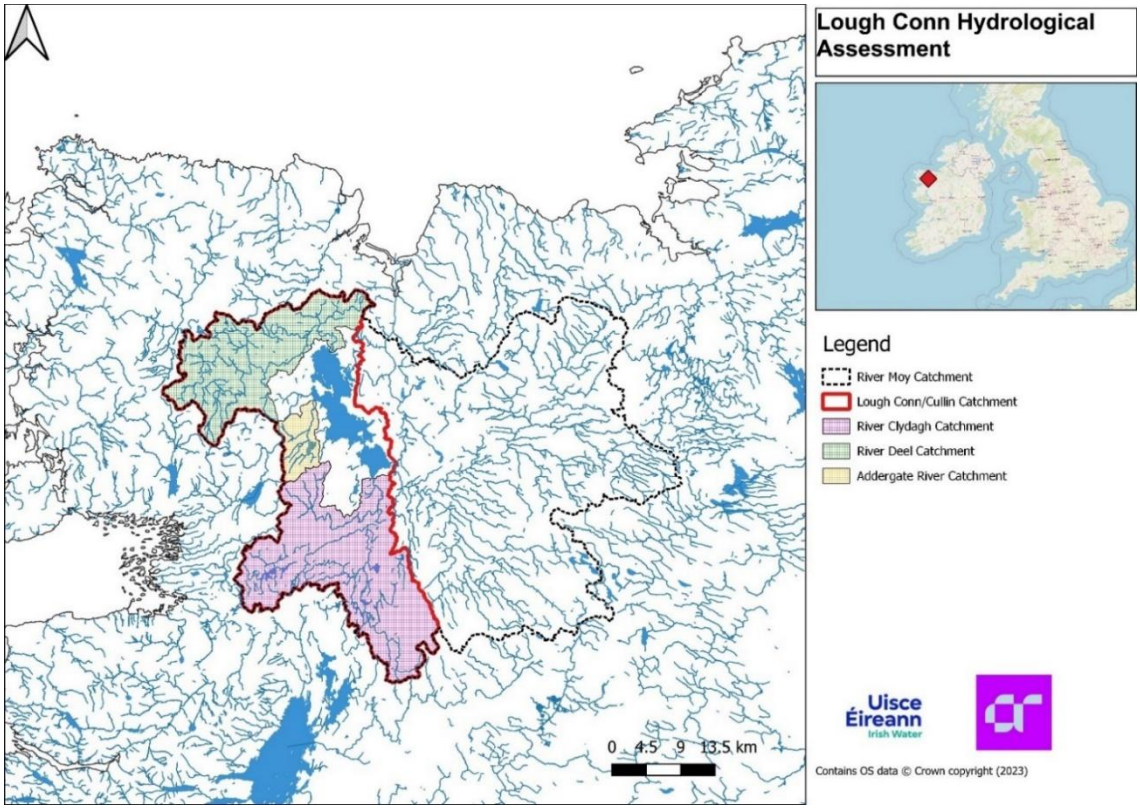


Figure 2-3 – Loughs Conn and Cullin catchments

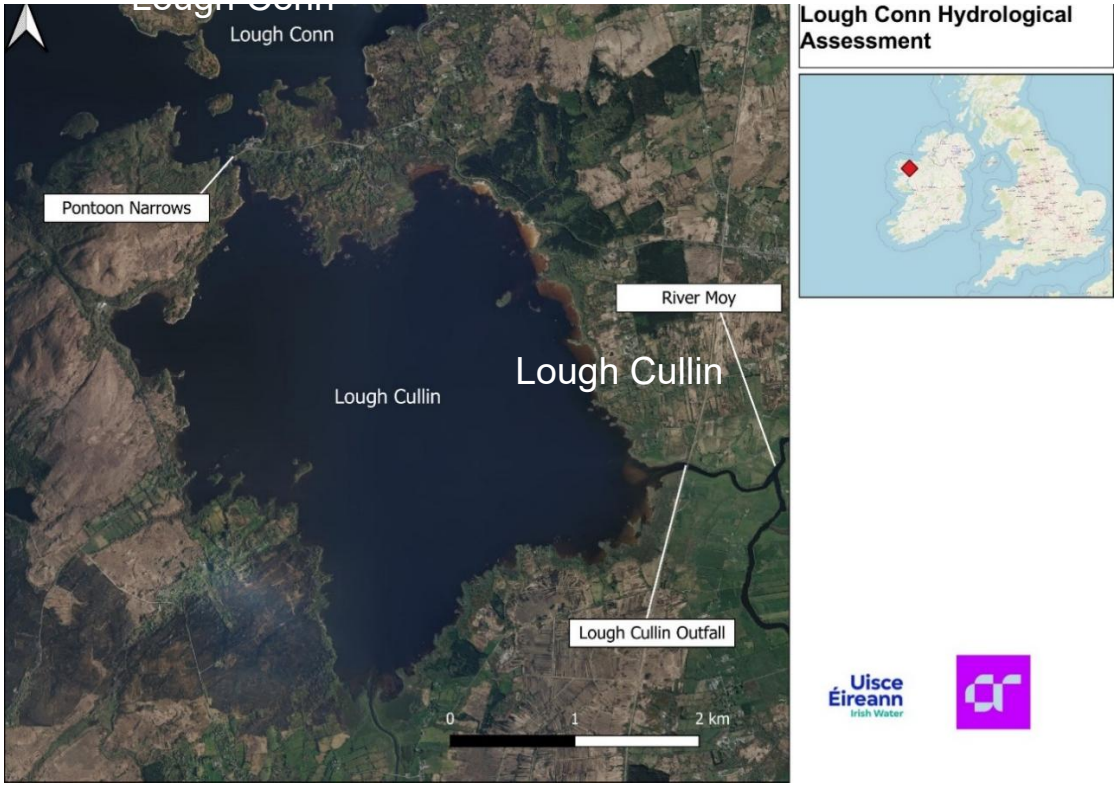


Figure 2-4 – Lough Cullin outflow and Pontoon Bridge narrows



Figure 2-5 – Pontoon Bridge looking downstream



Figure 2-6 – Lough Cullin outflow looking downstream

The main abstraction from Lough Conn is the existing abstraction for the Lisglennon and Wherrew WTPs . Upstream abstractions are thought to be insignificant, although there are some spring supplies for Crossmolina Eskeragh and Killeen Errew Group Water Schemes. A small GWS operated at the western side of the lough. This GWS has a total of 234 connections with an average daily demand of 150 m^3/day (0.15 MLD). Two notable discharges have been identified. This includes the Castlebar Waste Water Treatment Plant (WWTP) with an associated population of ~ 12,068 that discharges into the Castlebar River, which flows into Lough Cullin. This also includes the outfall of the Crossmolina

WWTP with a population of approx. 1,044 discharging into the Deel River, that flows into Lough Conn[5]. However, these discharges are not thought to be significant relative to the overall inflows to Lough Conn and Lough Cullin.

2.5 Geological characteristics

Groundwater bodies (GWBs) and bedrock geology associated with the Lough Conn and Lough Cullin are illustrated in Figure 2-7 and Figure 2-8. Most of Lough Conn is underlain by the Ballina groundwater GWB[6]. The GWB occupies an area between Crossmolina and Ballina and is encompassed by the Nephin Beg and the Ox Mountain ranges. The boundaries of the GWB are the contacts with the poorer aquifers of the Lahardaun, Bellacorrick-Killala and Foxford GWB's. Lough Conn acts as a boundary where it cuts into the southern half of the GWB. The land surface is characterised by relatively flat to undulating ground, with elevations from 0-90 m AOD. The aquifer is a regionally important karstified aquifer (Rk). The main aquifer lithology is Dinantian Pure Bedded Limestones and the subsoils are dominated by limestone till, covering 60% of the GWB. There is a high degree of interconnection between groundwater and surface water. The close interaction between surface water and groundwater in karstified aquifers is reflected in their closely linked water quality.

To the south, Lough Conn is underlain by Beltra Lough North GWB[7]. The GWB occupies an area from Beltra to L. Conn, comprising a NE-SW trending valley named Glen Nephin. It occupies the area between Nephin Beg Mountain range and the ground to the south of the valley. Elevations range from 10-130 m AOD. The main surface drainage is north and northwest to Lough Conn. The groundwater body is composed of Dinantian Sandstones and Dinantian Pure Bedded Limestones. Groundwater will discharge locally to streams and rivers crossing the aquifer and also to small springs and seeps. Owing to the poor productivity of the aquifers in this body it is unlikely that any major groundwater - surface water interactions occur.

Lough Cullin is associated with the Foxford GWB[8]. The GWB stretches from north of Castlebar to north of Tobercurry. It is characterized by the mountainous terrain of the Ox Mountain range. Elevations range from 10-450 m AOD. It is bounded to the south by the Swinford GWB. The eastern and western boundaries are surface water divides and Lough Conn acts as a boundary where it cuts into the GWB. The northern boundary is composed of the Ballina GWB and the coastline of Killala Bay. The River Moy is the principal river, draining the majority of the GWB. The GWB is predominantly composed of Precambrian Quartzites, Gneisses & Schists and Granites and other Igneous Intrusive rocks. Groundwater will discharge locally to streams and rivers crossing the aquifer and also to small springs and seeps. Owing to the poor productivity of the aquifers in this body it is unlikely that any major groundwater-surface water interactions occur.

The dominant subsoil types within the catchment consist of peat (40%), coarse loamy drift with siliceous stones (19%), and coarse loamy over calcareous gravels (18%).

[5] https://www.water.ie/connections/developer-services/capacity-registers/wastewater-treatment-capacity-register/mayo
[6] https://gsi.geodata.gov.ie/downloads/Groundwater/Reports/GWB/BallinaGWB.pdf
[7] https://gsi.geodata.gov.ie/downloads/Groundwater/Reports/GWB/BeltraLoughNorthGWB.pdf
[8] https://gsi.geodata.gov.ie/downloads/Groundwater/Reports/GWB/FoxfordGWB.pdf

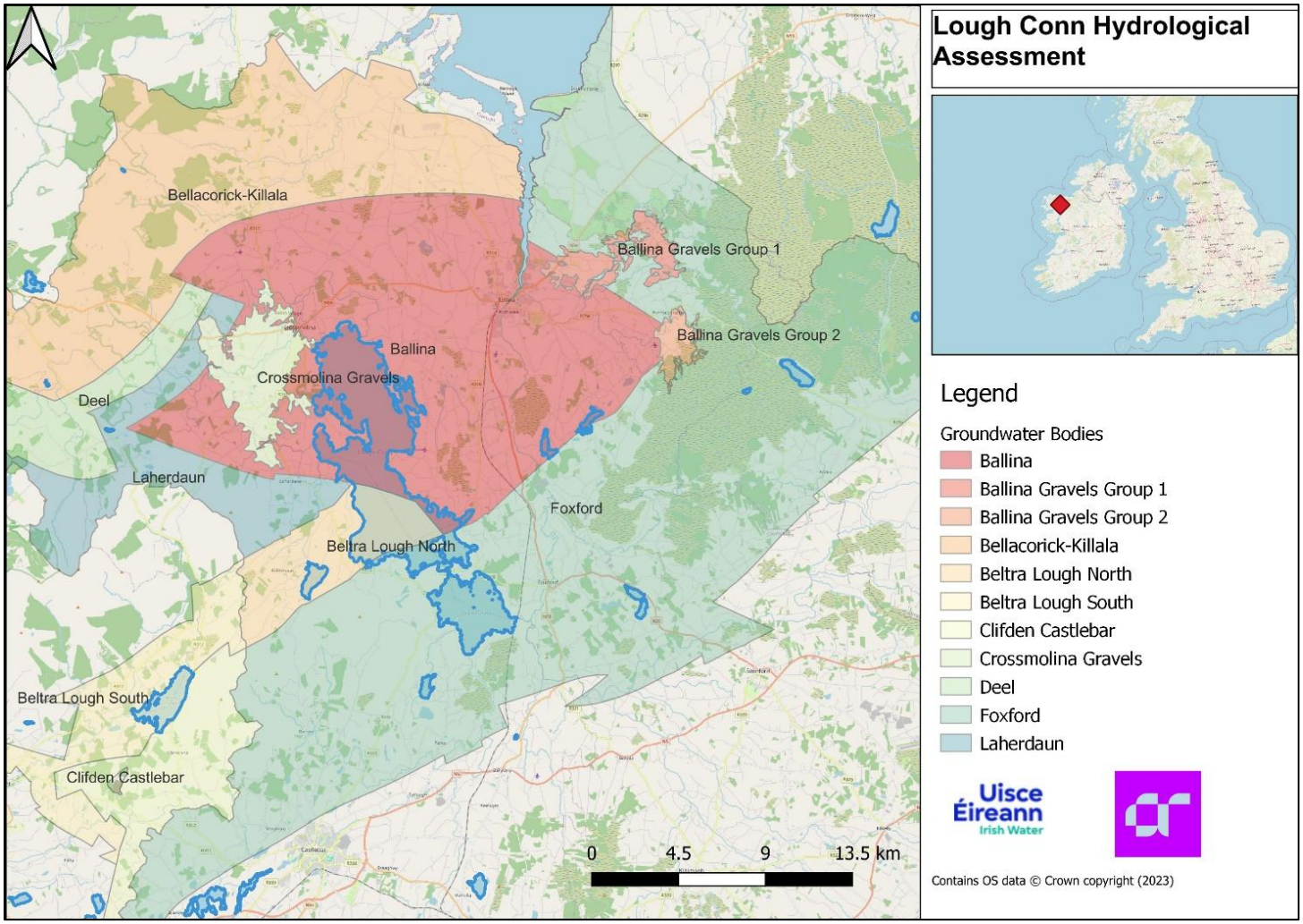


Figure 2-7 – Map showing the main groundwater bodies associated with Loughs Conn/Cullin

