

Eve O'Sullivan

Subject: Blessington RFI - modelling report
Attachments: Reg18(3)(b) Response_modelreport.pdf

From: Peter Keegan <pkeegan@water.ie>
Sent: Thursday 7 September 2023 10:48
To: Licensing Staff <licensing@epa.ie>
Cc: Eve O'Sullivan <E.O'Sullivan@epa.ie>
Subject: RE: Blessington RFI - modelling report

Good Morning,

Please see attached Water Quality Impact Assessment report as response to Regulation 18(3)(b) request for information. I am sending via email as unable to upload against the Notice on Eden.

If you have any queries, please do not hesitate to contact me

Kind regards
Peter

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07/09/2023

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Re: Blessington Reg. No. D0063-02 – Reg. 18(3)(b) Notice Response

In response to the Regulation 18(3)(b) request for information, please see below relevant information.

The primary discharge location for the Blessington agglomeration is situated between the Poulaphouca Dam, which impounds Blessington Lake, and the Golden Falls Dam, which balances discharges from the Golden Falls lake. Provide flow data for the receiving waterbody in the vicinity of the primary discharge point showing a constant minimum flow of 1.5m³/s at all times.

Please see attached a Water Quality Impact Assessment completed for the Blessington WwTP to support the licence review application reg. no. D0063-02. As part of this assessment, a detailed review of the available flow data shows that zero flow is passed between the reservoirs for up to 20% of the time (refer to Section 3 & 4 of the attached report). Modelling was therefore carried out under both mean and zero flow conditions and has demonstrated that the existing and proposed future wastewater discharges from the treatment works are compatible with the achievement of the WFD objectives of the receiving waters. A constant minimum flow of 1.5m³/s in the vicinity of the primary point is therefore not required to allow the receiving water quality to meet the relevant Environmental Quality Standards (EQSs)

Yours sincerely,



Peter Keegan

Wastewater Strategy

Enclosed: Appendix 1: Blessington WwTP Water Quality Impact Assessment

Uisce Éireann

Water Quality Impact Assessment

Blessington WWTP

Revision Number	Description of Change	Author(s)	Approved By	Date of Approval
01	For Issue to EPA	S Waite	R Kane	07/09/2023

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1 INTRODUCTION

In order to understand the potential impacts of wastewater discharges from the Wastewater Treatment Plant (WWTP) at Blessington a Water Quality Impact Assessment was carried out by Uisce Éireann . This assessment aimed to quantify the impact of the discharges on water quality in Golden Falls Reservoir under the 9,000 Population Equivalent (PE) design capacity of the WWTP and to confirm that the current Emission Limit Values (ELVs) as set in the Waste Water Discharge Licence (WWDL) are appropriate given the expected future increase in WWTP flows.

The Environmental Protection Agency provided the following request for information as part of the wastewater discharge authorisation application for Blessington (D0063-02)

“The primary discharge location for the Blessington agglomeration is situated between the Poulaphouca Dam, which impounds Blessington Lake, and the Golden Falls Dam, which balances discharges from the Golden Falls Lake. Provide flow data for the receiving waterbody in the vicinity of the primary discharge point showing a constant minimum flow of 1.5m³/s at all times.”

Flow data for the two reservoirs are provided in Section 3 and was used in the water quality analysis in Section 4.

2 SITE LOCATION AND WWTP DETAILS

2.1 Site Location

The River Liffey rises in the Wicklow Mountains south of Dublin and flows east towards Poulaphouca Reservoir (Water Framework Directive (WFD) waterbody IE_EA_09_71 Poulaphouca). Poulaphouca Reservoir is impounded by Poulaphouca dam and is a large reservoir constructed and maintained for hydroelectricity generation. The pass forward flow from Poulaphouca Reservoir is discharged to a very short (1.2km) reach of the River Liffey downstream of Poulaphouca dam (WFD waterbody IE_EA_09L010400 Liffey_040) but this section of the River immediately discharges into Golden Falls Reservoir (WFD waterbody IE_EA_09_53 Golden Falls) which is impounded by Golden Falls Dam. Blessington WWTP discharges treated wastewater to the short reach of the River Liffey immediately upstream of Golden Falls Reservoir, at Ordnance Survey Ireland National Grid Reference 294246E 208328N, southwest of Blessington (Figure 1). Pass forward flows from Golden Falls Reservoir are discharged to the River Liffey which then flows east and north towards Dublin.

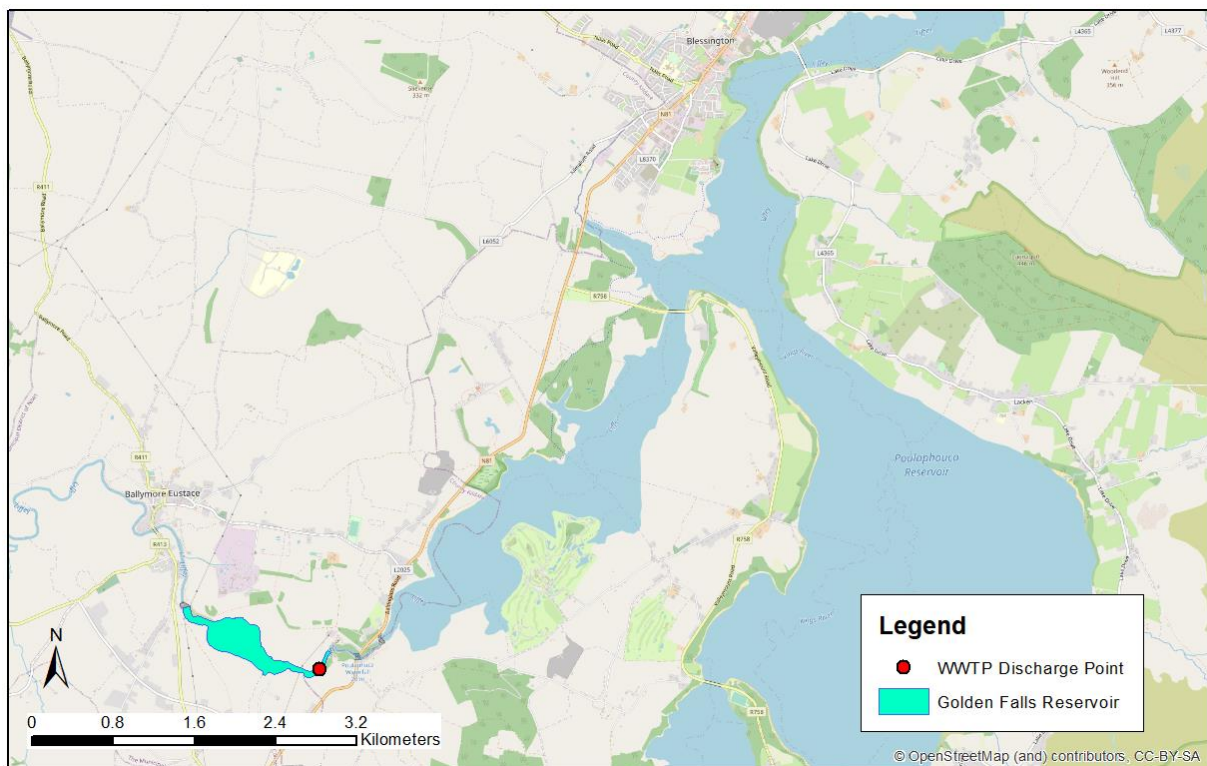


Figure 1: Blessington WWTP Outfall and Golden Falls Reservoir Location

2.2 WWTP Details

Blessington WWTP was upgraded in December 2022 from a capacity of 6,000 PE to a design capacity of 9,000 PE. During 2021 the maximum flow was estimated at 6,641 PE. The upgrades to the WWTP were completed in January 2023 and provide full primary, secondary and tertiary treatment (with phosphate removal) designed to meet the current WWDL ELVs. Upgrades to the existing aeration system are designed to cater for the increased biological load and nutrient removal required to reduce

ammonia concentrations in the final treated effluent to below 5mg/l. Effluent timeseries flow data for 2020 to 2022 are shown in Figure 2 – the current average effluent flow rate is 0.01m³/s.

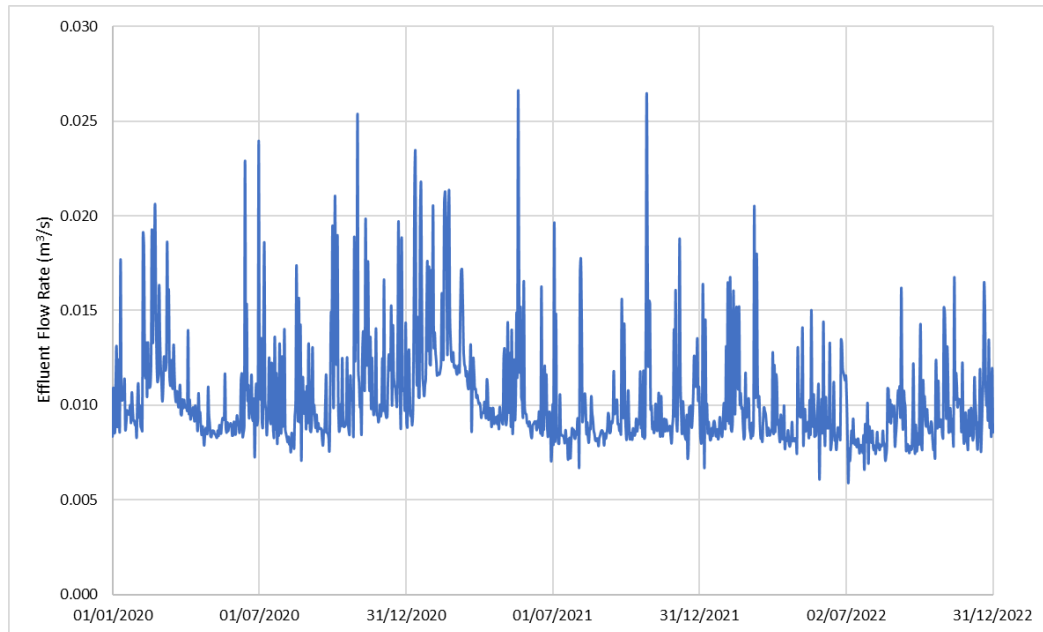


Figure 2: Blessington WWTP Influent and Effluent Flow Rates (2020-2022)