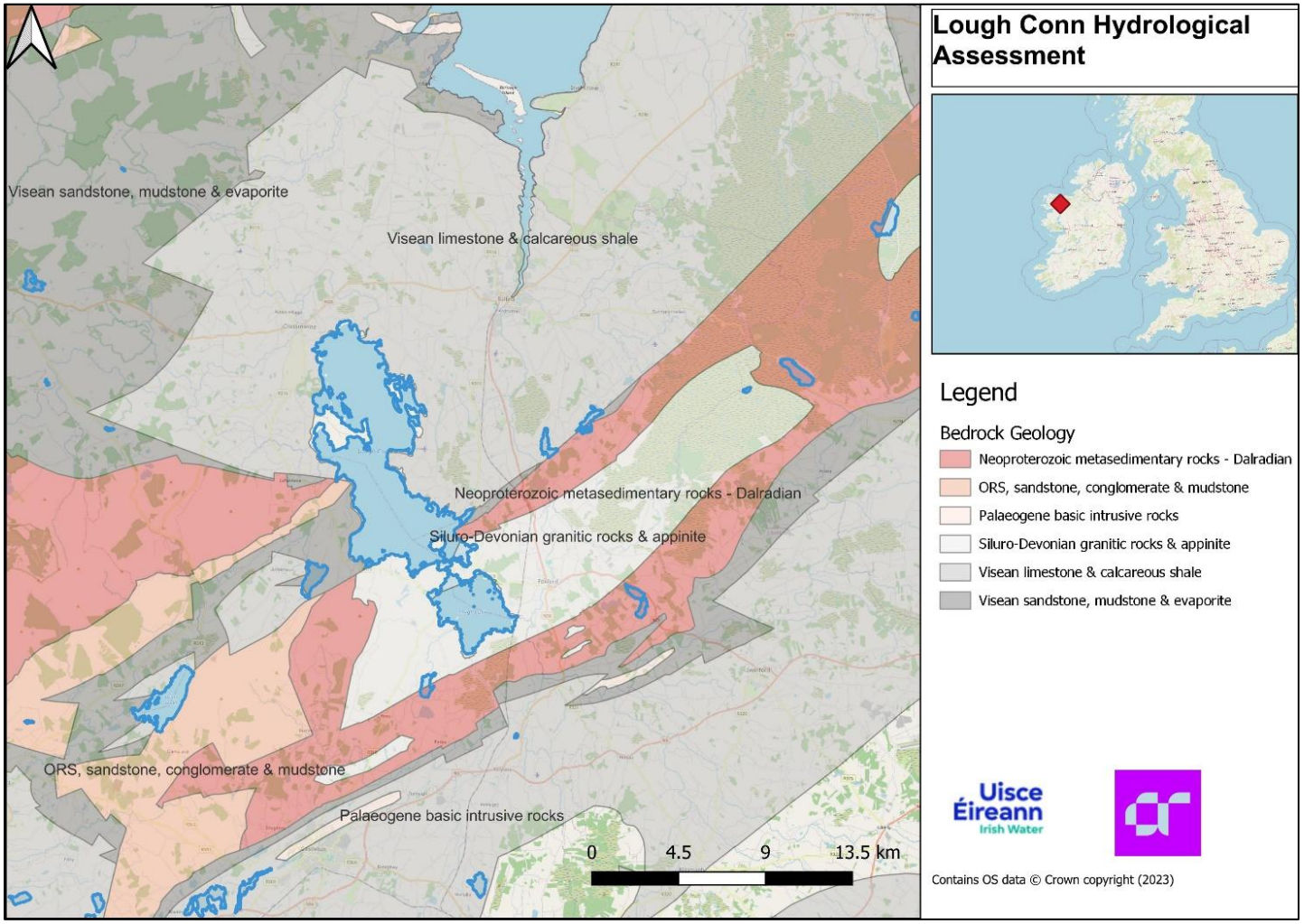


Figure 2-8 – Map showing the underlying bedrock geology in the Study Area

2.6 Watercourse Habitats

A single barrier has been identified on the River Moy, in Ballina. The Ballina Salmon Weir was restored in 2011. The weir is over 300 years old and was originally used to capture salmon heading upstream to spawn and now the structure is used to count the number of salmon that are making the journey up stream. No potential artificial barriers have been identified between Lough Conn and Lough Cullin with two potential barriers identified between Lough Cullin and the River Moy[9]. There are limited data available to describe the current habitat conditions of the River Moy downstream of the confluence with the Lough Cullin outflow. Data from the Wild Trout Trust [10] suggest that the River Moy has well-vegetated banks with a healthy riparian habitat, providing river margin shade, cover and structure. There is evidence that the channel had been severely degraded by past dredging work removing large volumes of the river's coarse substrate and lowering the bed level. This has altered the channel morphology and natural substrate of the river in many areas, with a lack of gravel and cobble bed features observed, particularly in the upper reaches of the watercourse (upstream of the confluence with Lough Cullin.

[9] The Inland Fisheries Ireland (IFI) database suggests two potential barriers near Foxford. It is understood that the includes an old eel weir at Foxford. These have been identified as potential barriers that need further assessment.
[10] Wild Trout Trust (2022). River Moy Habitat Assessment and Management Plan East Mayo Angling Association, Co. Mayo, Ireland July 2022

ASSESSMENT APPROACH

3. Assessment methodology

3.1 Summary of proposed approach

To determine the potential impacts on the hydrology and subsequently the WFD compliance risk, a phased approach has been adopted. This risk-based approach allows for an initial analysis of the potential environmental impacts associated with the change in abstraction at Lough Conn to determine the need for and the scope of any detailed modelling, monitoring and hydrological analyses.

The phased approach consists of the following:

- Phase 1 (this report): An initial impact assessment using available data and simplified modelled approaches to determine the magnitude of any potential environmental impacts associated with the change in abstraction at Lough Conn and, if required, define the scope of any monitoring, modelling and detailed assessment required.
- Phase 2: Depending on the outcomes of the initial assessment, there could be a need for further data collection. This phase would mostly focus on field surveys and additional data collection.
- Phase 3: If identified as a requirement following completion of Phase 1 and Phase 2, this phase would focus on the development, validation and calibration of model(s) to establish the relationship between lake inflows, lake level and lake outflows and model the potential changes as a result of changes in abstraction from Lough Conn.
- Phase 4: This phase would include a detailed impact assessment using the data collected in Phase 2 and the model developed in Phase 3.

As noted above and in Section 1.3, the focus of this report is the outcomes of the Phase 1 assessment. The approach adopted for the Phase 1 assessment is presented below.

3.2 Phase 1 assessment

An initial hydrological analyses and assessment have been undertaken to define the risk associated with the increase in abstraction from Lough Conn and determine the need for, and scope of any further monitoring, modelling and assessment.

3.2.1 Data collation and review

A summary of the data used in the Phase 1 can be found in Table 3-1.

Table 3-1 – Summary of data sources

Data	Source	Data summary
Water level	Gauged (Office of Public Works)	Observed lough level from gauges at Pontoon, Corryosla and Gortnaraby.
Flow	Gauged (Office of Public Works)	Observed flows at Ballysadare, Ballycaroon, Kiltimagh and Cloonacannana.
Flow	HydroTool (EPA)	Flow duration statistics at selected locations.
Lough surface rainfall	Gauged (Met Éireann)	Daily observed rainfall at Castlebarr, Laherdane, and Crossmolina).
Open water evaporation	Derived (Met Éireann)	Derived PET series for well-watered grass from Knock Airport weather station. Scaled to account for open water evaporation.
Lough Bathymetry	AtkinsRéalis	Estimated depth-storage-area based on assumed lough bed slope. Full bathymetric survey not available.
Water Quality	Catchments.ie	Water quality data for WFD waterbodies
WFD	EPA WFD Data	Data on water bodies, current status, risk and protected areas
Barriers	National Barriers Programme	Barrier surveys and risk assessment data from the National Barriers Programme Web Application.

The data sets available that are needed for hydrological assessment are variable in their extent and quality. There is excellent data coverage of the existing lough level regime, for both Lough Conn and Lough Cullin. Rainfall records in the area are also well defined. Measured inflows are less extensive, with flows measured at Ballycaroon on the River Deel being the only data set that was readily available. Although there are gauging stations in the River Clydagh catchment that drains to Lough Cullin, flow series for these stations are not currently available due to ongoing rating reviews. For future work it may be appropriate to derive ratings for these stations to support enhancements to the understanding of lough inflows (see Section 5 for further discussion). Lough Bathymetry is unavailable and therefore the relationship between lough volume, level and area is defined on a best endeavours basis in this phase of the project.

3.2.2 Hydrological assessment

EPA methods of abstraction assessment typically track abstraction impacts on naturalised flows and environmental flows (e-flows) throughout a catchment, mimicking the functionality embedded within the Qube model software that is described further in Section 3.2.2.2. In this instance, the need to account for the lake hydrological processes that are specific to Lough Conn/Cullin, and the fact that the proposal is highly unlikely to affect flows upstream, means a bespoke hydrological assessment has been developed that considers the potential impacts on water level in the loughs and the flow regime downstream of Lough Cullin.

3.2.2.1 Summary

The hydrological assessment approach considered Uisce Éireann's Technical Guidance for Hydrological Estimation[11]. This guidance sets out calculation methods for undertaking flow estimates (including deriving river flow duration curves) for gauged and ungauged catchments and the appropriate reporting and documentation required in preparation of a flow estimate. The Lough Conn/Cullin catchments are only partially gauged. As such, both HydroTool flow estimates and a donor gauge transfer approach was adopted to ensure that the in-lake and downstream hydrological risks are fully assessed.

In conjunction with the donor transfer approach, a lough routing model was developed to better account for lake hydrological processes and their effect on the flow regime downstream of Lough Cullin. The routing model also provided a means to estimate the impact of an increased abstraction on the lough level regime. The flow and level estimates derived from these approaches were subsequently used for an initial impact assessment in view of available WFD compliance targets. The hydrological assessment considers an increase in abstraction to 40,000 m^3/day

3.2.2.2 HydroTool assessment

The EPA have developed a methodology for estimating flow in rivers in ungauged catchments. This methodology has been incorporated into a web-based tool called HydroTool/Qube which is available via EPA Water Maps portal[12]. The methodology is predicated on hydrological similarity between an ungauged subject site and a pooling group of 3 hydrologically similar gauged donor sites to produce estimates of flow. Physical catchment descriptors are used to assess hydrological similarity[13].

HydroTool data were obtained from the EPA Water Maps portal for all inflows into Lough Conn and Lough Cullin as well as the outflow to the River Moy. These data were used to establish a Flow Duration Curve (FDC) at the outlet of Lough Cullin and for the River Moy downstream of the confluence with the Lough Cullin outlet. An assessment of the proportionate change in flow as a result of the increased abstraction was then completed using the relevant compliance thresholds (see Section 3.2.2.4).

[11] Uisce Éireann's (2022). Technical Guidance for Hydrological Estimation. Document No. IW-AMT-GL-022 Revision: 1.00
[12] https://gis.epa.ie/EPAMaps/Water
[13] https://www.epa.ie/publications/monitoring--assessment/freshwater--marine/estimated-fdc-and-mean-flow-for-ungauged-catchments.php

3.2.2.3 Donor catchment and routing model assessment

3.2.2.3.1 Donor Selection

As much of the Lough Conn / Cullin catchment is ungauged, donor gauges from gauged catchments were identified to estimate the inflows to Loughs Conn and Cullin for use within a lough routing model. This was achieved by reviewing the hydrological characteristics of other gauged catchments in Ireland contained in the Flood Studies Update (FSU) Physical Catchment Descriptors (Gauged) dataset.[14] All available donor catchments were ranked based on the similarity of their catchment descriptors to those at the Lough Cullin outflow shown in Table 3-2.

As per Uisce Éireann's Technical Guidance for Hydrological Estimation, rainfall, drainage density FARL (Flood Attenuation by Lakes and Reservoirs Index) and slope were used to identify the best donor catchments at representative inflows in dry conditions, i.e. Q95, where changes in abstraction likely to have the greatest impact. In addition to these, catchment area and distance of the donor gauge from the Lough Cullin outflow (the target site) were also considered. The inclusion of distance between target and donor catchments within the donor selection process was seen as particularly important for application of donor flows within a routing model, to ensure the donor flows correctly represented the timing of rainfall experienced in the Lough Conn catchment.

Table 3-2 – Lough Cullin Outflow Characteristics Used for Donor Selection

Catchment area (km^2)	Standard Annual average Rainfall (SAAR) (mm)	Flood Attenuation by Reservoirs and Lakes (FARL)	Drainage Density km/km^2	Slope m/km
819.394	1419	0.98*	1.395	1.067

* Note that it was assumed that the outflow FARL value of Lough Cullin was 0.98 (in reality, 0.67). This is because the purpose of this exercise was to select donors that could represent the inflows to Lough Conn/Cullin within a lough routing model and did not contain significant areas of open water in their own right.

An Excel based tool was developed to evaluate the suitability of candidate donors. For each donor station candidate, a score between 1 and 10 was assigned to each catchment characteristic depending on how similar the donor characteristic was to the equivalent at the target site with 10 being the most similar (see Table 3-3). As distance to the target site is seen as important for application of transposed flows in a routing model, distance between the donor and target was given a higher weighting than other descriptors. These weighted scores were then summed, and all catchments ranked according to their total scores.

The top 20 donor gauge candidates (based on catchment descriptors scores) were evaluated for completeness of record and concurrency of record with the Lough Conn/Cullin level regime (see Section 3.2.2.4). Stations with obvious artificial influences or close to the outflows of significant loughs upstream were excluded.

A total of three (3) donor gauges were identified as suitable for use within the routing model. These are:

[14] https://data.gov.ie/dataset/flood-studies-update-fsu-physical-catchment-descriptors-gauged

- Kiltimagh inflows (34024);
- Ballysadare inflows (35005); and
- Cloonacannana (34010).

In addition, the gauge at Ballycarroon (34007) has also been considered as it directly measures inflow to Lough Conn, noting this gauge ranked 30th when compared to all gauges in the donor selection exercise. Although the Ballycaroon record will provide the best representations of inflows in terms of the timing of peaks and recessions, is not a good representation of the overall rainfall-runoff response of all catchments that drain to Loch Conn and Cullin. Indeed, the main sub catchments described in Section 2.4 exhibit very different characteristics, and therefore using an individual scaled sub catchment as a proxy for total inflows is likely to be a poor representation of the overall hydrology. Without recourse to other approaches such as a semi distributed rainfall runoff model supported by additional flow gauging, a lumped transfer of selected donor records is thought to be the best overall representation of the lough inflows available.

The location of the selected gauges is show in Figure 3-1 and their characteristics presented in Table 3-3.

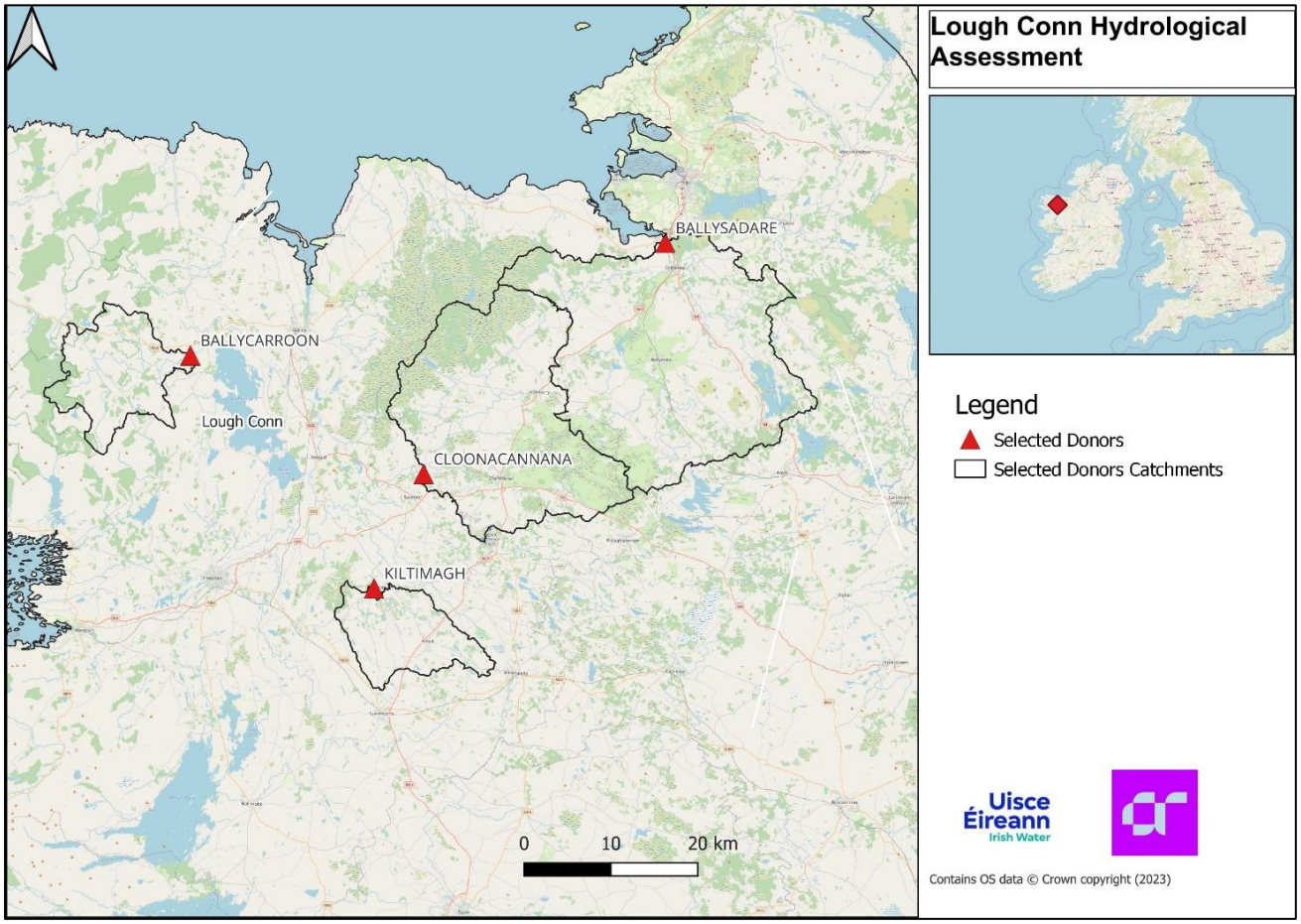


Figure 3-1 – Donor catchment locations

Donor gauge time series were scaled to Lough Conn/Cullin inflows using both catchment area and the ratio of target/donor Qmean values taken from the HydroTool. Scaling using HydroTool Qmean flows attempts to account for any differences in rainfall and PET between target and donor sites, leading to a better representation of the overall water balance of Lough Conn. In both these methods, scaling was done to exclude the area of open water in Lough Conn/Cullin to ensure the scaled flow series account for runoff generated upstream of the loughs only.

Based on the comparison of catchment descriptors, Cloonacannana is the most analogous donor catchment to the inflows of Lough Conn (see Figure 3-2). Given the variation of inflow regimes derived from catchment donors, all four stations were considered for utilisation in a lough routing model (see Section 3.2.2.3.4).

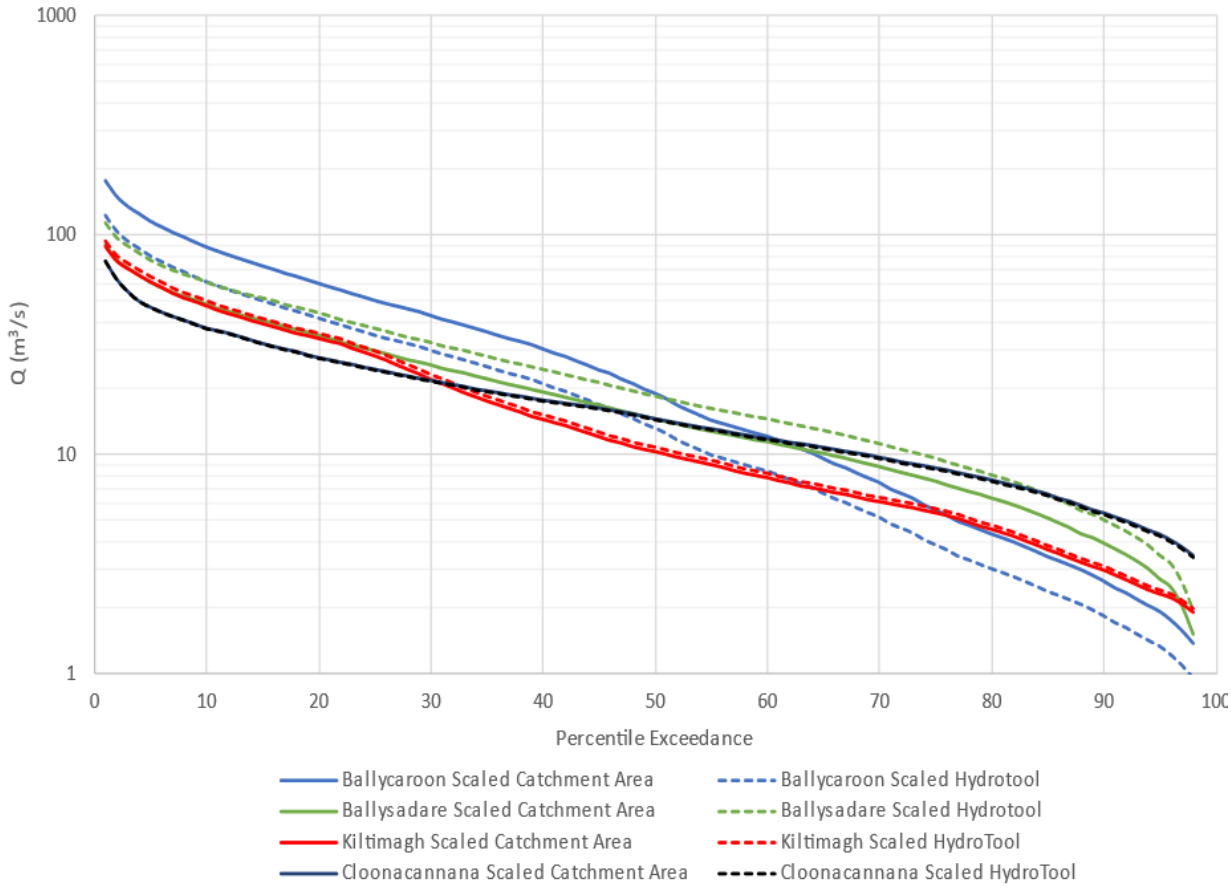


Figure 3-2 – Lough Conn/Cullin inflow duration curves considered as part of the hydrological assessment and used in the lough routing model.

Table 3-3 – Summary of top 20 donor gauge catchment characteristics (selected gauges shown in red)

		NODE_EAST	NODE_NORTH	Area	SAAR	FARL	DRAIND	S1085
Target Site	34_3741	125202	302503	819.394	1404	0.98	1.395	1.067

	Distance	AREA (km^2)	SAAR (mm)	FARL (index)	DRAIND (km/	Slope
Weightings	1.5	0.8	1	1	1	1

				Scores						Data						
Top 20 Gauges	Score	STATION_NU	LOCATION	Distance	AREA (km^2)	SAAR (mm)	FARL (index)	DRAIND (km/	Slope	Distance	AREA (km^2)	SAAR (mm)	FARL (inde	BFIsoil (in	DRAIND (k	S1085
1	58.9	34010	CLOONACANNANA	9.5	9.5	9.8	9.8	9.8	7.7	13.8	484.3	1385.7	0.988	0.401	1.421	27.762
2	56.9	34029	KNOCKADANGAN	9.3	9.2	9.4	10.0	7.9	8.4	19.1	226.8	1468.4	0.98	0.367	1.681	19.381
3	55.5	34024	KILTIMAGH	9.4	9.0	7.9	8.2	9.7	8.3	15.5	127.2	1177.5	0.922	0.521	1.361	20.726
4	54.5	35002	BILLA BR.	8.3	9.0	9.8	9.8	7.7	7.6	45.1	88.8	1380.6	0.986	0.4219	1.701	28.718
5	54.5	30001	CARTRONBOWER	8.9	9.0	6.4	8.6	9.8	9.0	27.3	121.0	1787.0	0.935	0.436	1.416	12.891
6	53.8	35011	DROMAHAIR	7.6	9.3	8.8	9.9	9.6	6.7	62.2	293.2	1534.3	0.978	0.3472	1.451	39.806
7	52.9	30021	CHRISTINA'S BR.	8.7	9.0	7.8	9.6	7.8	7.5	32.8	103.6	1168.1	0.994	0.55	1.103	30.851
8	52.8	35001	BALLYNACARROW	8.3	9.3	7.8	8.3	8.5	8.4	43.5	299.5	1172.8	0.923	0.5981	1.19	20.164
9	52.6	35004	BIG BRIDGE	8.4	9.0	7.2	9.6	8.4	7.7	42.5	117.0	1103.4	0.994	0.488	1.181	27.946
10	52.5	33001	GLENAMOY	8.2	9.0	9.4	9.4	8.7	5.5	47.4	76.1	1466.6	0.998	0.285	1.564	53.581
11	52.4	35005	BALLYSADARE	8.1	9.7	8.1	7.5	9.3	7.6	49.4	639.7	1198.3	0.898	0.6086	1.307	29.072
12	52.3	36021	KILTYBARDAN	6.7	8.9	8.4	9.5	9.4	7.7	84.5	23.4	1569.6	0.995	0.329693	1.473	28.528
13	52.1	30005	FOXHILL	8.7	9.2	7.8	9.8	6.7	7.5	34.3	237.8	1172.5	0.985	0.5637	0.943	30.851
14	52.0	34011	GNEEVE BRIDGE	9.5	9.1	8.5	6.5	8.3	7.1	11.7	143.0	1247.6	0.867	0.572	1.161	34.534
15	51.9	35071	LAREEN	6.9	9.2	9.6	9.5	8.5	6.6	79.9	247.2	1364.5	0.997	0.7659	1.187	40.849
16	51.9	30020	BALLYHAUNIS	8.7	8.9	8.0	9.4	6.7	7.7	33.6	21.4	1190.7	1	0.684	1.846	28.304
17	51.4	30037	CLOONCORMICK	8.6	9.1	7.8	9.8	6.9	6.7	34.9	210.2	1169.4	0.987	0.5522	0.975	39.788
18	51.4	25002	BARRINGTON'S BR.	4.1	9.2	9.0	9.4	9.8	9.7	153.6	221.6	1300.0	0.999	0.542	1.417	4.826
19	51.0	35073	L. GILL	7.8	9.4	9.1	4.1	9.6	8.9	55.7	362.6	1504.2	0.788	0.7206	1.445	13.609
20	50.8	30004	CORROFIN	7.615944335	9.832225009	7.168459457	9.633027523	5.566247224	9.188745684	61.6	699.3	1103.7	0.992	0.6062	0.796	10.559

3.2.2.3.2 Rainfall and evaporation

To support the development of a flow routing model of the loughs, rainfall and evaporation data were also obtained. A rainfall series for the open water area of the loughs was derived from a rainfall gauge at Crossmolina, with infilling from gauges at Laherdane and occasionally Castlebar to provide a continuous rainfall record for the period, 1983-2023 (see Figure 3-3 and Figure 3-6). Note this data represents rainfall on the lough surface and not the wider catchment rainfall which includes areas of greater rainfall in the higher elevation of the head waters.

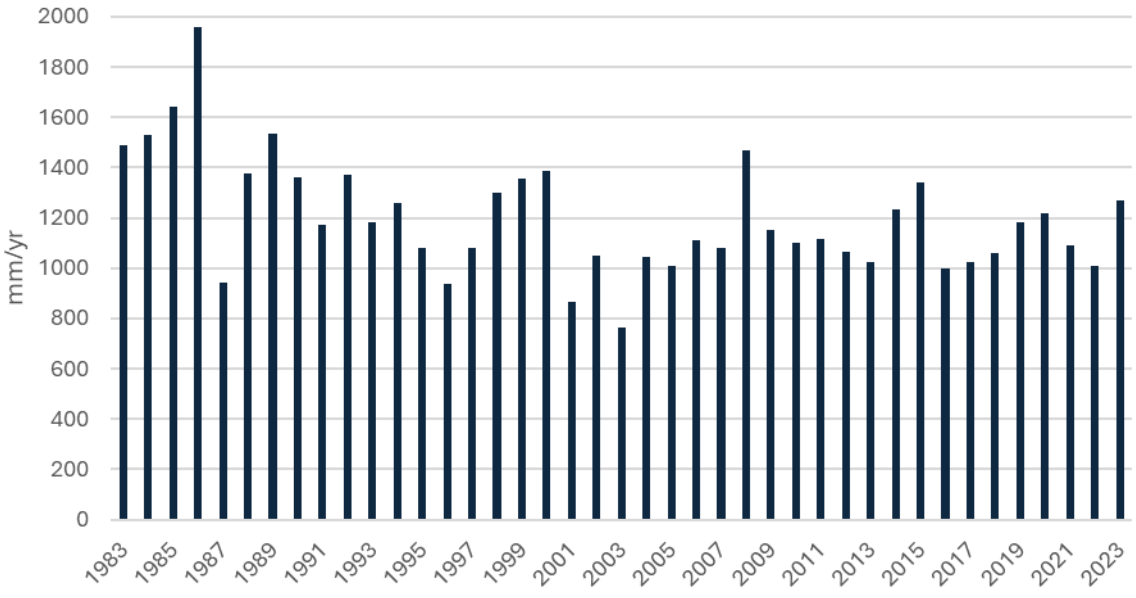


Figure 3-3 – Lough Conn/Cullin surface rainfall series

Open water evaporation was derived from potential evapotranspiration series (Penman method) taken from the weather station at Knock airport (25 km southeast of Lough Cullin). Potential evapotranspiration (PET) was scaled to open water evaporation using factors reported in Finch (2007)[15].

The rainfall and PET data were used as input data sets in the lough flow routing model (Section 3.2.2.3.4).