The quality of the final effluent discharged from Blessington WWTP is monitored in terms of compliance with ELV’s for maximum BOD, COD, suspended solids, ammonia and orthophosphate concentrations. The upstream and downstream water quality in Golden Falls reservoir is also monitored by Uisce Éireann and the Environmental Protection Agency to monitor impacts on water quality (Section 3.3). Effluent quality data for the period 2020-2023 are shown in Figure 3 below and summarised in Table 1. The plant was fully compliant with ELVs in 2022 and is compliant in 2023 year to date (July 2023)

Table 1: Blessington WWTP ELVs and Current Effluent Quality

Pollutant	ELV (mg/l)	2020-2023 Mean (mg/l)
Ammonia	5.0	3.51
BOD	20	6.98
Ortho-P	1.0	0.31
Total P	None	0.78
Suspended Solids	25	23.5
COD	125	51.3
Total Nitrogen	None	17.9

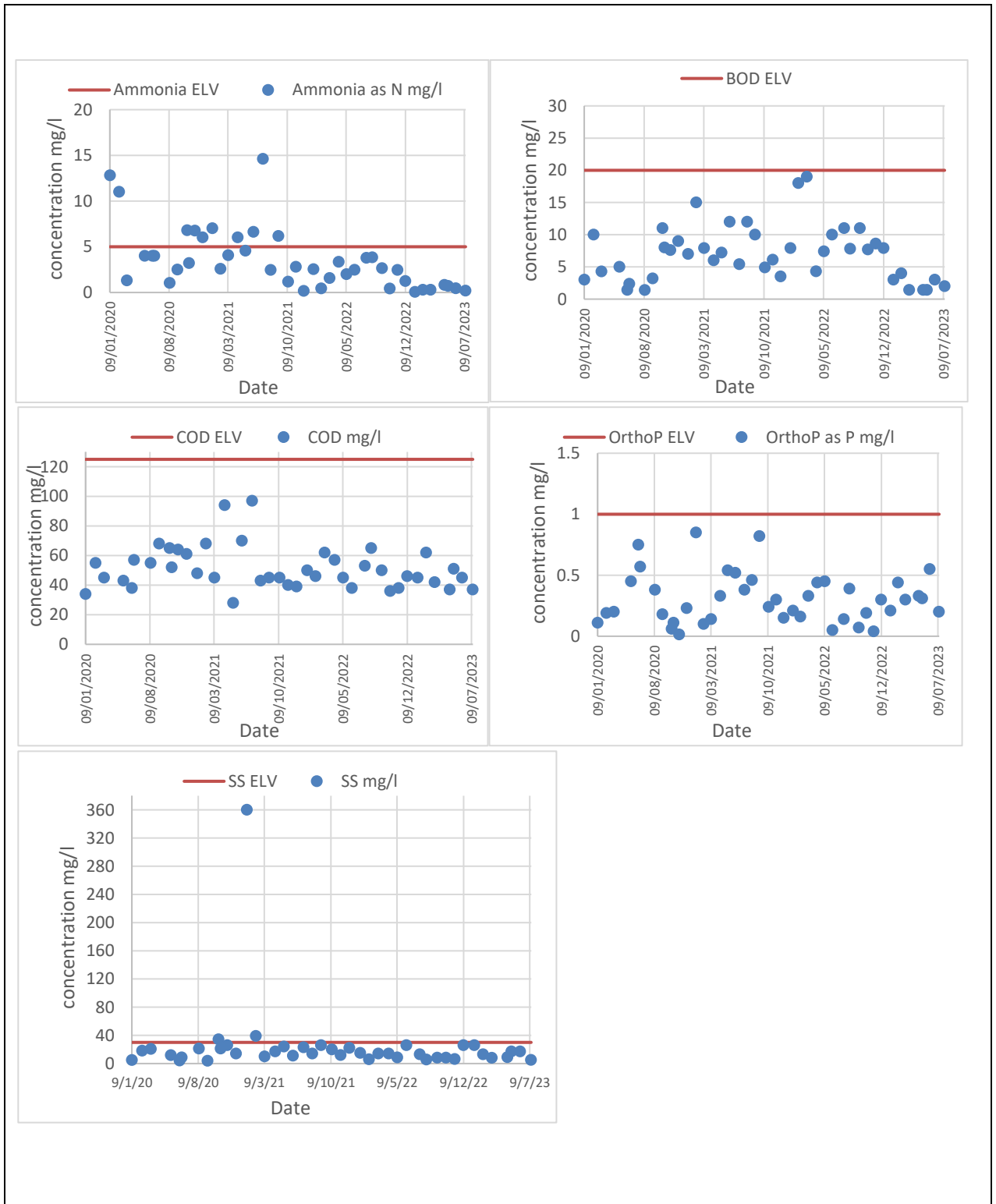


Figure 3: Effluent Quality Timeseries Data (2020-2023) for Parameters with ELVs

Final treated effluent is discharged to the River Liffey via a long pipeline (see Appendix A). The final outfall configuration consists of a 250mm pipe with a concrete headwall.

RECEIVING ENVIRONMENT

2.3 Environmental Context

Blessington WWTP discharge point discharges treated wastewater to the River Liffey within the Golden Falls Reservoir section. This section of river is impounded between the upstream Poulaphouca Reservoir dam and the downstream Golden Falls dam (Figure 1) and, while technically designated as a river, flows through this section are governed by the downstream impoundment at Golden Falls making this waterbody effectively part of the Golden Falls Lake system. Both dams are owned and operated by the Electricity Supply Board (ESB) as part of a hydroelectric power supply scheme.

The discharge is located within the Liffey_040 WFD River Sub-basin and the Liffey_050 and Liffey_060 sub-basins are immediately downstream (Figure 4). Golden Falls Reservoir receives additional inflow from two small watercourses which flow into the Reservoir directly, however the flow from these watercourses is small compared with the flow from Poulaphouca Dam.

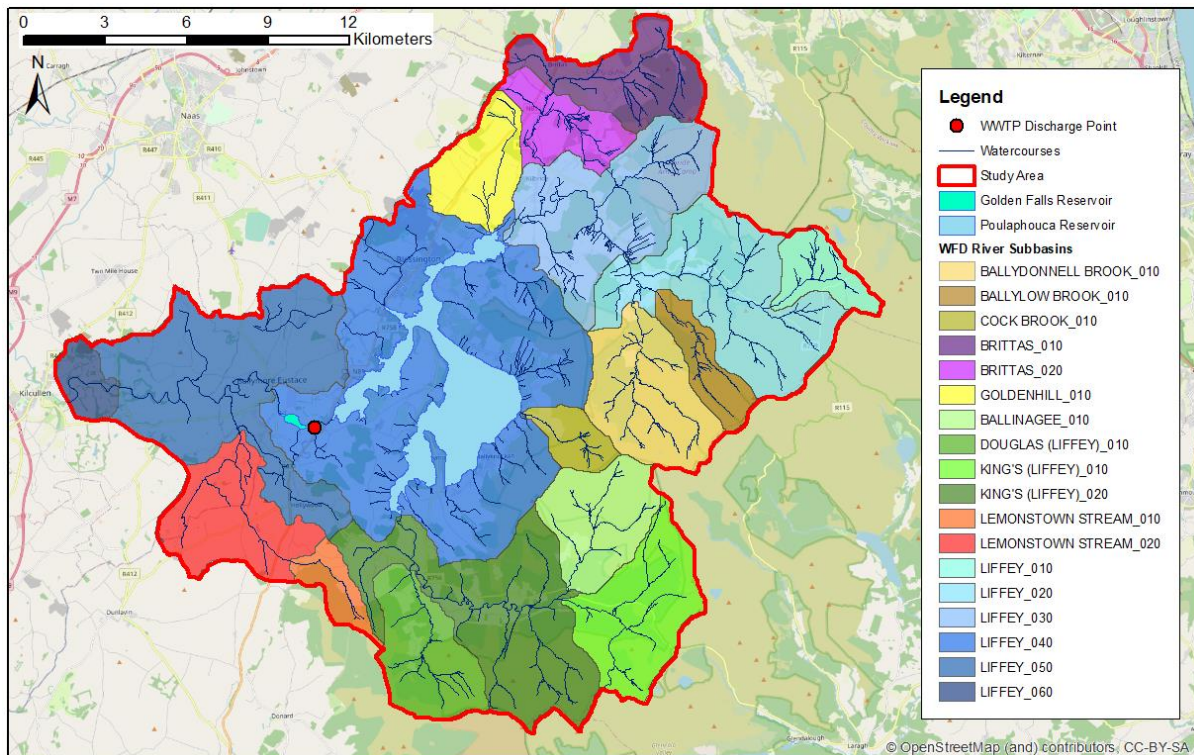


Figure 4: Study Area WFD River Sub Basins

The catchment is broadly divided into two areas in terms of land use. The higher area in the upstream, eastern catchment (catchment topography is shown in Figure 5) is dominated by peat bogs, moors and heathland with smaller areas of coniferous forest and transitional woodland shrubs. There is some agriculture, particularly along the river valleys (Figure 6). The lower lying western side of the catchment is dominated by pasture with small areas of arable land and forest of various types. Blessington is the largest urban settlement and there are several large mineral extraction sites around the Blessington area.