3.2.2.3.3 Bathymetry and lough levels

Bathymetry of the loughs was required to understand the relationship between depth / area and volume over the range of observed levels, primarily for inclusion within the routing model. In turn, the data allows for an understanding of how drawdown impacts habitat zone area and to confirm volume available for abstraction (for yield analysis). Several data sources were reviewed for bathymetry data, including:

[15] Finch, J. W., (2007) Empirical factors for estimating open-water evaporation from potential evaporation. Water and Environment Journal, Vol 17, Issue 1 p. 51-53

- GloBathy data: Global data set of lake bathymetry estimated by statistical methods[16].
  - The review of the available data identified that the GloBathy data set was not thought to be representative. This lough bed slope is very shallow (1.7 in 100) and maximum depths appears excessive.

- Inland Fisheries Ireland (IFI) bathymetric of Lough Conn in 2016.
  - The IFI spatial resolution of soundings is quite coarse and excludes Lough Cullin

- Synthetic bathymetry based on assumed slope of lough bed.
  - Synthetic bathymetry with assumed sloped optimised to provide best performance in routing model was selected as the preferred approach.

Comparison of the level record at Pontoon with other gauges suggests both loughs have synchronous level regimes, and the Pontoon narrows have negligible impact on levels (Figure 3-4). As the record of water level is not concurrent across all gauges, a lough level record has been derived from the gauge at Pontoon, with missing periods infilled from Corryosla and Gortnaraby. Based on the 2006-2013 record, the loughs typically have a level range of approx. 2 m (5th to 95th percentile), although flood events produce a total level range of 3.3 m (Figure 3-5).

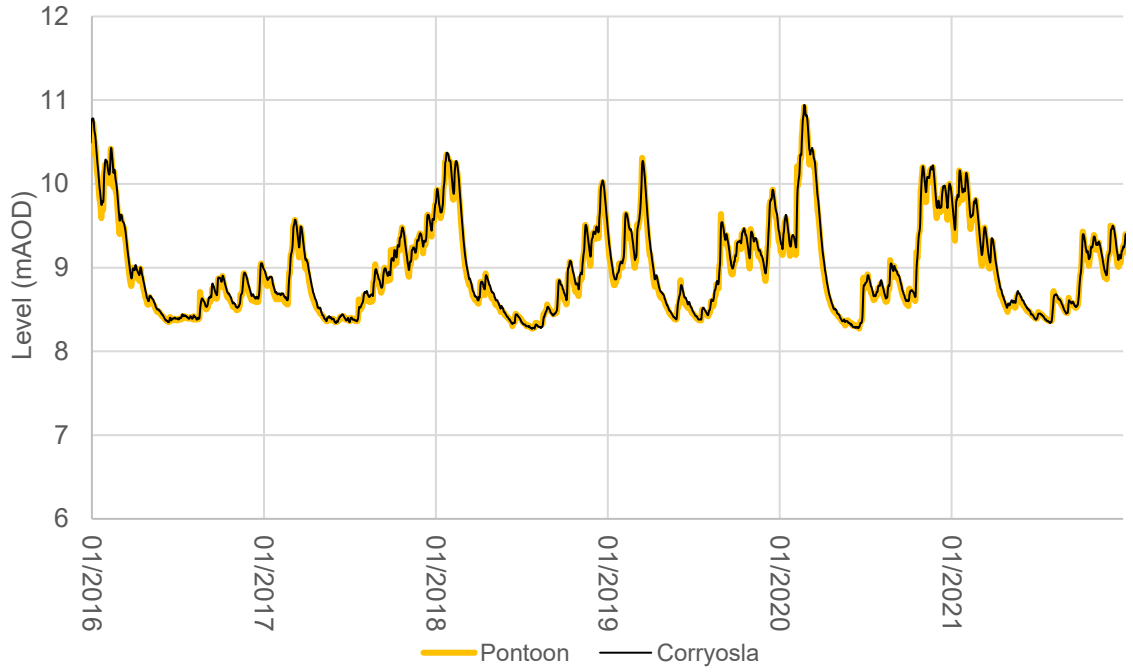


Figure 3-4 – Comparison of Pontoon (Lough Cullin) and Corryosla (Lough Conn) levels.

[16] Messager ML, Lehner B, Grill G, Nedeva I, Schmitt O. Estimating the volume and age of water stored in global lakes using a geo-statistical approach. Nat Commun. (2016 Dec) 15;7:13603. doi: 10.1038/ncomms13603. PMID: 27976671; PMCID: PMC5171767.

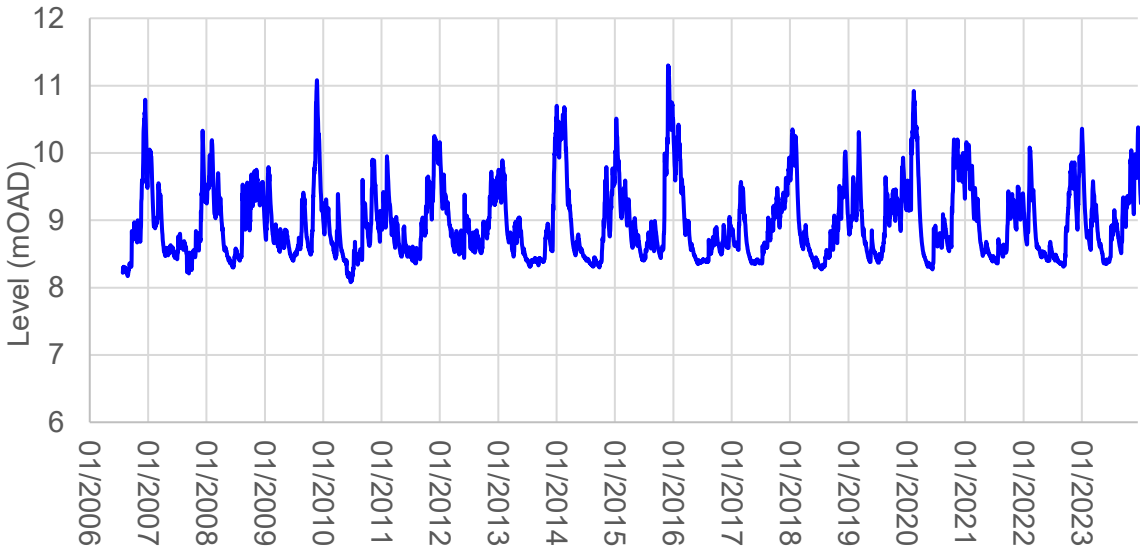


Figure 3-5 – Observed Lough Conn/Cullin levels derived from Pontoon, Corryosla and Gortnaraby gauges.

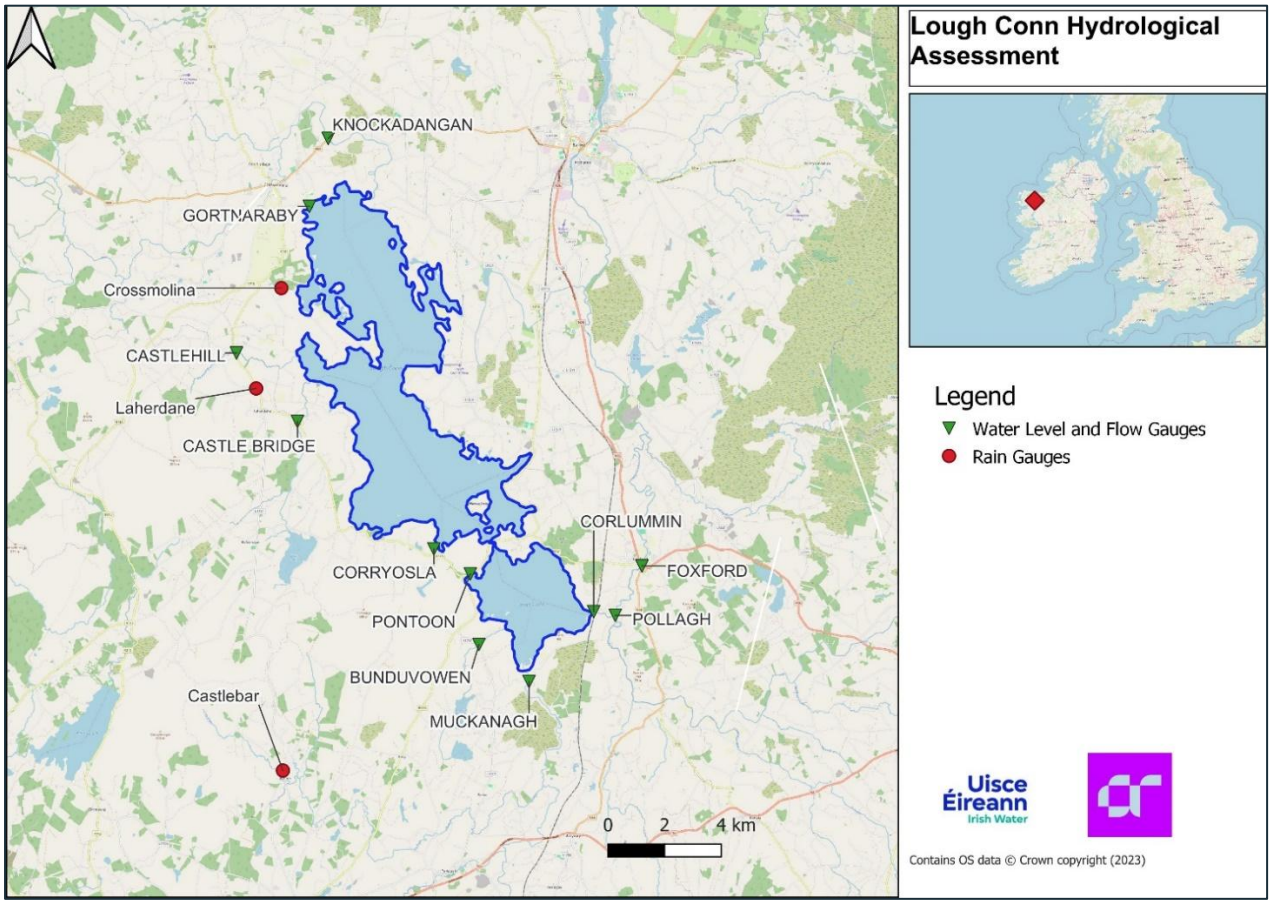


Figure 3-6 – Water level and rainfall monitoring locations

3.2.2.3.4 Flow Routing Model

A flow routing model was developed to consider how inflows, lough hydrological processes and abstraction combine to influence the downstream flow regime and lough water levels.

The model was developed within Excel and simulates the behaviour of the loughs at a daily timestep. The model represents the loughs as a single store of water, and makes the following assumptions about the loughs and their catchments:

- Lough bed slope is uniform around the whole lough perimeter.
- There is no bypass of flow though bed substrate at the outfall, or any other losses or gains from outside of the catchment via groundwater.
- The upstream catchment is free of significant artificial flow influences (other than the Uisce Éireann abstraction for Lisglennon and Wherrew WTPs).
- Lough Conn and Lough Cullin function as a single water body.
- Abstraction from Lough Conn is at a constant rate.

The processes that take place in the model are illustrated in Figure 3-7 and described as follows:

Each day in the model run, inflows and surface rainfall volumes are added to the previous end day storage, followed by the removal of evaporation and abstraction volumes. This allows the theoretical change in level before any water is lost to the River Moy to be calculated via the theoretical relationship between volume and depth. This relationship is derived from the assumed slope of the lough bed and area of the loughs. Once these calculations have taken place, flow leaving via the Lough Cullin outflow is calculated using a rating curve equation that represents the relationship between the water level above the hydraulic control at the outflow, and flow to the River Moy. A further nuance of the model set up is that the level over the outflow control used in outflow calculations is taken to be the mean of water level before any water has been added to the Lough at the start of the day, and the level after all additions and losses to abstraction and evaporation has taken place. During model development, it was found that this approach led to better model calibrations, especially during times of high-water levels.

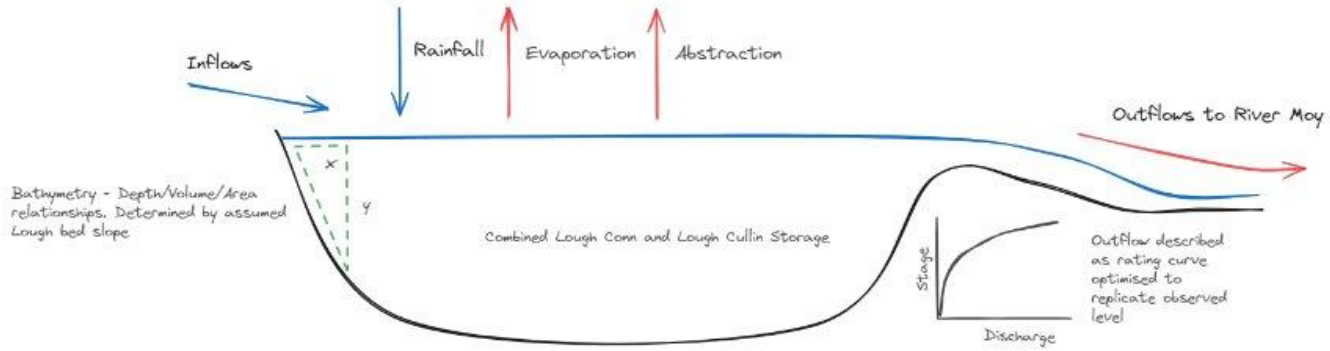


Figure 3-7 – Illustration of routing model structure and processes.

Because of the limitations in data available described in Section 3, not all parameters in the model could be defined on an empirical basis. In particular, the bed slope (and the corresponding relationship between depth and volume), and the outflow rating curve have been defined within the model calibration process.

The calibration process involved using the Excel Solver function to find the combination of bed slope and rating curve parameters that resulted in the best fit between observed and modelled water levels, assuming the existing abstraction volume. The calibration period chosen was based on the period where observed lough levels and scaled inflows are concurrent. This means that the August 2006 to May 2023 record was used for calibration, with the exception of the calibration for the Kiltimagh inflows, as this station record is shorter (calibration period = Sept 2009-May 2023).

Initially this process was applied to both donor inflows that had been scaled on catchment area and HT mean flow values, although it was quickly found that flows scaled on HT mean flows resulted in better calibrations. For this reason, donor flows, scaled using HydroTool data and routed though lough model have been taken forward to the WFD assessment. Existing demand was assumed to be 13,600 m^3/day for calibration purposes. The outputs from the selected calibration runs can be found in Appendix A. The model shows good agreement with the observed level regime. It is also noticeable that the concave upward shape of some optimised rating curves (exponents smaller or equal to 1) suggest that water could be impeded from leaving Lough Cullin by high water levels in the Moy as anecdotal counts suggest.

Once calibration was completed, the routing model was re-run with zero abstraction and the proposed increased abstraction volumes over the same period of record used for calibration. This resulted in a set of natural and proposed outflow and water level data sets, which were used to estimate the impact of altered abstraction on the downstream flow and level regimes, relative to WFD standards. These results are presented in Section 4.1.2.