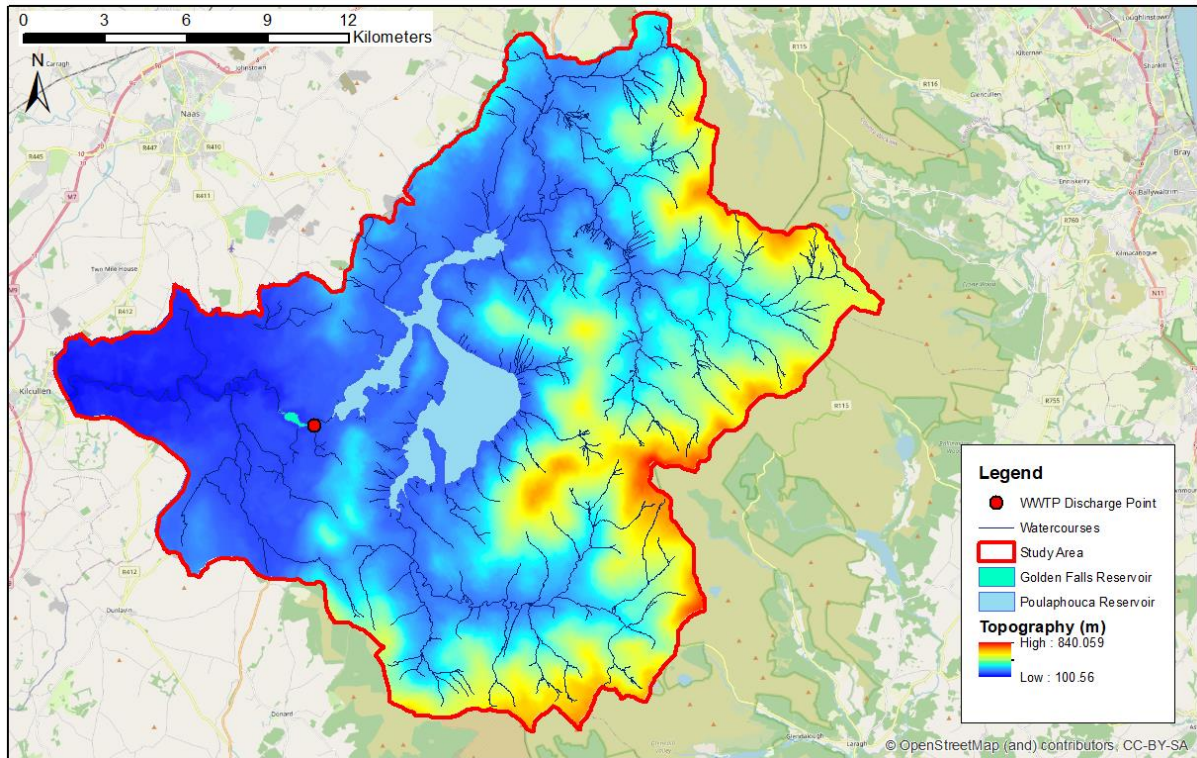


Figure 5: Study Area Topography

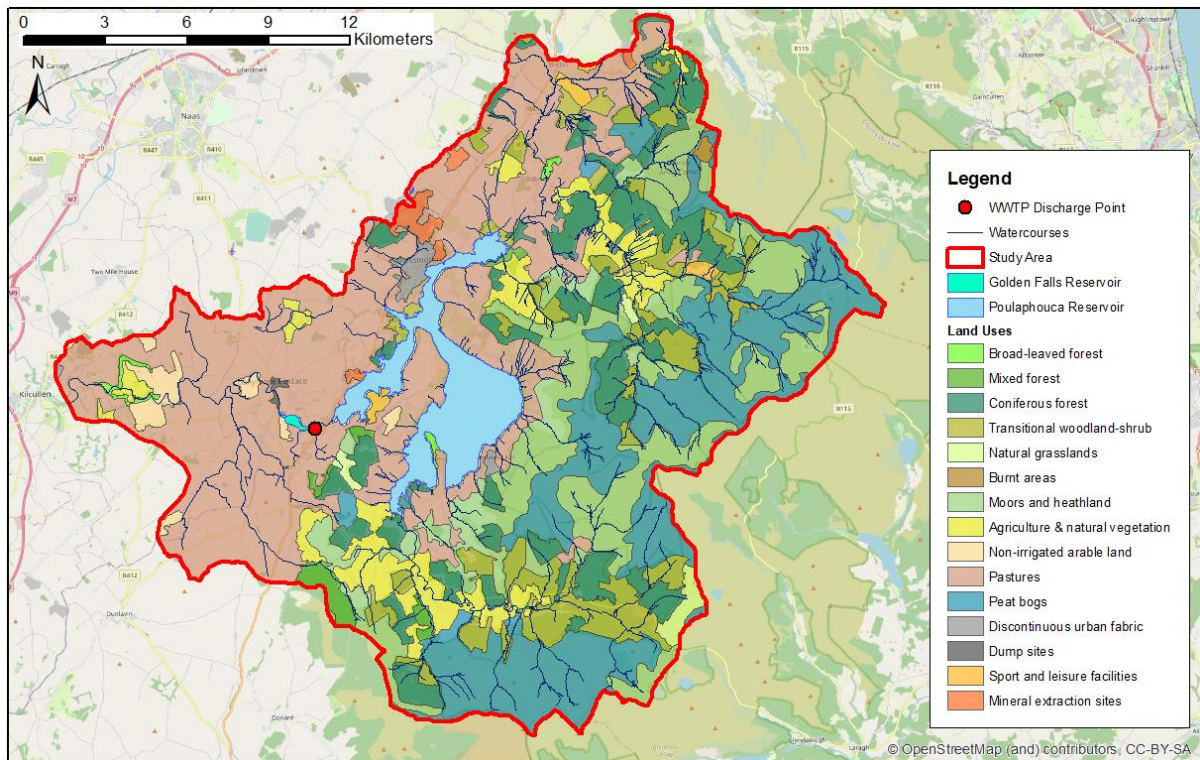


Figure 6: Study Area Land Use

The division in catchment land use largely reflects the soil types (Figure 7) which have developed from differing geology (Figure 8). The eastern side of the catchment is underlain by granite and other igneous rocks while the eastern side of the catchment is underlain by metasediments and volcanics. The

different bedrock permeability and topography results in peat soils in the eastern side of the catchment while the western side of the catchment is dominated by fine loamy drift with alluvium along the river valleys.

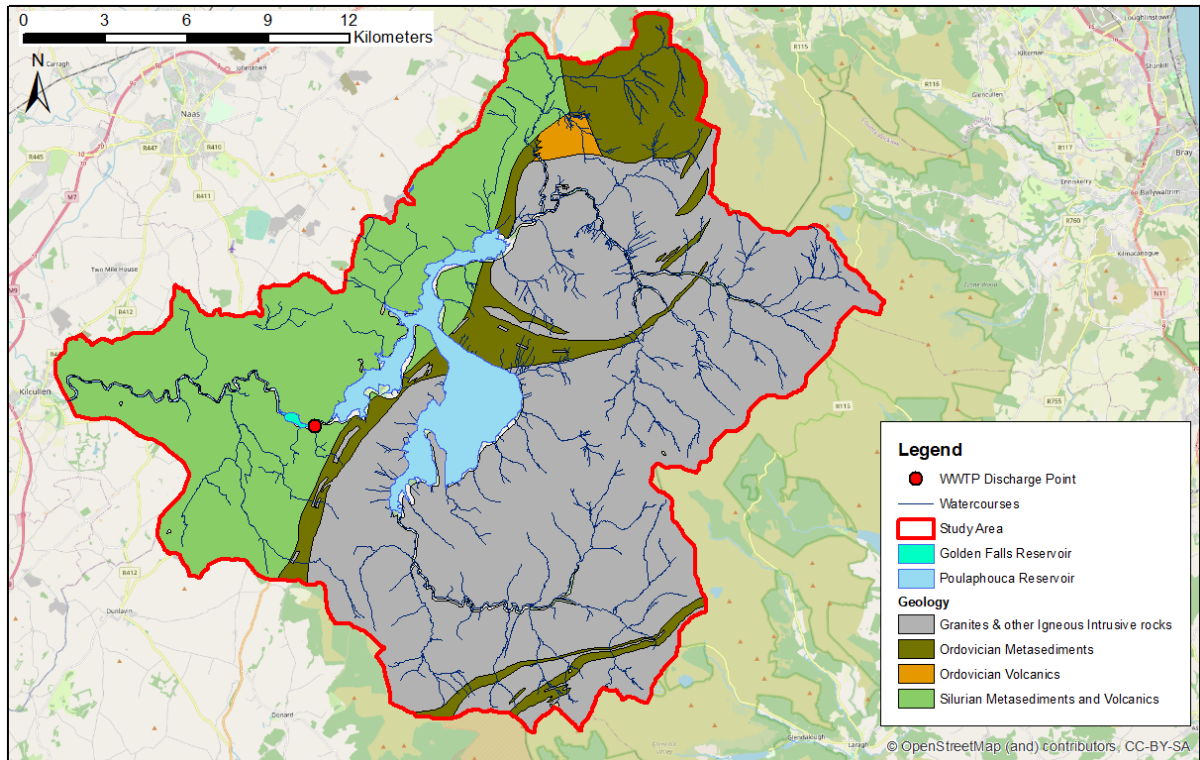


Figure 7: Study Area Geology

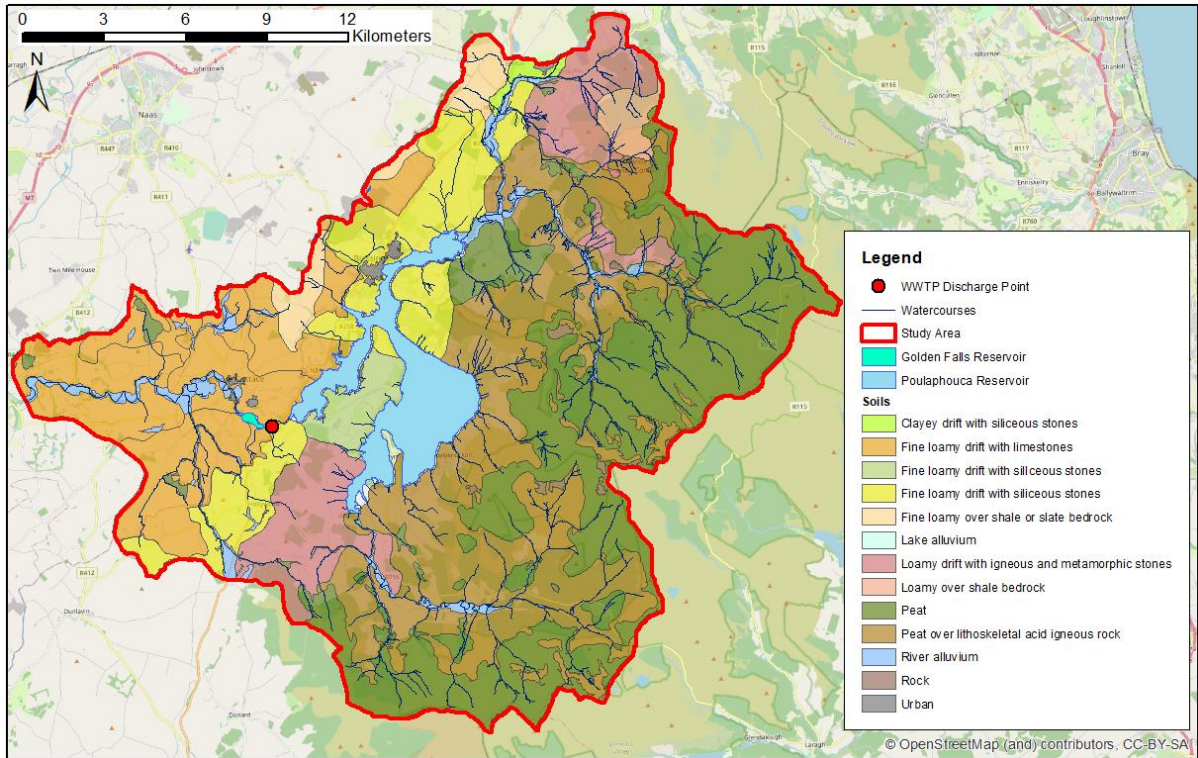


Figure 8: Study Area Soils

The rural nature of this section of the River Liffey catchment means that the Blessington WWTP discharge point is the largest discharge in the catchment. However, there are nine Section 4 discharge points and two WWTP serving less than 500 PE also discharging within the study area. Two of the Section 4 discharges and one WWTP discharge to watercourses downstream of the Blessington WWTP outfall, however the other eight discharge points are upstream (Figure 9). The impact of these discharges will need to be accounted for by using ambient water quality data from a location upstream of Blessington WWTP discharge point and downstream of the other discharge points when carrying out the water quality analysis.