3.2.2.4 Establishing compliance targets

The Water Environment (Abstractions and Associated Impoundments) Act 2022 aims to align abstraction licencing with the requirements of the WFD. Since August 2024, the act is fully enacted and implemented across Ireland. Under this framework, the risk assessment of abstraction licenses draws on the technical guidance from the United Kingdom Technical Advisory Group (UKTAG)[17]and the EPA (2025) national guidelines on Water Abstractions and Associated Impoundments[18].

In England and Wales UKTAG guidance has been adapted for the purpose of water resource management to determine the volume of water available for abstraction from a water body whilst maintaining environmental compliance (e.g. with the WFD). This is achieved through the use of the Environment Flow Indicator (EFI) which defines the proportionate change in naturalised flows considered acceptable for different watercourses, depending on the sensitivity of the watercourses. In Scotland, UKTAG guidance is implemented within the Scottish regulatory regime as ‘flow standards’ contained with statutory instruments, which equate to the EFI applied in England and Wales. WFD implementation in Scotland also included spatial standards which dictate the spatial extent that a flow standard can be breached before the overall waterbody status is downgraded. In Ireland, EPA has adapted UKTAG guidance hydrological limits and methodologies for Irish conditions.

[17] UKTAG (2008). UK Environmental Standards And Conditions (Phase 1) Final report. April 2008 (SR1 – 2006).

[18] Water Abstractions and Associated Impoundments - Methodology to Assess and Identify Significant Abstractions in Ireland (2025)

For the purpose of this hydrological assessment, the applicable environmental flow standards are those set out in the EPA's 2025 Guidance. These standards define allowable flow reductions for rivers with High, Good, Moderate and Poor status objectives. It should be noted that Lough Conn, Lough Cullin and the River Moy do not have a High status objective under WFD. Based on the UKTAG-derived river typology, the River Moy (the downstream water body associated with Lough Conn) is considered a **C2 (downstream)** water body type when considering the Standard Average Annual Rainfall (SAAR), Base Flow Index (BFI) and Catchment area (km^2). The environmental standards for river flows considered in this assessment are summarised in Table 3-4.

Table 3-4 – Summary of the environmental standards for river flows for C2 (downstream) river types considered in this assessment.

	Permitted abstraction per day as a percentage of the natural mean daily flow (Q)			
	Maximum % abstraction at Q exceeding Q60	**Maximum % abstraction at Q exceeding Q70**	**Maximum permitted % abstraction at Q exceeding Q95**	**Maximum permitted % abstraction at Q not exceeding Q95**
High	-	-	10	5
Good	25	20	15	10
Moderate	70	40 - 70[19]	40	35
Poor	Qx less 35% of Q90	Qx less 35% of Q90	65	60

With regards to the WFD compliance assessment, an abstraction may result in a non-compliance with the WFD where:

- An abstraction results in changes in river flows that prevent the attainment the standards for "Good" ecological status, and/or
- An abstraction results in the deterioration in ecological status based on the environmental standards.

In addition to the standards for river flow in Table 3-4, abstractions from lake source must also comply with Table 5 in the EPA Abstraction and Associated Impoundments 2025 guidelines, which limits the allowable change in Q50 outflow to 10%.

3.2.3 Water quality

The WFD specifies limit values or Environmental Quality Standards (EQS) for multiple water quality parameters in surface waters and lakes. For each identified waterbody, water quality data has been downloaded for the most downstream site where several years of data were available. The water quality monitoring stations used for this assessment are outlined in Table 3-5 and Figure 3-8.

Table 3-5 – Water quality monitoring stations used for this assessment.

Watercourse	ID	Name
Deel (Crossmolina)	RS34D010300	Knockadangan Bridge
Lough Conn	LS340011004300010	Conn Station 1

[19] Incremental increase in allowable take at flows <Q60 to ≥ Q90

Watercourse	ID	Name
	LS340011004300020	Conn Station 2
	LS340011004300030	Conn Station 3
	LS340011004300040	Conn Station 4
	LS340011004300050	Conn Station 5
	LS340011004300060	Conn Station 6
	LS340011004300070	Conn Station 7
	LS340011004300080	Conn Station 8
	LS340011004300090	Conn Station 9
Lough Cullin	LS340011006700010	Site 1
	LS340011006700030	Site 3
	LS340011006700040	Cullin station 40
River Moy	RS34M020770	U/S Foxford Bridge (LHS)

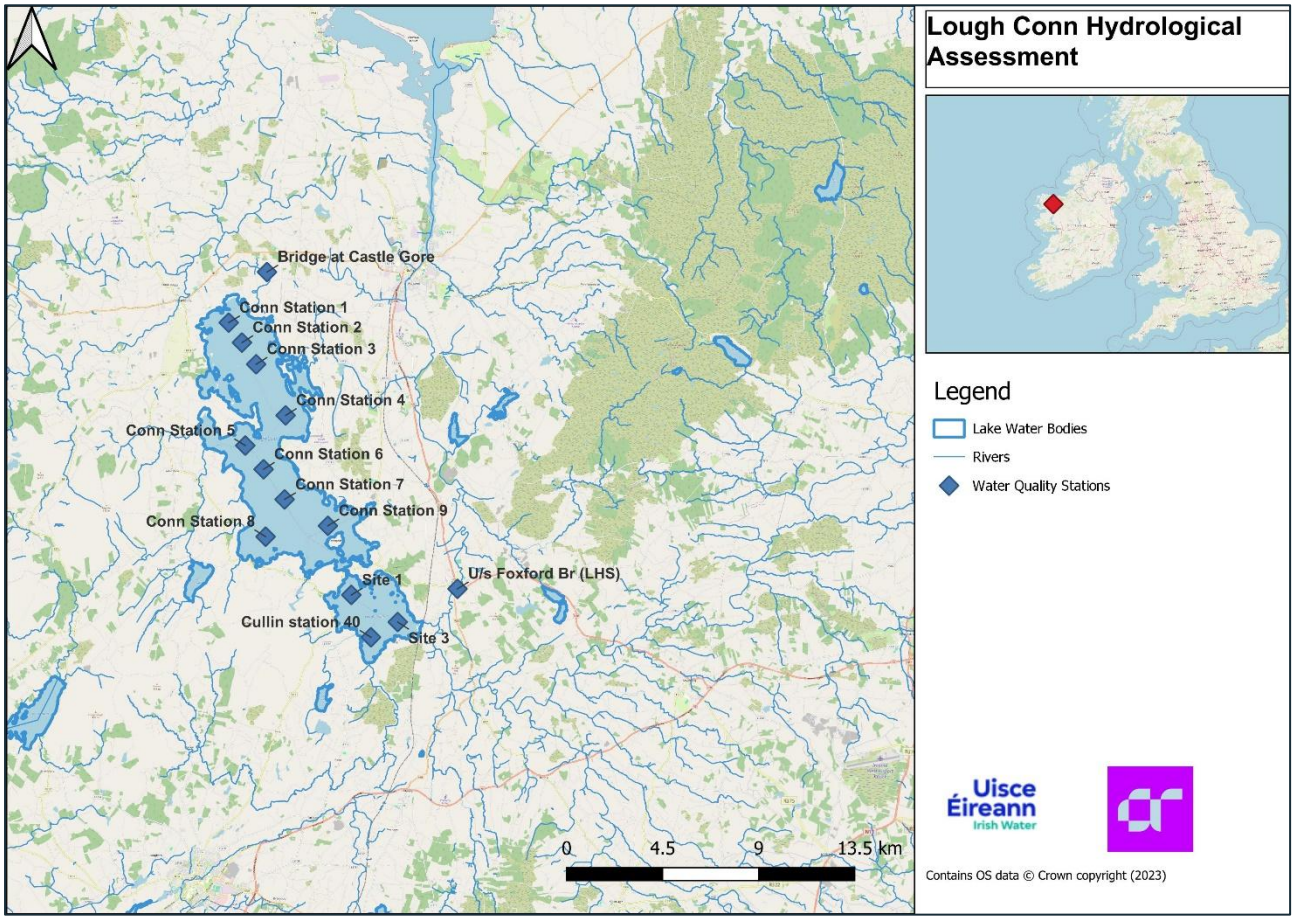


Figure 3-8 – Map showing the location of the water quality monitoring stations used in the assessment

Water quality data was downloaded from the website Catchments.ie. Where available, a total of 10 years' worth of data has been reviewed. This data has been reviewed against applicable WFD water quality standards (SI 77/2019).. Water quality standards for all waterbodies have been assumed as

"Lowland and high alkalinity" based on an average altitude of 8m and using the mean alkalinity for each site.

3.2.4 WFD compliance assessment

3.2.4.1 Background

There are a number of WFD objectives in respect of which the quality of water is protected. The key objectives at EU level are the general protection of aquatic ecology, specific protection of unique and valuable habitats, the protection of drinking water resources, and the protection of bathing water (see Table 3-6). The objective is to achieve this through a system of river basin management planning and extensive monitoring. 'Good Status' means both "Good Ecological Status" (GES) (or "Good Ecological Potential" (GEP) for a HMWB) and "Good Chemical Status" (GCS).

Table 3-6 – WFD Environmental Objectives

Objective
Member States shall implement the necessary measures to prevent deterioration of the status of all bodies of surface water.
Member States shall protect, enhance and restore all bodies of surface water, subject to the application of subparagraph (iii) for artificial and heavily modified bodies of water, with the aim of achieving good surface water status by 2015.
Member States shall protect and enhance all artificial and heavily modified bodies of water, with the aim of achieving good ecological potential and good surface water chemical status by 2015. Where this is not possible and subject to the criteria set out in the Directive, aim to achieve good status by 2021 or 2027.
Progressively reduce pollution from priority substances and cease or phase out emissions, discharges and losses of priority hazardous substances.
Prevent Deterioration in Status and prevent or limit input of pollutants to groundwater

The WFD was initially transposed into Irish law by S.I. No. 722/2003 – European Communities (Water Policy) Regulations 2003 (commonly referred to as the Water Policy Regulations). The Water Policy Regulations require the assessment of permanent impacts of a project on WFD waterbodies (this includes both operation and construction related impacts).

For the purpose of this assessment the focus is on the operational impacts (i.e. the change in abstraction regime) to determine whether the abstraction changes will not result in:

- Changes affecting "High" ecological status sites;
- Changes that will cause failure to meet surface water GES or GEP or result in a deterioration of surface water ecological status or potential;
- Changes which will permanently prevent or compromise the Environmental Objectives being met in other water bodies; and
- Changes that will cause failure to meet good groundwater status or result in a deterioration of groundwater status.

As noted, the existing maintenance issues at the intake (noted Table 1-1) will also need to be addressed as part of any proposals to increase abstraction from Lough Conn to assess the impacts associated with outages to accommodate manual silt removal and to improve the interface with the lakeshore. Any works required to address the maintenance issues are not subject to this assessment report but will need to be considered as part of the wider assessments (e.g. the EIA).

The Water Abstractions and Associated Impoundments – Methodology to Assess and Identify Significant Abstractions (EPA, 2025) provides the national framework for assessing the impacts of abstractions on river, lake and groundwater bodies in Ireland, ensuring that abstraction activities are evaluated in line with the WFD requirements. In addition, The UK Planning Inspectorate provides a three-stage assessment framework to structure WFD appraisals[20]. This assessment comprises of the following stages:

- Stage 1: Screening (baseline assessment),
- Stage 2: Scoping (preliminary assessment) and,
- Stage 3: Detailed impact assessment.

3.2.4.2 Screening

Water bodies were selected for inclusion at this early stage of the compliance assessment with reference to the relevant River Basin Management Plan (RBMP). An initial screening exercise has been undertaken to identify the relevant WFD water bodies located in the zone of influence (see Section 4.3). To support the screening exercise, a desktop review was undertaken to collate and review data on the water body status and status objectives information for the relevant WFD water bodies.

3.2.4.3 Scoping (preliminary assessment)

Scoping comprises a more detailed assessment to identify risks from the proposed abstraction on the relevant WFD water bodies and their quality elements. The aim of this assessment is to identify whether there is potential for deterioration in water body status or failure to comply with WFD objectives for any of the water bodies identified in the screening stage (and their WFD quality elements) and establish if further assessment is required.

3.2.4.4 Detailed assessment

Stage 3 is a detailed assessment of water bodies and activities carried forward from the scoping stage. It includes identification of water bodies, description of the project under investigation, embedded mitigation, methods used to determine impacts, risk of deterioration, and mitigation required. The objective of the impact assessment is to establish the nature and anticipated magnitude of the effects of relevant scheme components on the WFD quality elements of the surface water and groundwater bodies affected by the scheme. These effects are to be considered in terms of the potential for deterioration of current status and/or the prevention of status objectives.

[20] The Planning Inspectorate (2017) Advice Note 18: The Water Framework Directive. June 2017

IMPACT ASSESSMENT

4. Impact assessment

4.1 Hydrological impacts

The hydrological impacts of the increased abstraction from Lough Conn have been assessed under the scenario of increased demand to 40,000 m^3/day. The impact of this scenario has been considered against WFD flow standards shown in Table 3-4, and estimates of natural flows downstream of Lough Cullin derived from the flow routing model, and the gauged record at Foxford.

It is important to note that the assessment location represents approximately 1 km of the Moy_100 water body, which extends for approximately 46 km. Under the guidance for significant abstraction assessment, up to 15% of the water body may fail the e-flow test. Consequently, the identification of a local e-flow breach at this location would not, in itself, demonstrate non-compliance at the overall WFD water-body level.

4.1.1 HydroTool flow estimates

The results for the proposed abstraction rate were compliant with the targets for at least "Good" ecological status at all flows at the downstream Moy confluence when considering the HydroTool estimate (Table 4-1), with the only exception of Q95, that is borderline non-compliant (0.66%, Moderate)

Uisce Éireann's Technical Guidance for Hydrological Estimation requires that, where HydroTool flow estimates are to be used in licencing applications, the impact on the watercourse should be assessed for the modelled Q95 flow and the Q95 flow ±50% to understand the importance of the Qn95 flow estimate for the impact assessment.

The compliance assessment for the naturalised flows + 50% is provided in Table 4-2. The results indicate that the existing and proposed abstraction rates are compliant with the targets for at least "Good" ecological status at all flows in this scenario.

Considering the compliance assessment for the naturalised flows - 50% (see Table 4-3), this scenario indicates that the outflow of Lough Cullin would be at risk of non-compliance with "Good" ecological status in low flow conditions (Q90 and Q95), while the downstream Moy confluence would only be at risk of non-compliance for Q95.