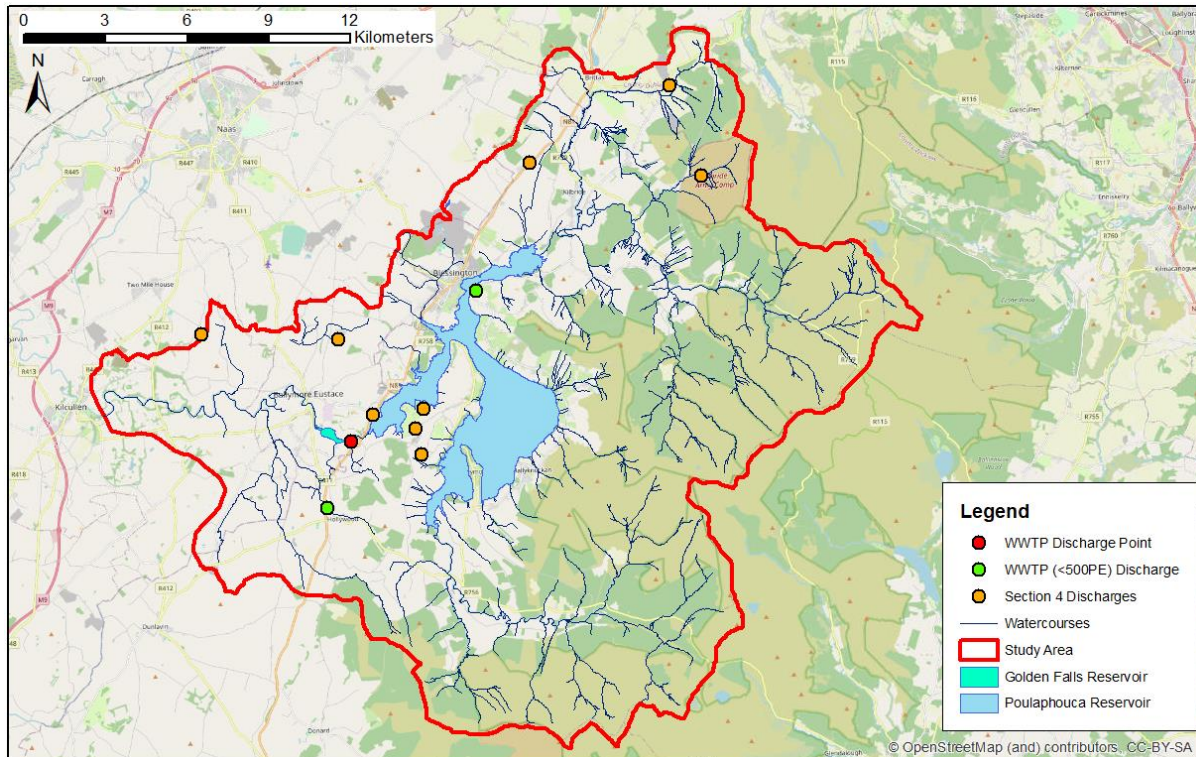


Figure 9: Study Area Catchment Discharges

2.4 Environmental Receptors

The study area includes part of Wicklow Mountains Special Area of Conservation (SAC) and Special Protected Area (SPA). However, these areas are upstream of Blessington WWTP discharge point and are designated for habitats and species associated with the peat bogs and moorlands in this area. The discharge from Blessington WWTP will not impact on these designated sites because they are located upstream of the discharge and are not water dependant habitats. Poulaphouca Reservoir is also a designated SPA due to the presence of waterbirds (Greylag Goose and Lesser Black-backed Gull) however the designation does not extend to the Golden Falls reservoir and Poulaphouca reservoir is upstream of the discharge point. There are no nature reserves within the study area.

The River Liffey and Golden Falls reservoir at the discharge point are not designated as nutrient sensitive environments. There is some recreational use of Golden Falls reservoir associated with the water ski club, however the reservoir is not a designated bathing water. The river and reservoir are not designated as a salmonid watercourse.

Poulaphouca Reservoir, Golden Falls reservoir and the surrounding watercourses are designated as drinking water sources. Poulaphouca reservoir is used as a water supply for Ballymore Eustace water treatment plant, however the intake is upstream of the Blessington WWTP discharge point. The River Liffey, Golden Falls Reservoir and other tributaries are designated for protection of the drinking water abstraction at Leixlip but this is approximately 54km downstream of Golden Falls reservoir so there is minimal potential for impacts arising from the Blessington WWTP discharges. The designation for drinking water protection is the only sensitive environmental designation at Blessington WWTP

discharge point.

2.5 Legislative Context

2.5.1 Urban Wastewater Treatment Directive

The Urban Wastewater Treatment Directive (UWwTD, 2007)¹ requires regulators to limit pollution of receiving waters (i.e. Golden Falls Reservoir) due to wastewater discharges. This report aims to provide the level of information required to determine the impact of the discharges from the Blessington WWTP. In addition, this report provides information on receiving water flows through this section of the River Liffey in response to the Environmental Protection Agency's request for information (see Sections 1 and 4).

2.5.2 European Communities Environmental Objectives (Surface Waters) Regulations 2009

The Water Framework Directive (WFD, Directive 2000/60/EC) defines the ecological status of waterbodies as high, good, moderate, poor or bad. Under WFD, member states are required to prevent pollution of waterbodies and work to improve water quality toward a minimum of good status. The WFD was enacted into Irish Law through the European Communities Environmental Objectives (Surface Waters) Regulations 2009² (amended in 2015 and 2019, and hereafter "the Surface Water Regulations").

The Surface Water Regulations set standards which can be used to identify the current status of waterbodies which may be affected by discharges from Blessington WWTP and to determine the impacts of the discharge on future water quality. The standards are set for ecological community assemblage and for the physio-chemical parameters that affect it. Table 2 shows the physio-chemical standards for good and high ecological status in rivers and lakes - the discharges from Blessington WWTP are to a lake waterbody currently considered to be at moderate status under WFD (Section 3.5).

2.5.3 European Union (Wastewater Discharge) Regulations (2020)

The EPA issues licences for wastewater discharges under the European Union (Wastewater Discharge) Regulations (2020)³. These regulations aim to ensure that wastewater discharges do not have adverse impacts on the environment, taking into account the above Directive and Regulations. This is achieved by taking a "combined approach," whereby "*the emission limits for the discharge are established on the basis of the stricter of either or both, the limits and controls required under the Urban Waste Water Regulations, and the limits determined under statute or Directive for the purpose of achieving the environmental objectives established for surface waters.*"

Table 2: Water Quality Standards for Rivers and Lakes under the Surface Water Regulations

Waterbody	Parameter	Classification System	High-Good boundary	Good-Moderate
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¹ <http://www.legislation.gov.uk/nisr/2007/187/regulation/7/made>

² Statutory Instruments SI No 77/2019 <http://www.irishstatutebook.ie/eli/2019/si/77/made/en/print>, accessed 19 June 2020

³ <http://www.irishstatutebook.ie/eli/2020/si/684/made/en/print>, accessed 19 June 2020

Type		boundary		
Rivers	BOD (mg/l)	Mean	1.3	1.5
		95%ile	2.2	2.6
	Total Ammonia (mg/l)	Mean	0.04	0.065
		95%ile	0.09	0.14
	MRP (mg/l)	Mean	0.025	0.035
		95%ile	0.045	0.075
pH	Mean	Hard Water (CaCO ₃ >100mg/l) = 6-9 Soft Water (CaCO ₃ <100mg/l) = 4.5-9		
Dissolved Oxygen (%)	95%ile value	80-120%		
Lakes	Total Ammonia (mg/l)	Mean	0.04	0.065
		95%ile	0.09	0.14
	Total Phosphorus (mg/l)	Mean	0.01	0.025
	pH	Mean-	Hard Water (CaCO ₃ >100mg/l) = 6-9 Soft Water (CaCO ₃ <100mg/l) = 4.5-9	
	Dissolved Oxygen (%)	95%ile value	80-120%	

2.6 Ambient Water Quality

Extensive water quality data are available at four locations upstream and downstream of the Blessington WWTP discharge point (Figure 10). The most upstream monitoring point is immediately upstream of Poulaphouca dam, while the other three are within the Golden Falls reservoir.

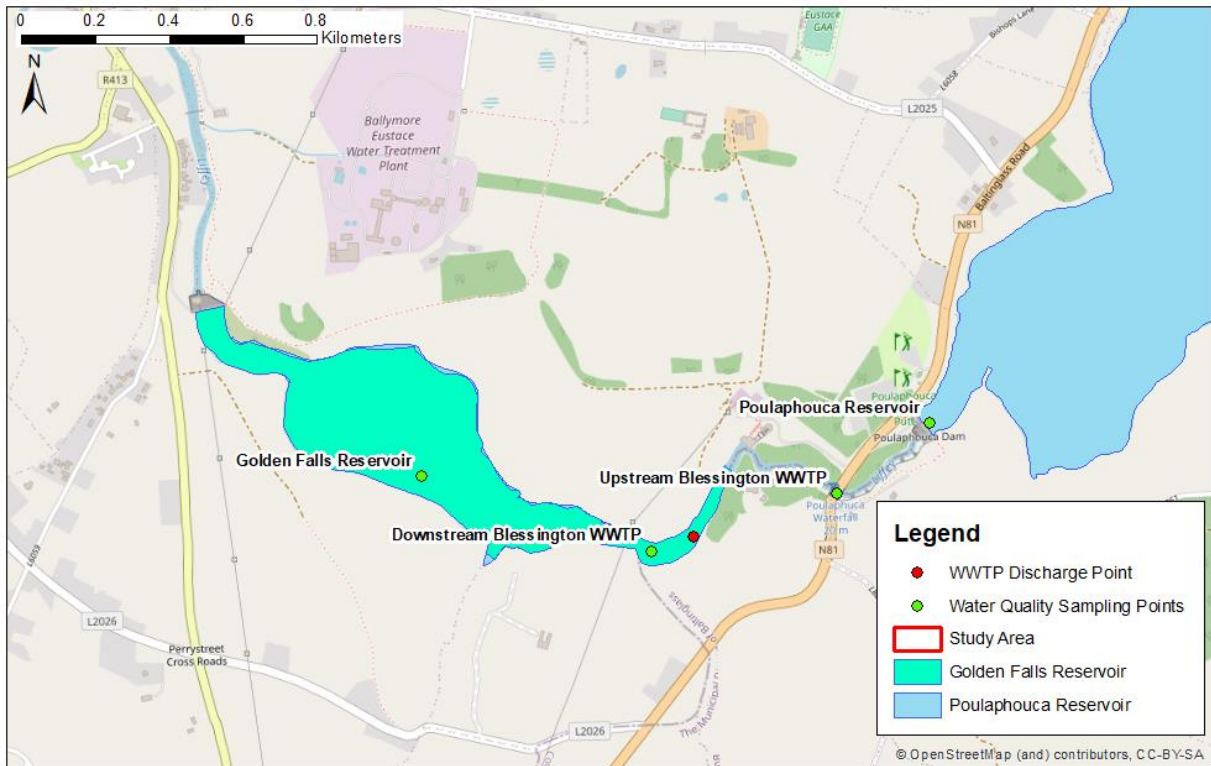


Figure 10: Water Quality Monitoring Locations

Figure 11 shows the timeseries of ammonia concentrations for all four locations. There was a reduction

in ammonia concentrations within Golden Falls Reservoir between 2016 and 2018 followed by a slight increase in ammonia concentrations recorded at all monitoring locations from 2018 onwards. The post-2018 data appear consistent over time and show mean ammonia concentrations 56% lower than the pre 2016 period. Water quality statistics from 2018 onwards are representative of current water quality and are summarised in Table 3.

It is important to note when considering downstream ambient concentrations that the completed upgrade of the Blessington WWTP in January 2023 represented a step-change in BOD and ammonia loadings to the receiving waters (as demonstrated in Figure 3 above). As such, downstream sample data collected prior to January 2023 is no longer representative of current effluent loading conditions in receiving waters. The data however has been presented here for transparency purposes.

The mean and 95%ile ammonia concentrations upstream of Blessington WWTP discharge point meet the EQS for high indicative quality for both lakes and rivers (0.018mg/l and 0.04mg/l respectively). Ammonia concentrations increase downstream of the WWTP discharge point and at Golden Falls but still meet the EQS for high indicative quality.

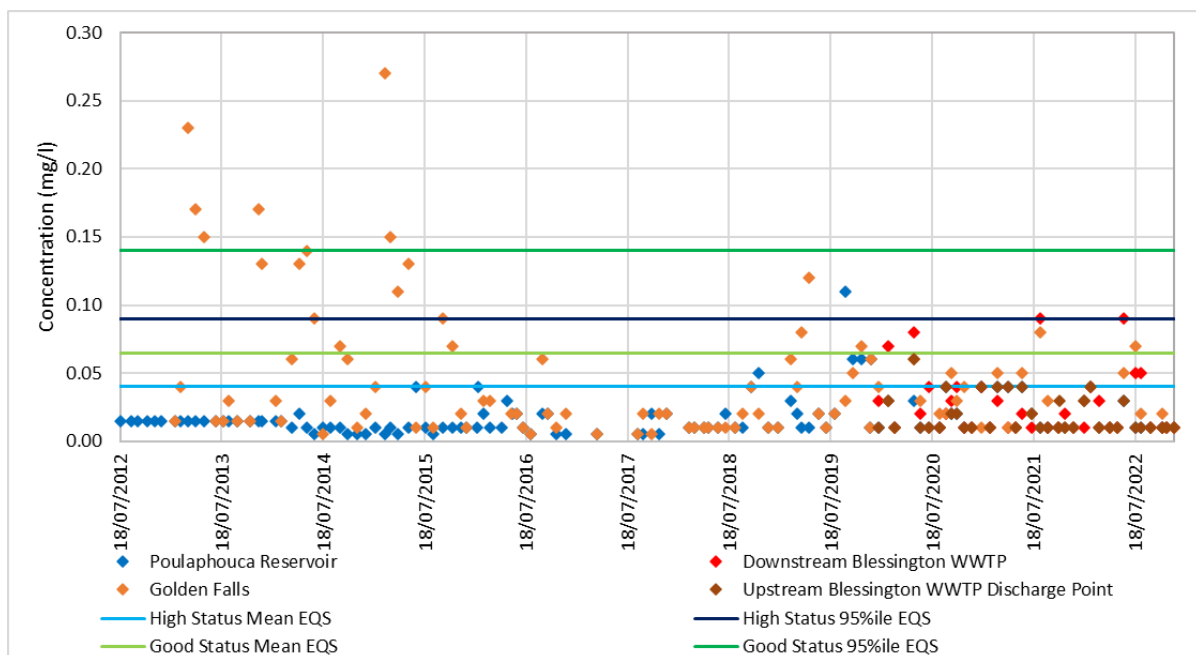


Figure 11: Ammonia Concentrations at Ambient Water Quality Monitoring Locations

Table 3: Ambient Water Quality Summary (2018-2023) and EQS Standards for Rivers and Lakes

	Poulaphouca Reservoir	Upstream Blessington WWTP	Downstream Blessington WWTP	Golden Falls Reservoir	High Status WFD EQS	Good Status WFD EQS
Mean Ammonia (mg/l)	0.019	0.018	0.028	0.027	0.040	0.065
95%ile Ammonia (mg/l)	0.051	0.040	0.083	0.071	0.090	0.140
Mean BOD (mg/l)	0.93	1.09	1.16	1.16	1.30	1.50
95%ile BOD (mg/l)	2.24	2.40	2.95	3.00	2.20	2.60

Water Quality Impact Assessment:

Blessington

Blessington WWTP

Water Quality Impact Assessment



Mean Orthophosphate as MRP (mg/l)	0.011	0.012	0.015	0.012	0.025	0.035
95%ile Orthophosphate as MRP (mg/l)	0.030	0.030	0.030	0.021	0.045	0.075
Mean Total Phosphorus (mg/l)	0.016	0.013	0.017	0.019	0.010	0.025
95%ile Dissolved Oxygen (%)	107	104	109	109	80-120	
pH	7.5	7.5	7.5	7.5	7-9	

Figure 12 shows the timeseries BOD concentrations for all four locations. BOD concentrations were low in both Poulaphouca Reservoir and Golden Falls Reservoir prior to 2018 but increased at both locations in subsequent years (mean concentrations increased by 38% in Poulaphouca Reservoir and 41% in Golden Falls Reservoir). The post-2018 data appear consistent over time and give an average BOD concentration upstream of Blessington WWTP discharge point of 1.09mg/l, thereby meeting the mean EQS for high indicative quality for BOD in rivers, and a 95%ile of 2.40mg/l, which meets the EQS (2.60mg/l) for good indicative quality in rivers (Table 3). Both the mean and 95%ile BOD concentrations increase downstream of the discharge, with the downstream mean concentration continuing to meet the EQS for high indicative quality for BOD in rivers, while the downstream 95%ile concentration fails to meet the EQS for good indicative quality (note that the upstream 95%ile concentration is already within 10% of the Good/Moderate threshold and at risk of failing to meet good indicative quality)

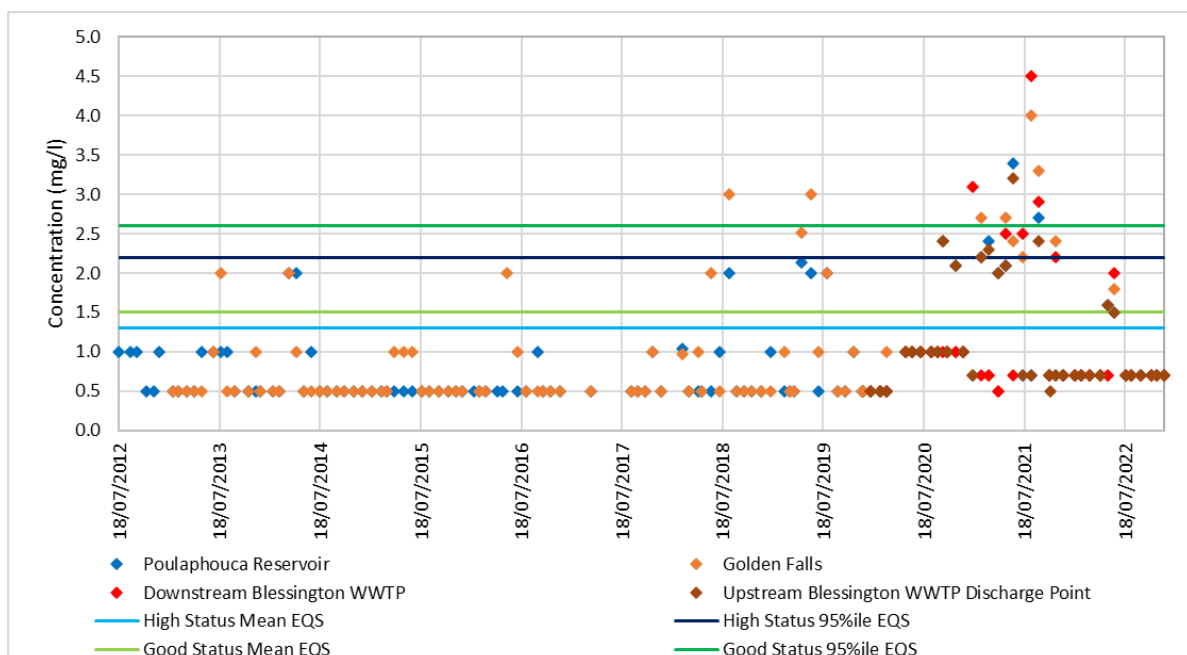


Figure 12: BOD Concentrations at Ambient Water Quality Monitoring Locations

Phosphate concentrations are regulated using orthophosphate concentrations (MRP) in rivers and total phosphorus concentrations in lakes. Concentrations of phosphate in the final treated effluent from Blessington WWTP are regulated through an ELV applied for orthophosphate concentrations only

(Section 2). Figure 13 shows the orthophosphate concentrations recorded at all water quality monitoring points and Figure 14 shows the total phosphorus concentrations. As with ammonia and BOD, the data in Figures 13 and 14 show lower concentrations in both Poulaphouca Reservoir and Golden Falls Reservoir prior to 2018 and increases at both locations in subsequent years. Mean orthophosphate concentrations in both reservoirs are 33% higher in the post-2018 period than in the pre-2018 period and total phosphorus concentrations are 40% higher in Poulaphouca Reservoir and 38% higher in Golden Falls Reservoir.