Table 4-1 – Flow standards based on HydroTool flow estimates at the Lough Cullin outflow and the River Moy outflow

Q (%ile)	Permissible Take of Qn	Qn (m^3/s)	Proposed Take	Proposed take compliance
	Good			
Lough Cullin Outfall				
NATQ1	25%	112.48	0.41%	High
NATQ10	25%	56.98	0.81%	High
NATQ20	25%	39.05	1.19%	High
NATQ30	25%	29.73	1.56%	High
NATQ40	25%	23.27	1.99%	High

Q (%ile)	Permissible Take of Qn	Qn (m^3/s)	Proposed Take	Proposed take compliance
	Good			
NATQ50	25%	18.21	2.54%	High
NATQ60	20%	14.23	3.25%	High
NATQ70	15%	10.97	4.22%	High
NATQ80	15%	8.31	5.57%	High
NATQ90	15%	5.71	8.11%	High
NATQ95	10%	4.35	10.66%	Moderate
D/S Moy Confluence				
NATQ1	25%	250.71	0.18%	High
NATQ10	25%	130.32	0.36%	High
NATQ20	25%	87.39	0.53%	High
NATQ30	25%	64.58	0.72%	High
NATQ40	25%	48.47	0.96%	High
NATQ50	25%	36.37	1.27%	High
NATQ60	20%	26.98	1.72%	High
NATQ70	15%	19.38	2.39%	High
NATQ80	15%	13.34	3.47%	High
NATQ90	15%	8.06	5.74%	High
NATQ95	10%	5.81	7.97%	Good

Table 4-2 – Flow standards based on HydroTool flow estimates +50% at the Lough Cullin outflow and the River Moy outflow

Q (%ile)	Permissible Take of Qn	Qn (m^3/s)	Proposed Take	Proposed take compliance
	Good			
Lough Cullin Outfall				
NATQ1	25%	168.72	0.27%	High
NATQ10	25%	85.47	0.54%	High
NATQ20	25%	58.57	0.79%	High
NATQ30	25%	44.59	1.04%	High
NATQ40	25%	34.90	1.33%	High
NATQ50	25%	27.31	1.69%	High
NATQ60	20%	21.34	2.17%	High
NATQ70	15%	16.46	2.81%	High
NATQ80	15%	12.47	3.71%	High
NATQ90	15%	8.57	5.40%	High
NATQ95	10%	6.52	7.10%	Good
D/S Moy Confluence				
NATQ1	25%	376.06	0.12%	High
NATQ10	25%	195.48	0.24%	High
NATQ20	25%	131.09	0.35%	High
NATQ30	25%	96.86	0.48%	High
NATQ40	25%	72.71	0.64%	High
NATQ50	25%	54.56	0.85%	High
NATQ60	20%	40.46	1.14%	High
NATQ70	15%	29.07	1.59%	High
NATQ80	15%	20.01	2.31%	High
NATQ90	15%	12.09	3.83%	High
NATQ95	10%	8.71	5.32%	High

Table 4-3 – Flow standards based on HydroTool flow estimates -50% at the Lough Cullin outflow and the River Moy outflow

Q (%ile)	Permissible Take of Qn	Qn (m^3/s)	Proposed Take	Proposed take compliance
	Good			
Lough Cullin Outfall				
NATQ1	25%	56.24	0.82%	High
NATQ10	25%	28.49	1.62%	High
NATQ20	25%	19.52	2.37%	High
NATQ30	25%	14.86	3.11%	High
NATQ40	25%	11.63	3.98%	High
NATQ50	25%	9.10	5.08%	High
NATQ60	20%	7.11	6.51%	High
NATQ70	15%	5.49	8.44%	High
NATQ80	15%	4.16	11.14%	Good
NATQ90	15%	2.86	16.21%	Moderate
NATQ95	10%	2.17	21.31%	Moderate
D/S Moy Confluence				
NATQ1	25%	125.35	0.37%	High
NATQ10	25%	65.16	0.71%	High
NATQ20	25%	43.70	1.06%	High
NATQ30	25%	32.29	1.43%	High
NATQ40	25%	24.24	1.91%	High
NATQ50	25%	18.19	2.55%	High
NATQ60	20%	13.49	3.43%	High
NATQ70	15%	9.69	4.78%	High
NATQ80	15%	6.67	6.94%	High
NATQ90	15%	4.03	11.49%	Good
NATQ95	10%	2.90	15.95%	Moderate

4.1.2 Donor gauge/ flow routing model

According to the analysis presented in Figure 4-1, the proposed abstraction rates are compliant with the standards required to achieve “Good” ecological status across the full range of flow conditions. The only exception occurs when flows transferred from the Kiltimagh gauge are used within the routing mode. Therefore, the proposed abstraction rate results in a minor breach of “Good” flow standard. As previously concluded, this exceedance is considered negligible and is not expected to have a significant effect with regard the overall water body status.

Ballysadare Hydrology				
Q (%ile)	Permissible Take of Qn Good	Qn (m^3/s)	Proposed Take	Proposed Standards
NATQ1	25%	86.33	0.5%	High
NATQ10	25%	56.03	0.8%	High
NATQ20	25%	43.96	1.0%	High
NATQ30	25%	36.03	1.3%	High
NATQ40	25%	29.65	1.5%	High
NATQ50	25%	24.26	1.9%	High
NATQ60	20%	19.09	2.5%	High
NATQ70	15%	15.09	3.0%	High
NATQ80	15%	11.18	4.1%	High
NATQ90	15%	7.67	5.7%	High
NATQ95	10%	5.86	7.5%	Good

Kiltimagh Hydrology				
Q (%ile)	Permissible Take of Qn Good	Qn (m^3/s)	Proposed Take	Proposed Standards
NATQ1	25%	62.32	0.6%	High
NATQ10	25%	43.16	1.0%	High
NATQ20	25%	34.52	1.3%	High
NATQ30	25%	29.02	1.6%	High
NATQ40	25%	22.72	2.2%	High
NATQ50	25%	16.31	3.2%	High
NATQ60	20%	12.12	4.8%	High
NATQ70	15%	9.31	4.9%	High
NATQ80	15%	6.66	5.8%	High
NATQ90	15%	4.03	9.7%	High
NATQ95	10%	3.07	11.7%	Moderate

Cloonacannana Hydrology				
Q (%ile)	Permissible Take of Qn Good	Qn (m3/s)	Proposed Take	Proposed Standards
NATQ1	25%	43.57	1.0%	High
NATQ10	25%	32.42	1.4%	High
NATQ20	25%	27.47	1.6%	High
NATQ30	25%	24.41	1.9%	High
NATQ40	25%	21.60	2.0%	High
NATQ50	25%	18.43	2.5%	High
NATQ60	20%	16.06	2.8%	High
NATQ70	15%	14.12	3.2%	High
NATQ80	15%	11.48	4.0%	High
NATQ90	15%	8.76	5.7%	High
NATQ95	10%	7.12	6.7%	Good

Ballycaroon Hydrology				
Q (%ile)	Permissible Take of Qn Good	Qn (m^3/s)	Proposed Take	Proposed Standards
NATQ1	25%	69.67	0.6%	High
NATQ10	25%	0.79	0.7%	High
NATQ20	25%	1.04	1.1%	High
NATQ30	25%	1.30	1.3%	High
NATQ40	25%	1.53	1.7%	High
NATQ50	25%	1.92	1.9%	High
NATQ60	20%	2.47	2.6%	High
NATQ70	15%	3.02	3.4%	High
NATQ80	15%	4.05	5.0%	High
NATQ90	15%	5.66	9.7%	High
NATQ95	10%	7.53	7.3%	Good

Figure 4-1 – Compliance with flow targets at the outflow of Lough Cullin in view of modelled inflows using the selected donor gauges

4.1.3 Gauged data

The compliance standards for river flows were also applied to Foxford gauge record, downstream of Lough Cullin/River Moy confluence for this assessment. Basic naturalisation was applied to observed record before application of standards. The result of increasing the proposed abstraction rate to 40,000 m^3/day is presented in Table 4-4. Results indicate that both the existing and proposed abstraction rates are compliant with the targets for Good status at all flows.

Table 4-4 – Compliance with flow targets at the Foxford on the River Moy in view of naturalised flow form gauged data

Q (%ile)	Permissible Take of Qn (Good)	Qn (m3/s)	Proposed take	Proposed standard
NATQ1	25%	170.16	0.3%	High
NATQ10	25%	111.16	0.4%	High
NATQ20	25%	85.46	0.5%	High
NATQ30	25%	69.76	0.7%	High
NATQ40	25%	57.76	0.8%	High
NATQ50	25%	46.46	1.0%	High
NATQ60	20%	36.16	1.3%	High
NATQ70	15%	26.16	1.8%	High
NATQ80	15%	18.06	2.6%	High
NATQ90	15%	10.96	4.4%	High
NATQ95	10%	7.68	6.4%	Good

4.1.4 Changes in lough water levels

Under the EPA (2025) guidance, Table 4 of the guidance sets allowable reductions in the lake habitable zone area of 1%, 5%, 10%, and 20% for lakes with “High”, “Good”, “Moderate”, and “Poor” ecological status, respectively. However, due to insufficient bathymetric and light-penetration data for Lough Conn/Cullin, an alternative approach recommended by the guidance was applied. This approach, outlined in Table 5 of the EPA (2025) guidance, is based on evaluating allowable changes in the naturalised Q50 lake outflow. The calculated percentage reductions in outflow at the River Moy (Foxford gauge) remain well below the 10% threshold, as demonstrated in Table 4-4. For context, summer

evaporation losses from the lake can exceed 200,000 m^3/day, substantially greater than the proposed abstraction rate.

Of course, the long-term changes in level are more complex than can be inferred from the simple assumptions of the lough level regime described above. The interactions between the hydraulics of the Lough Cullin outflow, bathymetry and seasonal variations in hydrological processes means the lough routing model is a more robust method for estimating changes in level caused by increased abstraction.

The change in level regime caused by increased abstraction to 40,000 m^3/day is almost imperceptible when viewed across the whole level regime. Table 4-5 shows deviation from a "zero abstraction" regime in mm. The change in level regime is between approx. 11 and 31 mm depending on the inflows used within the routing model.

It is thought that the proposed change to level regime caused by increased abstraction would be extremely difficult to measure over the long term and may not be discernible from the uncertainties and noise that are associated with lough level measurement and long-term data sets.

It is likely that abstractions from loughs will be assessed for WFD compliance in future. Uisce Éireann's current assumption is that abstractions will be restricted to 10% of the natural Q50 inflow to ensure WFD compliance. shows that the proposed increased abstraction is considerably less than this threshold.

Table 4-5 – Change in level (mm) associated with increasing abstraction from 0 m^3/day to 40,000 m^3/day

Level Percentile	Change in level Ballysadare Hydrology	Change in level Ballycaroon Hydrology	Change in level Kiltimagh Hydrology	Change in level Cloonacannana Hydrology
5	-14.2	-19.5	-21.5	-30.7
10	-14.4	-17.1	-18.8	-31.1
20	-14.1	-17.5	-18.5	-29.0
30	-13.9	-15.1	-17.0	-27.9
40	-13.3	-16.0	-17.4	-27.3
50	-13.0	-14.7	-14.4	-25.1
60	-13.1	-14.4	-13.9	-24.4
70	-13.3	-13.5	-15.8	-22.8
80	-13.4	-12.8	-17.2	-21.8
90	-14.2	-11.4	-21.3	-21.2
95	-14.7	-13.8	-24.0	-19.2

Lastly, a consideration of the abstraction relative to the Qn50 inflow is provided in Table 4-6.

Table 4-6 – Increased abstraction for future domestic and non-domestic use as a proportion of Qn50 inflows

Flow Estimate Method	Qn50 (m^3/day)	40,000 m^3/day as % take of Q50 inflow
HydroTool	1,486,000	2.6%
Ballycaroon HT Scaled	1,138,000	3.5%

Flow Estimate Method	Qn50 (m^3/day)	40,000 m^3/day as % take of Q50 inflow
Kiltimagh HT Scaled	937,000	4.2%
Ballysadare HT Scaled	1,596,000	2.5%
Cloonacannana HT Scaled	1,236,000	3.2%

4.2 Water quality

4.2.1 Baseline

Summary statistics for each waterbody are provided in Table 4-7.

- Ammonia concentrations at all assessed sites achieved at least “Good” ecological status .
- Dissolved oxygen saturation in the River Deel and River Moy achieved the standard for “Good” ecological status. Dissolved oxygen concentration in Lough Conn and Lough Cullin also achieved the standard for “Good” ecological status.
- Orthophosphate (SRP) concentrations were below the target for “Good” ecological status in the River Deel and River Moy while Total Phosphorus in Lough Coon and Lough Cullin were also below WFD target for “Good” ecological status.
- pH at all assessed sites achieved at least “Good” ecological status.

Table 4-7 – Summary statistics for each assessed waterbody

Determinand	Statistic	River Deel (Crossmolina)	Lough Conn	Lough Cullin	River Moy
Ammonia (mg/l)	Annual average	0.017	0.022	0.015	0.1
BOD (mg/l)	Annual average	0.75	-	-	0.5
Dissolved Oxygen Saturation %	95th percentile	88	95.0	93.0	99
Orthophosphate (mg/l)	Annual average	0.012	0.0053	0.0054	0.0085
pH	Annual average	7.75	8.17	8.29	8.15
Total P (mg/l)	Annual average	0.028	0.0084	0.011	-

4.2.2 Impact assessment

The hydrological assessment has identified a minimal change in flow level with <5% change anticipated. As all assessed hydrological parameters in both river and lake waterbodies achieve at least “Good” WFD status, with most achieving High status, the proposed scheme is not expected to result in significant impacts on water quality.

4.3 WFD compliance

4.3.1 Screening

4.3.1.1 Water bodies

The change in abstraction has the potential to impact on surface water bodies directly associated with the abstraction and water bodies downstream of the loughs. The scheme is unlikely to affect surface water bodies upstream of the loughs (i.e. lough inflows) and is also unlikely to affect groundwater bodies.

The WFD water bodies screening is summarised in Table 4-8. Although the River Moy (Moy_100) is hydrologically connected to the downstream water bodies, the hydrological assessment indicates that the proportionate change in flow downstream of Foxford is of a magnitude that will not result in any discernible changes in flow.

Table 4-8 – Summary of screening of WFD water bodies associated with the investigation

Name	ID	Type	Overall status (2019 – 2024)	Screening (In/Out)
Conn	IE_WE_34_406b	Lake	Good	In
Cullin	IE_WE_34_406a	Lake	Moderate	In
Moy_100	IE_WE_34M020800	River	Moderate	In
Moy_110	IE_WE_34M020850	River	Good	Out
Moy_120	IE_WE_34M021100	River	Moderate	Out
Moy Estuary	IE_WE_420_0300	Transitional	Moderate	Out

4.3.1.2 Water body baseline information

Ireland is currently in the third cycle of WFD implementation, which covers the period 2022-2027. Ireland's draft River Basin Management Plan, which was published in 2021, sets out the status objectives to be achieved by year 2027. The latest available status classification for all water bodies covers the period 2019-2024.