The post-2018 data (Table 3) give an average orthophosphate concentration of 0.012mg/l and a 95%ile concentration of 0.030mg/l upstream of Blessington WWTP discharge point, thereby meeting the respective EQSs for high indicative quality for rivers. Mean orthophosphate concentrations increase to 0.015mg/l downstream of the discharge point but still meet the mean EQS for high indicative quality. There is no change in the 95%ile orthophosphate concentration.

The mean total phosphate concentrations (0.013mg/l) upstream of the discharge meets the mean EQS for good indicative quality. Concentrations slightly increase downstream of the discharge to 0.017mg/l but still meets the EQS for good indicative quality

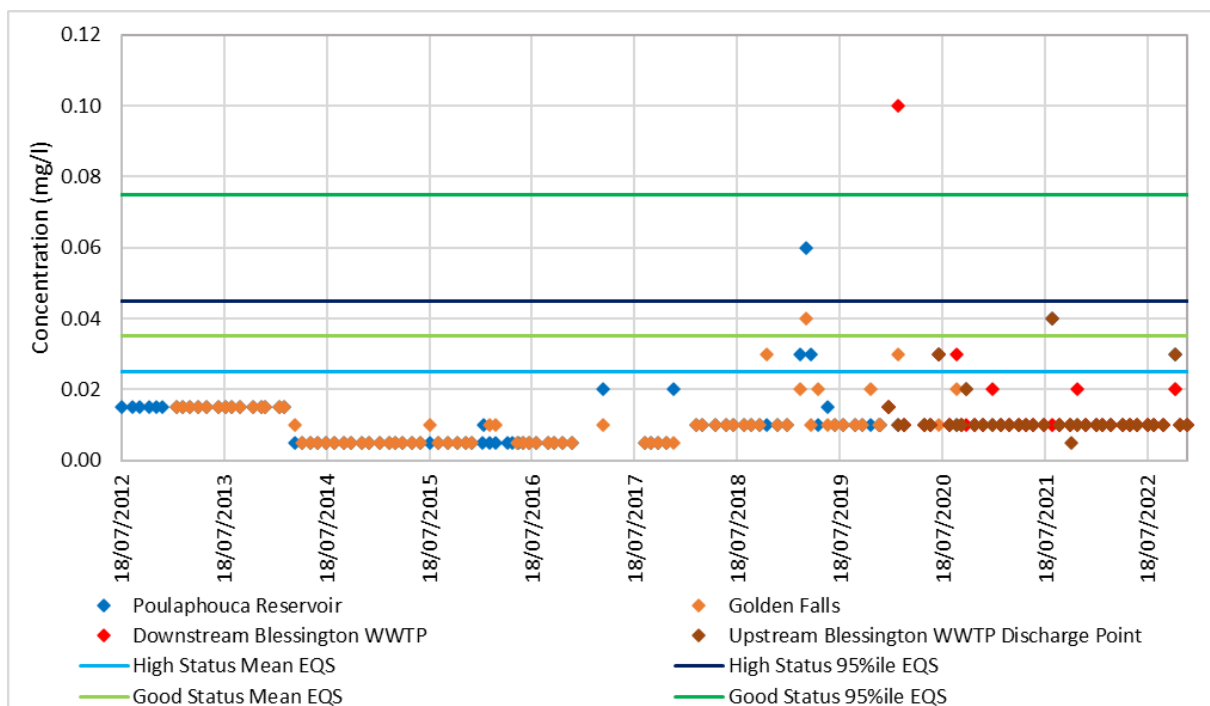


Figure 13: Orthophosphate Concentrations at Ambient Water Quality Monitoring Locations

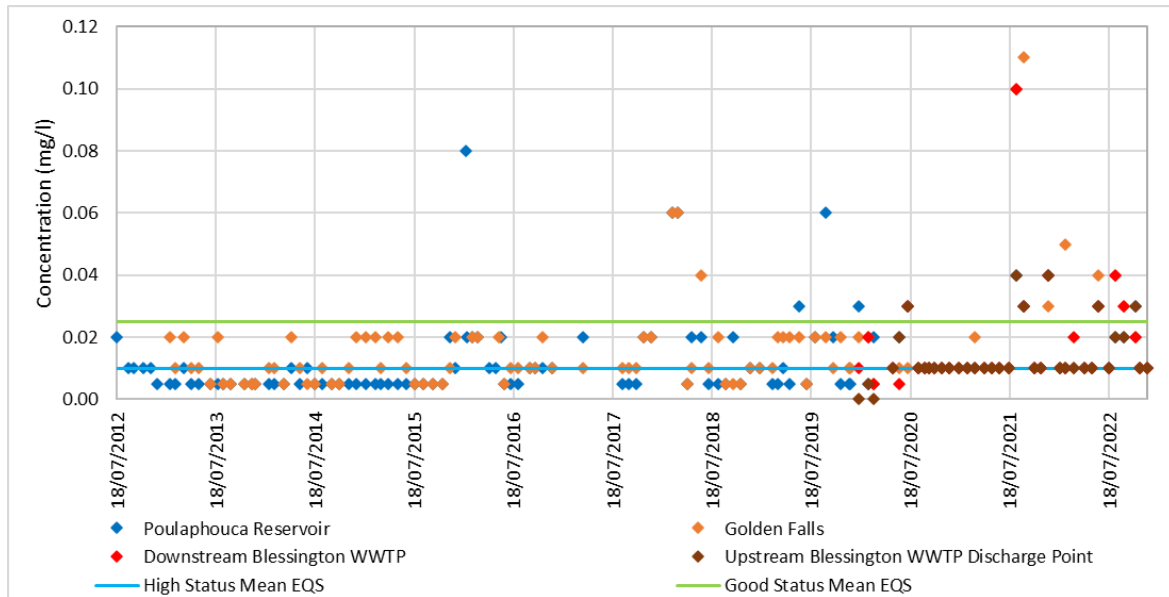


Figure 14: Total Phosphate Concentrations at Ambient Water Quality Monitoring Locations

Figures 15 and 16 show the pH and dissolved oxygen data from each monitoring point. The pH at all locations is well within the upper and lower limits required under the Surface Water Regulations from 2015 onwards. The data from Poulaphouca reservoir indicate high pH values prior to 2015, however these data may be erroneous because the pH at Golden Falls was lower during this period and in all subsequent data the pH at Poulaphouca Reservoir and Golden Falls is the same. The current mean pH is 7.5 at all monitoring locations (Table 3), which is compliant with the requirements of the Surface Waters Regulations, as amended, and shows no significant change from Blessington WWTP discharge. The 95%ile dissolved oxygen levels are also similar at all locations (Table 3) and comply with the requirement for High Status indicative water quality.

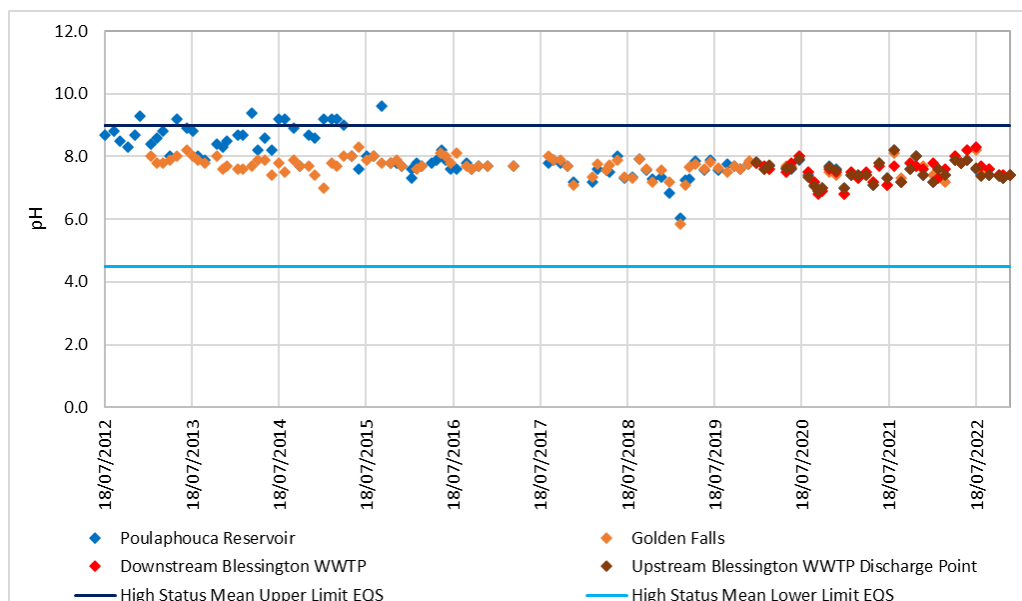


Figure 15: pH Recorded at Ambient Water Quality Monitoring Locations

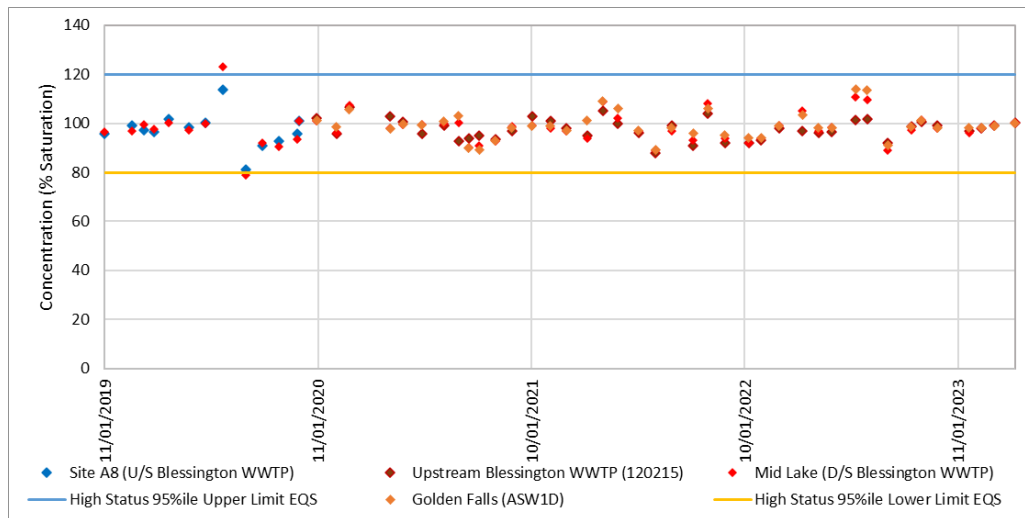


Figure 16: Dissolved Oxygen Saturation at Ambient Water Quality Monitoring Locations

Golden Falls Reservoir and the section of the River Liffey between Poulaphouca Reservoir and Golden Falls Reservoir were given the following overall ecological status classification by the EPA over the last three river basin management plan cycles:

- 2010 to 2015: River Liffey at moderate ecological status, Golden Falls Reservoir unclassified
- 2013-2018: River Liffey at moderate ecological status, Golden Falls Reservoir unclassified (both at risk)
- 2016 to 2021: River Liffey at good ecological status, Golden Falls Reservoir at moderate ecological status

The EPA Water Maps website⁴ shows that both the River Liffey and Golden Falls Reservoir were classified as “at risk” of failing to achieve good status in the first two monitoring periods, however only Golden Falls Reservoir was considered to be at risk in the most recent cycle. Neither the River Liffey nor Golden Falls Reservoir have high status objectives. The EPA assessment of significant pressures on either the River Liffey between Poulaphouca dam and Golden Falls Reservoir, and on Golden Falls Reservoir itself, only identifies pressures from hydromorphology and from urban wastewater. Based on the available water quality data upstream and downstream of Blessington WWTP discharge point, it would appear that the principle pressure on ecological status is the hydromorphological changes associated with Poulaphouca and Golden Falls dams.

⁴ <https://gis.epa.ie/EPAMaps/Water> accessed 4 August 2023

3 HYDROLOGICAL ANALYSIS

Flows through the Poulaphouca Reservoir and Golden Falls Reservoir system are managed by the ESB and the flow duration curve for this section of the River Liffey is therefore significantly altered by anthropogenic influences. Daily mean flow (pass forward flow from the dams) and reservoir level data between 1950 and 2013 were provided for Poulaphouca Dam and Golden Falls Dam by the ESB and the timeseries is shown in Figure 17.

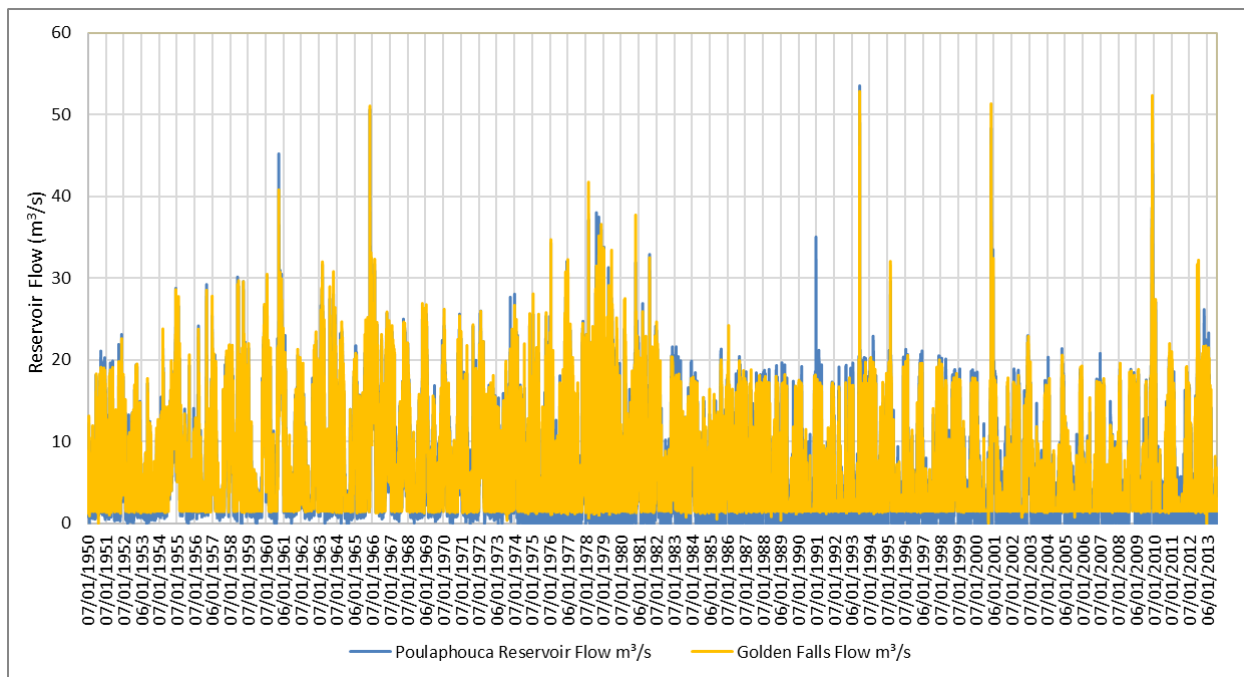


Figure 17: Dam Flow Timeseries for Poulaphouca Reservoir and Golden Falls Reservoir

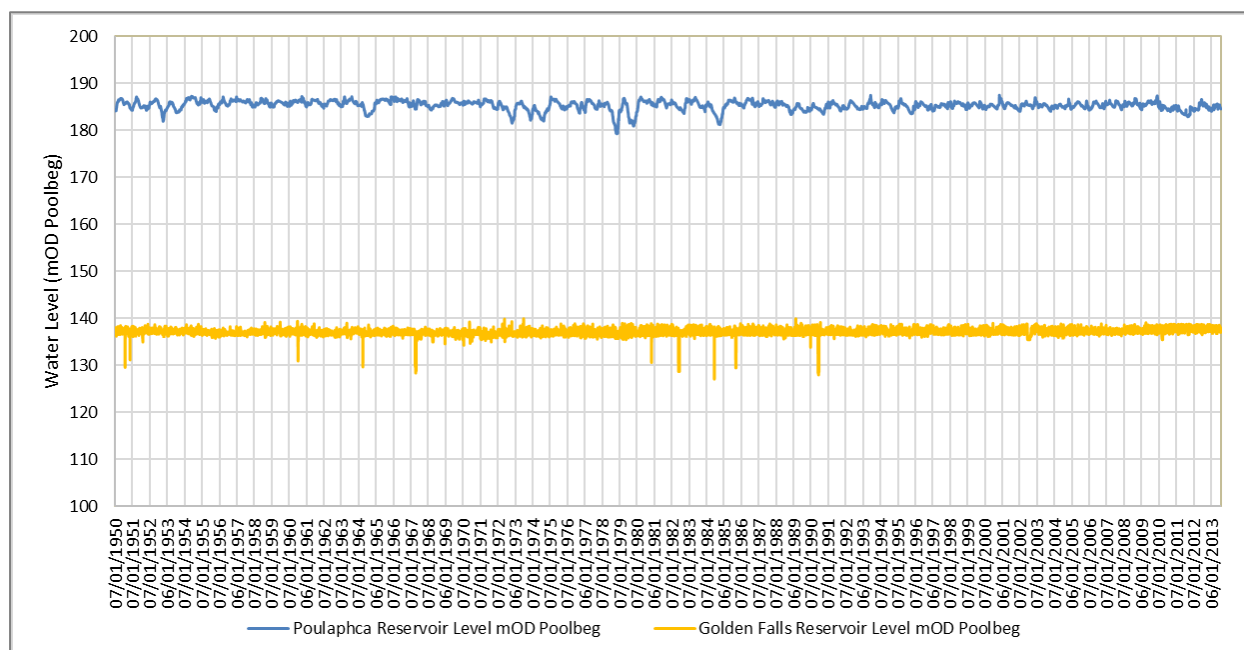


Figure 18: Lake Level Timeseries for Poulaphouca Reservoir and Golden Falls Reservoir

Figure 18 shows that the flows released from the reservoirs track closely, as would be expected given the location of the Golden Falls reservoir immediately downstream of the Poulaphouca reservoir. The flows through the system can reach up to 52.8m³/s, although average pass forward flow rates have reduced since 1984. The reservoir level data in Figure 18 show no significant corresponding change in reservoir level showing that the change in reservoir management is towards lower discharge rates which are sustained over longer periods. Water levels in Poulaphouca reservoir are maintained between 187.5-182.9mODP with an average of 185.3mODP while levels in Golden Falls Reservoir are maintained between 136.0-140.0mODP with an average of 137.3mODP.

The calculated flow duration curves at both locations are shown in Figure 19 and annual flow statistics are provided in Tables 4 and 5. The flow duration curve has been calculated using the data from 1985 onwards as this is representative of current operating conditions. The most important difference between the discharges from both dams is that flows from Poulaphouca Reservoir fall to zero for 20% of the time while flows from Golden Falls Reservoir are maintained at a minimum of 1.5m³/s (Figure 17 and Figure 19). Reservoir levels in Golden Falls reduce slightly during the periods of zero flow from Poulaphouca Reservoir.

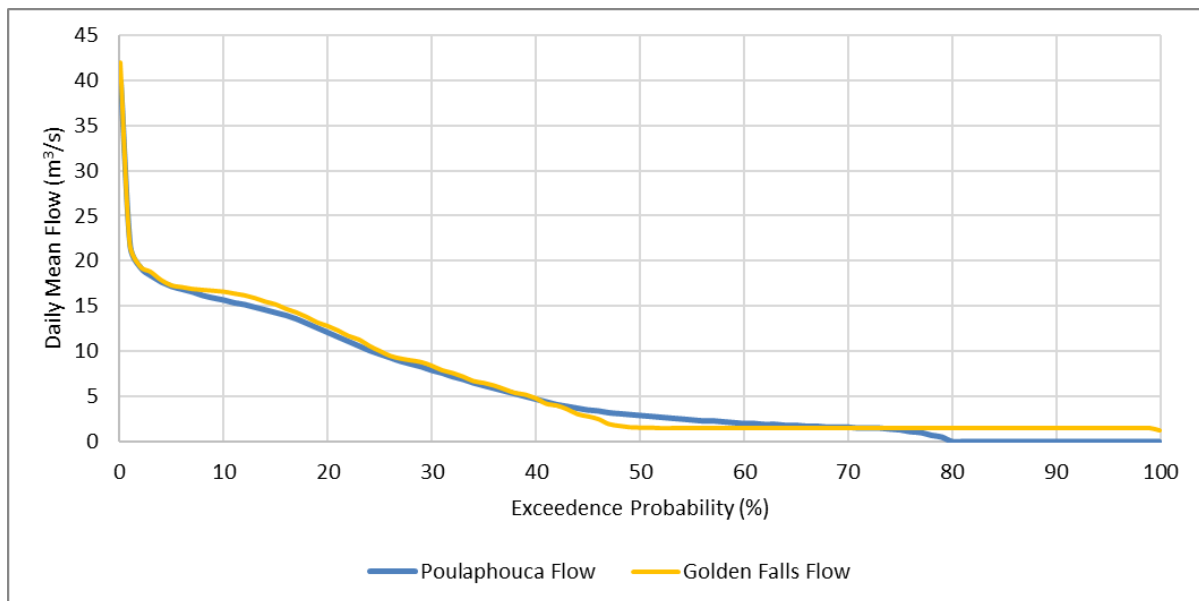


Figure 19: Flow Duration Curves for Poulaphouca Dam and Golden Falls Dam (1985-2013)

The 1985-2013 average flow is 7.24m³/s for Poulaphouca Dam (excluding periods of zero flow) and 9.2m³/s for Golden Falls Dam. The 1985-2013 Q₉₅ flow is 0m³/s for Poulaphouca Dam and 1.5m³/s for Golden Falls Dam.