The latest WFD baseline condition has been summarised below in Table 4-9 for those WFD water bodies that have been screened into the assessment. This includes their status, failing elements and designations based on the 2019 – 2024 data.

As identified in Section 2.3, the WFD water bodies are associated with the River Moy SAC and the Lough Conn and Lough Cullin SPA. The water bodies are not considered artificial or heavily modified and are not noted as reservoirs.

Table 4-9 – WFD surface water body information summary (data obtained via the EPA's Water Map data viewer[21])

	Conn	Cullin	Moy_100
Water Body ID	IE_WE_34_406b	IE_WE_34_406a	IE_WE_34M020800
Type	Lake	Lake	River
WFD Risk	Review	At Risk	At Risk
Designation	Not artificial, not a reservoir, not heavily modified	Not artificial, not a reservoir, not heavily modified	Not artificial, not a reservoir, heavily modified (unknown)
High Status Objective	No	No	No
Protected Area	Yes	Yes	Yes
Transboundary	No	No	No
Ecological Status or Potential	Good	Moderate	Moderate
Biological Status or Potential	Good	Moderate	Moderate
Phytoplankton Status or Potential	High	High	-
Other Aquatic Flora Status or Potential	Good	Moderate	-
Macrophyte Status or Potential	Good	Moderate	-
Phytobenthos Status or Potential	Not Applicable	Good	-
Invertebrate Status or Potential	Not Applicable	Monitored, but no standards	Moderate
Fish Status or Potential	Not Applicable	Moderate	-
Hydromorphological Conditions	Good	Moderate	-
Supporting Chemistry Conditions	High	Moderate	Pass
General Conditions	High	Moderate	Pass
Thermal Conditions	High	Pass	
Water Temperature (C)	High	Pass	-
Oxygenation Conditions	High	Pass	Pass
Dissolved Oxygen (% Sat)	High	-	Pass
Other determinands for oxygen condition	-	-	High
Acidification Conditions	High	High	Pass
pH	High	High	Pass

[21] Data - Catchments.ie - Catchments.ie

	Conn	Cullin	Moy_100
Nutrient Conditions	High	Moderate	Pass
Other determinand for nutrient conditions	High	Moderate	-
Nitrogen Conditions	High	High	Pass
Nitrate	-	-	High
Ammonium	High	High	High
Phosphorous Conditions	High	Good	High
Orthophosphate	-	-	High
Total phosphorous	High	Good	-
Specific Pollutant Conditions	Not Applicable	Pass	-
Chemical Surface Water Status	Not Applicable	-	-

4.3.1.3 Significant Pressures

Significant pressures on the Ecological status have been identified for the Cullin water body. This includes urban wastewater, invasive species and agriculture. Significant pressures have been identified for the Moy_100 water body (agriculture).

4.3.1.4 Status failure reasons

The reasons for failure for the Cullin water body have been identified as Mercury Failure for Chemical Status in 2020, and macrophytes not attaining “Good” ecological status due to the presence of invasive species.

4.3.2 Scoping (Preliminary assessment)

The change in abstraction could also result in various impacts that could directly or indirectly affect the WFD status of the water bodies. The following potential impacts associated with the change in abstraction are summarised in Table 4-10 below. The scoping (preliminary assessment of risk to WFD compliance) considered the following:

- Changes in flow, flow velocity and / or water level;
- Changes in water quality and water quality processes;
- Loss of habitat; and
- Changes in barrier porosity.

Potential impacts have been identified on several elements in all of the water bodies screened in for assessment. As such, a detailed assessment is required.

Table 4-10 – Scoping of potential impacts for risk to WFD quality elements (red = potential impact pathway applicable for element, green = impact pathway not applicable for element)

Main Element	Changes in flow, flow velocity and / or water level	Changes in water quality and water quality processes	Loss of habitat	Changes in barrier porosity
Conn (IE_WE_34_406b)				
Biological Status or Potential				
Hydromorphological Conditions				
Supporting Chemistry Conditions				
Chemical Surface Water Status				
Cullin (IE_WE_34_406a)				
Biological Status or Potential				
Hydromorphological Conditions				
Supporting Chemistry Conditions				
Chemical Surface Water Status				
Moy_100 (IE_WE_34M020800)				
Biological Status or Potential				
Hydromorphological Conditions				
Supporting Chemistry Conditions				
Chemical Surface Water Status				

4.3.3 Detailed assessment

4.3.3.1 Changes in flow, flow velocity and / or water level

The change in abstraction could result in changes in water levels within the lakes as well as flows, flow velocity and water levels in the downstream / receiving water bodies. This could have direct impacts on biological elements as well as indirect impacts on hydromorphology.

Direct impacts on biology includes, for example:

- A loss in physical habitat due to changes in lake extent and watercourse wetted width and /or depth.
- A change in aquatic community structure with a loss of riverine taxa with a preference for fast flow water (resulting in a change in biological quality scores).
- Changes in fish migration triggers resulting in delayed migration.

To quantify the risk to WFD quality elements, a compliance assessment was undertaken in view of available WFD standards. The potential risk to WFD compliance as a result of the change in abstraction and the consequent changes in water levels are considered in more detail in Section 4.1. This risk assessment considered the WFD compliance risk for all water bodies screened in for further assessment (i.e. lake and river water bodies). This was achieved by considering the available WFD standards for the permitted abstraction per day as a percentage of the natural mean daily flow (Q) for rivers and also considered the reduction in the habitable zone lake surface area.

The hydrological assessment used Uisce Éireann's Technical Guidance for Hydrological Estimation to define inflows and outflows and also used measured data (e.g. lake level data).

- The modelled data suggests that the increase in abstraction would equate to a level change between 11 and 31 mm over a lough surface area of 54.1 km^2. As the change in lake levels be imperceptible, there is unlikely to be any change in shoreline habitat quality and interaction with wetland habitats that support the protected bird communities.
- The compliance assessment also indicates that river flows will remain compliant with the target for achieving "Good" ecological status under all flow conditions. The assessment did indicate a potential risk to WFD compliance at low flows, especially when adopting an approach of reducing modelled Q90 and Q95 flows by 50%. The HydroTool accuracy varies across the flow duration curve and is approximately ±50% for Q95 flow estimates. Based on a donor gauge assessment approach with flow routing modelling, and in view of measured data, the reduction in flows by 50% is not considered to accurately represent the low flows in the River Moy.

4.3.3.2 Changes in water quality and water quality processes

Changes in lake levels or river flows / levels could result in changes in the water quality process. This includes, for example, increased temperatures, decreased dissolved oxygen concentrations and decrease in dilution capacity resulting in increased nutrient concentrations. Based on the available data it is concluded that lake levels and river flows will remain compliant with WFD standards for achieving "Good" to "High" ecological status. As such, there is unlikely to be any water quality changes as a result of the change in abstraction regime.

4.3.3.3 Loss of habitat

A change in river flows, velocity and / or level could result in change in hydromorphology and river process such as erosion and deposition. This could result in habitat loss or change in habitat conditions with direct impacts on biological quality elements. A change in lake levels could result in a direct loss of habitat. This includes the extent of the shoreline habitat and the reduction in the habitable zone lake surface area.

Based on the available data it is concluded that lake levels and river flows will remain compliant with WFD standards for achieving “Good” to “High” ecological status. As such, there is unlikely to be any change in geomorphological process or a loss of habitat as a result of the change in abstraction regime.

4.3.3.4 Changes in barrier porosity

Changes in river flows / level could affect the porosity of instream barriers and the functioning of fish passes. A review of the available data suggests a barrier on the River Moy (the Ballina Salmon Weir was restored in 2011). Two potential barriers identified between Lough Cullin and the River Moy (which included an old eel weir). As river flows will remain compliant with the WFD standards and there will be no discernible change in flow downstream of Foxford, there is no risk to changes in barrier porosity.

As changes in river flow will not be discernible, there is unlikely to be any fragmentation of habitats or barriers to migration, especially during autumn and winter flows (when Atlantic salmon and lamprey species are undertaking spawning migration).

4.3.4 Summary

A summary of the assessment in view of the quality elements in each water body that could be affected by the change in abstraction regime is provided in Table 4-11. In view of the potential impacts on lake levels and river flows, the change in abstraction regime will not result in a deterioration in existing status of any of the WFD water bodies in either of the abstraction scenarios considered and will also not prevent the water bodies from attaining “Good” ecological status where not currently achieved.

Furthermore, abstraction has not been identified as a significant pressure or a status failure reason. As the lake levels and river flows will remain compliant with WFD standards for achieving “Good” to “High” ecological status, the change in abstraction will not contribute to the status failure reasons or the significant pressures that have been identified for the surface water bodies.

Table 4-11 – Summary of assessment against WFD quality elements for each surface water body (green = no risk to WFD stats/objectives; NA = impact pathway not applicable to WFD element)

Main Element	Changes in flow, flow velocity and / or water level	Changes in water quality and water quality processes	Loss of habitat	Changes in barrier porosity
Conn (IE_WE_34_406b)				
Biological Status or Potential				N/A

Hydromorphological Conditions		N/A		N/A
Supporting Chemistry Conditions	N/A		N/A	N/A
Chemical Surface Water Status	N/A		N/A	N/A
Cullin (IE_WE_34_406a)				
Biological Status or Potential				N/A
Hydromorphological Conditions		N/A		N/A
Supporting Chemistry Conditions	N/A		N/A	N/A
Chemical Surface Water Status	N/A		N/A	N/A
Moy_100 (IE_WE_34M020800)				
Biological Status or Potential				
Hydromorphological Conditions		N/A		N/A
Supporting Chemistry Conditions	N/A		N/A	N/A
Chemical Surface Water Status	N/A		N/A	N/A

CONCLUSIONS

5. Conclusion and recommendations

In setting out to appraise the risk to WFD compliance of increasing abstraction from Lough Conn, this report brings together existing WFD classification with hydrological information that is currently available to assess the likely change to water level, river flows and water quality. Lough Conn is a substantial water resource and based on our Phase 1 assessment, we conclude that the risk to WFD compliance caused by increased abstraction is very low and no further investigation would be required.

This is confirmed by applying WFD compliance targets using three separate hydrological approaches. A summary of key findings, remaining uncertainty and recommendations are provided below.

5.1 Summary of key findings

- Lough Conn and Lough Cullin sits within the Moy River catchment. The upstream sub-catchments include the Deel (Crossmolina), Addeergoole and Castlebar. Lough Conn and the downstream Lough Cullin sit within the Moy sub-catchment. Lough Conn has an RBMP3 C3 classification of "Good' WFD status whereas Lough Cullin achieves Moderate WFD status. The downstream River Moy also achieves Moderate WFD status.
- Lough Conn, Lough Cullin and the River Moy are associated with protected areas including the River Moy SAC and Lough Conn and Lough Cullin SPA.
- The extent of hydrological data sets needed to assess compliance against WFD targets is variable depending on the data set in question. The Lough Conn catchment is well served by the existing rain gauge network for example, but less so by gauges that directly measure inflow to the lough. A detailed bathymetric survey and information on the outflow control hydraulic characteristics are absent. However, data on water levels is considered good for both Lough Conn and Lough Cullin.
- A visual inspection of the Pontoon Narrows and the water level record of both Lough Conn and Lough Cullin suggest that water passes through the narrows unhindered and both loughs have the same level regime. Therefore, the assessment assumed that Lough Conn and Lough Cullin should be treated as one body of water.
- Three separate approaches have been used to assess the impact of increased abstraction on downstream river flow, namely the EPA HydroTool, direct flow measurement and donor transfer with lough routing. These approaches considered an increase in abstraction to 40,000 m^3/day. Use of differing approaches allows the sensitivity of WFD compliance thresholds to flow estimation methods to be understood and adds confidence to the overall results as outputs from individual approaches align.
- The geology of the Lough Conn catchment is complex and consequently it is thought that rainfall-runoff response could vary substantially on a sub catchment basis. This has not been explored in this phase of the project. Instead, inflows have been estimated using donor transfer methods to generate a variety of plausible inflows and examine the impact of abstraction increase. As above, this allows the sensitivity of WFD compliance thresholds to hydrological assumptions be understood and adds confidence to the overall results.
- River flow standards taken from the EPA Abstraction and Associated Impoundments Registration and Licence Application Guidance (EPA, 2025), which incorporates hydrological limits from

UKTAG have been applied in this assessment. The hydrological assessment showed that flow standards at the outflow of Lough Cullin would typically be “High” or “Good” depending on the flow estimation method applied following an increase in abstraction. One of the flow estimates derived from the lough routing approach suggested an exceptionally marginal failure of “Good” flow standards. However, we do not believe this would be material in respect of the overall waterbody status given the very marginal nature of the failure and its limited spatial extent. Further discussion on this issue is provided Section 5.2 below.

- The lough routing approach shows that the change in level caused by increased abstraction in Loughs Conn and Cullin would be very small compared to their existing level regime. Changes in water level are estimated to typically fall between 11 and 31 mm. In contrast the loughs have an existing regime of 3.3 m. Because the estimated change in level regime is very small relative to the existing level regime, we do not expect changes to level to affect and appreciable change to habitable zone area. It is also highly unlikely that the increased abstraction would exceed 10% of Q50 inflows, and it remains well below EPA’s 10% Q50 outflow screening criterion used as an alternative for lake risk assessment.
- Water Quality determinand data taken from the website Catchments.ie were assessed against the applicable WFD classification standards used by the EPA in Ireland. Ten years’ worth of data were reviewed and all determinands were identified as achieving at least “Good” WFD status in all waterbodies. Impacts on water quality as a result of this scheme are considered negligible.
- In view of the potential impacts on lake levels and river flows, the change in abstraction regime, will not result in a deterioration in existing status of any of the WFD water bodies and will also not prevent the water bodies from attaining “Good” ecological status where not currently achieved. Furthermore, the limited change in water level and flow within the River Moy will not result in any impacts on the designated habitats and species of the River Moy SAC or the habitats that support the designated bird communities of the SPA.

5.2 Key areas of residual uncertainty

Where hydrological data sets are incomplete or spatially sparse, understanding of some hydrological characteristics of the Lough Conn catchment is less certain. The limited nature of gauged inflows means a donor transfer approach has been used which will be inherently less certain compared to a comprehensive gauging network in the catchment. This can be seen in the differences in lough inflows derived from the donor transfer approach illustrated in Figure 3-2. There are also uncertainties associated with the HydroTool method, especially at the extremes of the flow duration curve (factorial standard error = 56% at Q95[22]).

The lough routing approach applied here also contains uncertainty. Most notable is the lack of information around the depth of the control at the outflow from Lough Cullin, its hydraulic characteristics, and the impact of high-water levels in the River Moy on outflows from the Lough Cullin catchment. Lack of a comprehensive bathymetry survey of the loughs is also a gap in current understanding. Further uncertainties may exist within the climate data used within the lough routing model, particularly open

[22] Bree, T., (2018) Flow Duration Curves for Ungauged Catchments in Ireland, *Environmental Protection Agency/Wallingford HydroSolutions Ltd.*

water evaporation. The routing model also makes a number of other assumptions which in reality may not reflect the true hydrological processes that occur in these loughs.

Despite these residual uncertainties, it does not follow that the overall conclusions of this assessment are uncertain. The methods applied have assessed WFD compliance using a range of methods, and in the case of the lough routing approach, four different inflow sequences were applied (instead of one). The calibrated routing models effectively represent the observed level regime using bathymetry and outflow ratings that are thought to be realistic. In nearly all assessment methods, the change in river flow and lake levels caused by increased abstraction result in “Good” or “High” standards, with the exception some marginal failure of good standards at Q95, which we do not to believe to be material in relation to overall water body status. The estimated change in water level caused by additional abstraction is very small compared to the existing level regime and is consistent in magnitude for a range of inflows applied in the routing model.

APPENDICES

Appendix A.

A.1 Routing model calibrated parameters and outflow rating curves

Table A-1 – Optimised rating parameters and lough bed slope.

Inflow Hydrology	Optimised Bed Slope	Rating Curve 1*			Rating Change Point (m)	Rating Curve 2*		
		Multiplier	*Offset*	*Exponent*		*Multiplier*	*Offset*	*Exponent*
Ballycaroon	1 in 10	23.36	7.99	1.74	8.35	35.10	8.30	0.74
Kiltimagh	1 in 5.1	21.32	7.95	2	8.66	34.79	8.47	0.7
Ballysadare	1 in 5.3	31.88	8.07	1.17	8.85	36.30	8.22	0.90
Cloonacannana	1 in 10.5	22.22	8.07	0.71	N/A single rating	N/A single rating	N/A single rating	N/A single rating

*Rating form $Q = C(h - \alpha)^{\beta}$

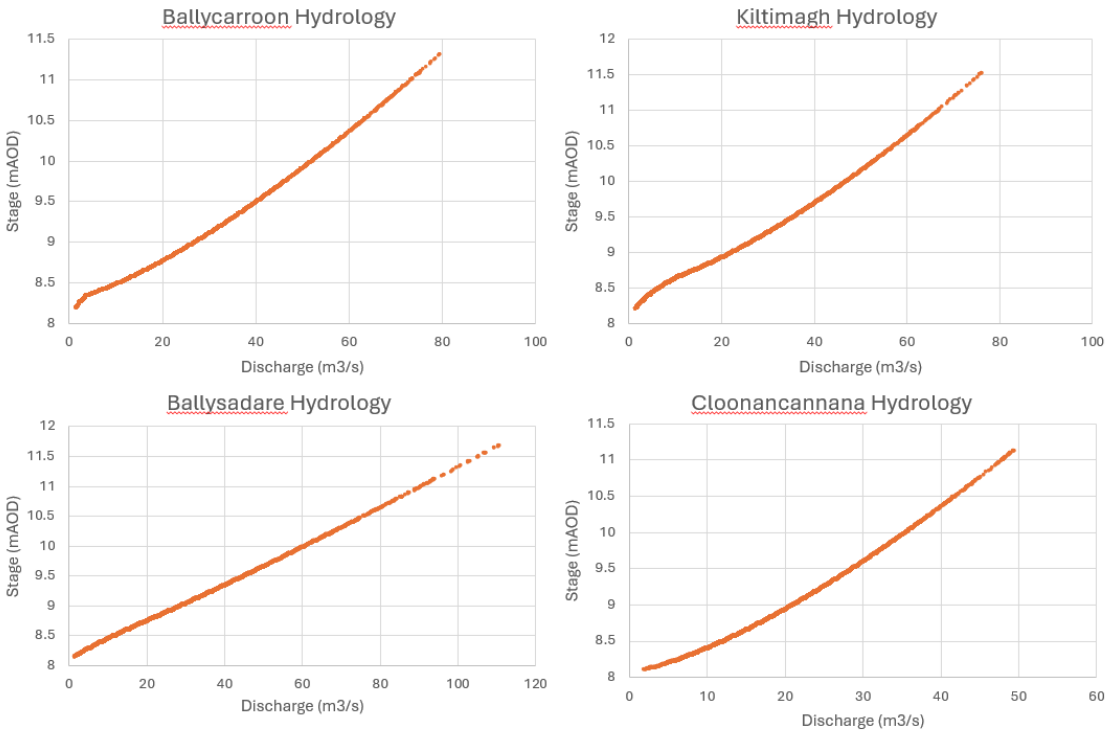


Figure A-1 – Optimised Lough Cullin Outflow Rating Curves

A.2 Routing Model Calibration – Water Level Timeseries

Observed and modelled lough levels for calibrations runs (black and red) and modelled inflows and outflows (light/dark green).

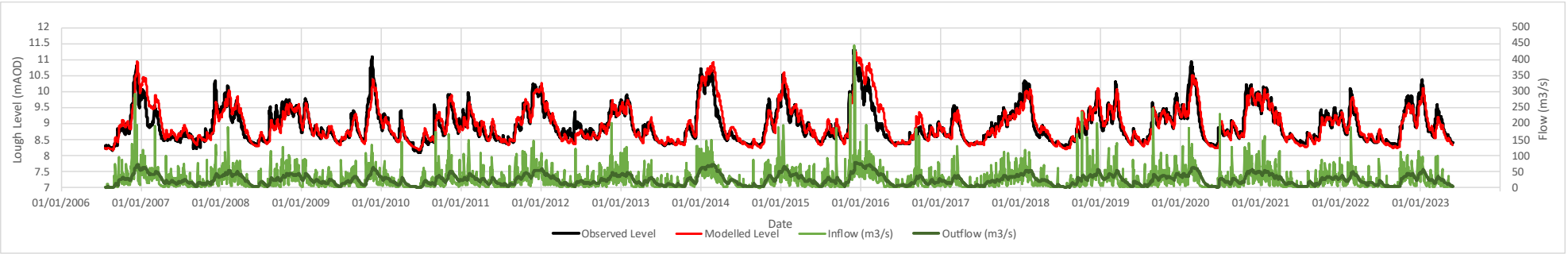


Figure A-2 – Ballycaroon Calibration

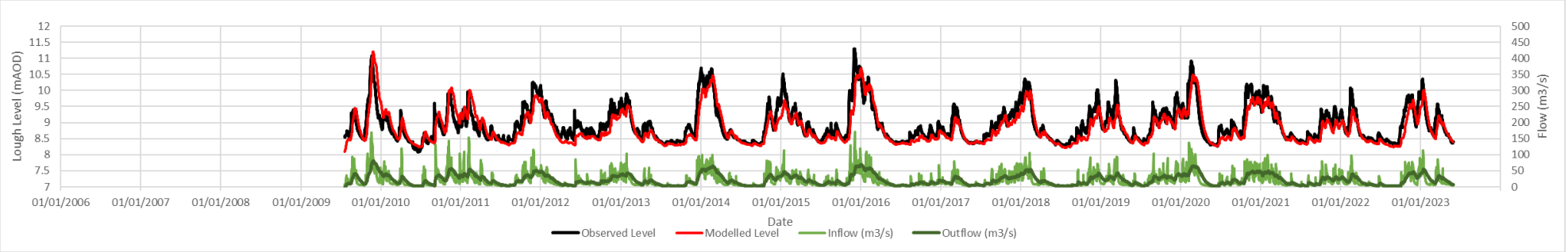


Figure A-3 – Kiltimagh Calibration

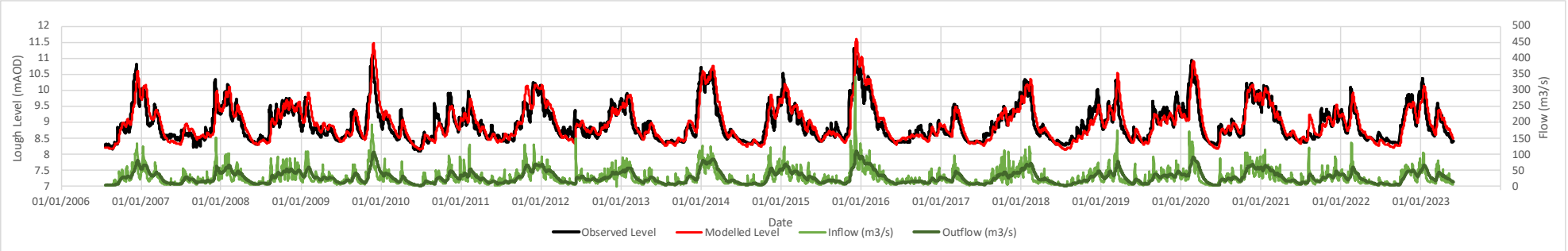


Figure A-4 – Ballysadare Calibration

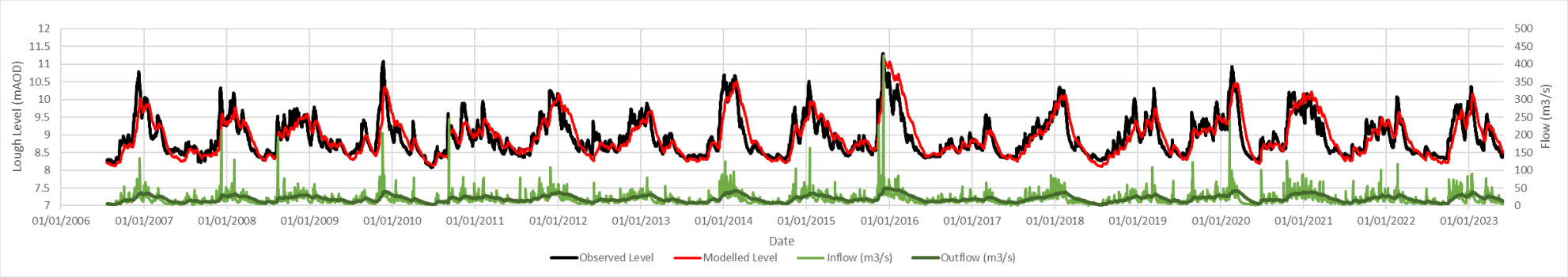
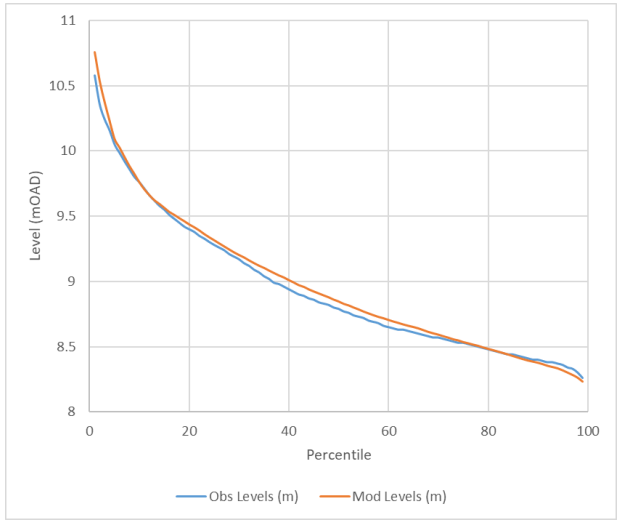


Figure A-5 – Cloonacannana Calibration

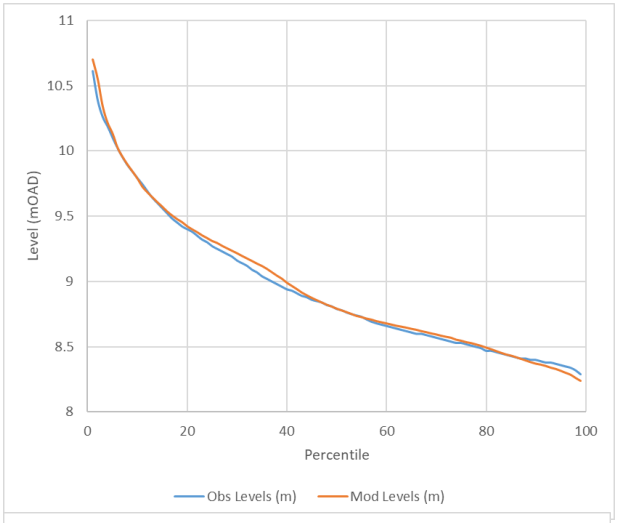
A.3 Routing Model Calibration – Level Duration Curves

Figure A-6 – Modelled and observed flow duration curves for Ballycarroon inflows (1), Kiltimagh inflows (2), Ballysadare inflows (3), Cloonacannana (4).

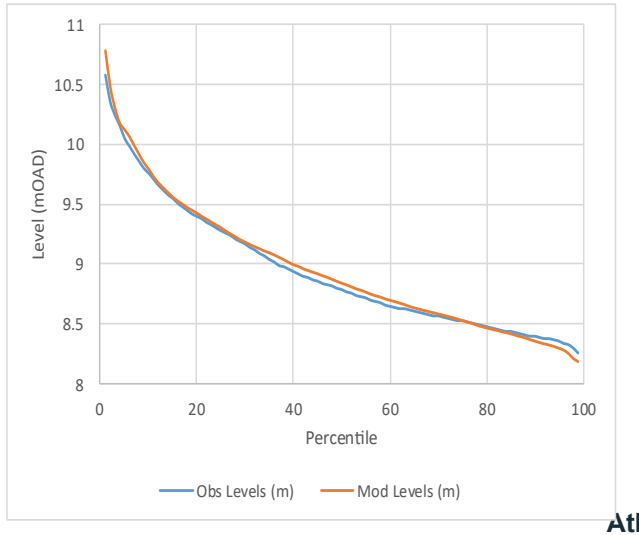
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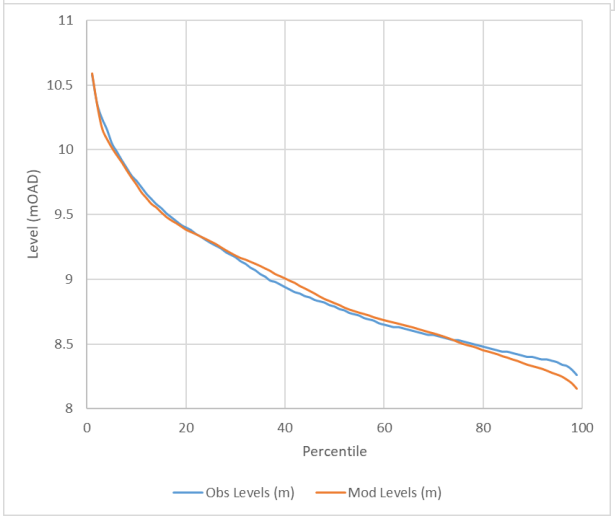
2.



3.



4.



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