With reference to the Environmental Protection Agency’s request for information in Section 1, this hydrological analysis shows that there is not a consistent flow of 1.5m³/s at the WWTP discharge point. The impact of the discharge will need to be assessed under two scenarios, one where there is flow between the two reservoirs and one where there is no flow entering Golden Falls Reservoir from Poulaphouca reservoir. These analyses are carried out in Section 5.

Water Quality Impact Assessment:

Blessington

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Table 4: Annual Flow Statistics for Pass Forward Flows from Poulaphouca Reservoir

Year	Flow (m ³ /s)												
	Max	Min	Q ₅	Q ₁₀	Q ₂₀	Q ₃₀	Q ₄₀	Q ₅₀	Q ₆₀	Q ₇₀	Q ₈₀	Q ₉₀	Q ₉₅
1950	21.8	0.30	18.0	17.0	14.8	11.8	8.53	6.82	5.51	3.90	2.31	1.40	0.76
1951	23.0	0.00	17.3	15.3	12.4	10.7	8.59	6.88	4.88	3.26	2.12	1.14	0.69
1952	19.2	0.11	13.8	9.83	7.29	5.93	4.98	3.41	2.60	2.10	1.69	1.04	0.72
1953	22.5	0.44	13.4	12.5	10.4	8.18	6.69	4.90	4.14	3.55	2.80	1.82	1.19
1954	28.8	0.00	20.1	18.0	15.2	13.5	11.3	8.42	6.27	4.75	3.06	1.82	0.91
1955	29.2	0.57	15.3	11.2	8.11	6.36	4.77	4.07	3.36	2.83	2.16	1.35	1.13
1956	25.4	0.34	18.2	16.3	12.5	8.95	6.66	4.69	3.32	2.37	1.88	1.50	1.22
1957	29.7	0.00	19.8	18.9	15.7	14.1	12.7	10.9	8.40	6.68	3.43	1.50	0.79
1958	29.5	0.00	18.4	15.5	9.45	6.03	3.71	3.05	2.44	1.84	1.25	0.91	0.82
1959	30.3	0.00	22.0	20.2	17.4	14.4	12.0	9.00	4.67	2.38	1.62	1.03	0.66
1960	45.1	0.00	27.9	24.3	20.2	15.6	10.6	5.59	2.93	1.99	1.29	1.00	0.93
1961	20.6	0.44	15.7	13.6	10.6	8.42	6.45	4.82	2.93	2.19	1.65	1.25	1.05
1962	31.6	0.00	23.6	21.9	18.7	15.7	11.0	7.50	4.90	2.29	1.55	0.95	0.83
1963	28.0	0.00	21.7	19.8	16.9	13.5	10.1	5.54	3.20	2.30	1.60	1.20	0.93
1964	21.9	0.50	18.3	15.6	12.3	9.80	7.58	5.50	3.56	2.30	1.50	1.00	0.90
1965	50.6	0.60	26.2	22.0	19.1	16.8	14.1	11.2	7.96	5.82	3.88	2.04	1.60
1966	25.6	0.40	20.4	18.8	16.8	14.5	11.8	9.10	5.90	3.10	1.80	1.50	1.02
1967	24.9	0.10	19.6	17.6	14.1	10.2	7.20	4.50	2.90	1.90	1.30	0.90	0.80
1968	25.6	0.40	21.1	18.8	15.0	11.7	8.00	6.00	4.40	2.90	2.10	1.44	0.92
1969	24.1	0.00	17.6	15.5	11.9	9.20	6.84	5.00	3.70	2.70	1.90	1.30	0.90
1970	25.6	0.10	18.3	16.5	12.9	8.60	5.90	4.60	3.90	2.70	1.70	1.24	1.00
1971	25.9	0.00	19.9	17.5	14.4	12.0	9.50	7.80	6.20	4.25	2.50	1.30	0.90
1972	18.6	0.00	13.5	11.5	9.32	7.38	6.04	4.60	3.60	2.80	2.00	1.20	0.80
1973	27.9	0.00	20.9	18.9	16.1	13.3	10.8	7.60	4.76	2.42	1.40	0.06	0.00
1974	25.5	0.00	15.8	12.3	8.40	5.02	3.50	2.10	1.40	0.70	0.00	0.00	0.00
1975	34.3	0.00	17.0	13.0	7.20	4.35	2.90	1.90	1.10	0.25	0.00	0.00	0.00
1976	31.6	0.00	21.2	17.6	14.0	9.80	6.36	3.70	2.30	1.30	0.60	0.00	0.00
1977	37.6	0.00	22.3	19.5	15.6	12.9	9.38	6.80	3.60	2.30	1.28	0.42	0.00
1978	36.7	0.00	25.1	21.1	15.6	10.3	6.04	3.70	2.10	1.30	0.16	0.00	0.00
1979	25.1	0.00	17.7	14.2	9.00	6.00	4.50	3.25	2.10	1.50	0.70	0.00	0.00
1980	32.9	0.00	19.7	17.1	14.0	11.6	9.48	7.40	6.10	3.90	2.50	0.88	0.00
1981	24.1	0.00	17.7	15.8	12.1	7.76	5.00	3.30	2.00	1.20	0.30	0.00	0.00
1982	21.6	0.00	18.3	16.6	14.6	12.2	9.94	5.90	3.70	2.30	1.30	0.04	0.00
1983	19.7	0.00	16.0	14.5	12.3	9.25	6.50	4.95	3.50	2.30	1.00	0.00	0.00
1984	21.1	0.00	15.0	11.2	6.92	4.80	3.24	2.20	1.80	1.10	0.10	0.00	0.00
1985	20.4	0.00	16.6	15.1	12.8	10.0	5.68	3.50	2.30	1.30	0.00	0.00	0.00
1986	18.2	0.00	15.9	14.9	12.0	7.98	4.92	2.60	1.40	0.20	0.00	0.00	0.00
1987	18.8	0.00	16.2	15.0	12.4	9.00	6.30	3.70	1.90	0.80	0.00	0.00	0.00
1988	19.5	0.00	16.3	14.7	8.32	3.88	2.50	1.20	0.00	0.00	0.00	0.00	0.00
1989	19.2	0.00	14.6	13.5	10.5	4.60	3.00	2.20	1.10	0.00	0.00	0.00	0.00
1990	35.0	0.00	17.2	15.9	12.6	8.40	5.70	3.60	2.70	1.82	0.00	0.00	0.00
1991	19.3	0.00	14.6	11.7	7.70	4.55	2.70	1.90	1.10	0.00	0.00	0.00	0.00
1992	53.4	0.00	18.7	16.2	12.8	7.08	3.80	2.80	2.00	1.40	0.00	0.00	0.00
1993	22.9	0.00	18.8	17.7	15.4	13.3	10.6	7.80	5.50	2.80	1.80	0.00	0.00
1994	29.5	0.00	17.5	15.5	12.4	7.98	3.70	2.60	2.20	1.70	0.70	0.00	0.00
1995	21.3	0.00	18.4	17.3	10.8	5.75	3.50	2.60	2.10	1.65	0.60	0.00	0.00
1996	21.1	0.00	17.1	15.0	6.64	4.30	3.00	2.40	1.86	1.60	0.98	0.00	0.00
1997	20.5	0.00	17.9	16.9	15.3	12.0	8.22	5.90	3.70	2.30	1.80	0.90	0.00
1998	18.9	0.00	16.8	15.9	14.6	10.3	6.70	3.40	2.60	2.02	1.50	0.00	0.00
1999	18.8	0.00	16.6	15.1	10.7	6.15	3.70	2.80	2.20	1.70	1.00	0.00	0.00
2000	48.2	0.00	30.1	18.3	14.9	11.6	4.64	2.80	2.20	1.80	1.20	0.00	0.00
2001	18.9	0.00	16.2	15.1	10.1	7.66	4.24	2.60	2.00	1.50	1.50	0.00	0.00
2002	22.8	0.00	18.8	16.4	13.2	6.78	4.30	3.00	2.30	1.60	0.00	0.00	0.00
2003	20.3	0.00	13.8	11.1	7.60	4.70	3.40	2.40	1.90	1.50	0.00	0.00	0.00
2004	21.3	0.00	17.3	14.9	8.70	6.18	3.84	2.70	2.00	1.80	1.30	0.00	0.00
2005	18.8	0.00	14.8	12.3	6.14	3.28	2.40	2.10	1.80	1.60	1.08	0.00	0.00
2006	20.8	0.00	16.4	15.4	12.0	8.80	7.30	4.80	2.40	1.90	1.60	1.10	0.00
2007	18.9	0.00	15.9	15.3	9.30	7.50	6.00	3.75	3.00	2.00	1.50	0.00	0.00
2008	18.4	0.00	16.9	16.4	15.2	9.90	8.60	6.00	3.20	2.00	1.50	0.00	0.00
2009	46.4	0.00	28.8	22.3	16.0	11.4	5.76	3.00	1.90	1.60	0.40	0.00	0.00
2010	20.2	0.00	17.0	15.7	10.8	6.36	3.44	2.00	1.66	1.50	0.80	0.00	0.00
2011	29.8	0.00	20.6	16.4	14.4	11.1	7.20	4.20	2.00	1.65	1.40	0.00	0.00
2012	25.8	0.00	17.3	16.2	12.0	9.23	3.20	1.80	1.60	0.00	0.00	0.00	0.00

Water Quality Impact Assessment:

Blessington

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Water Quality Impact Assessment



Table 5: Annual Flow Statistics for Pass Forward Flows from Golden Falls Reservoir

Year	Flow (m ³ /s)												
	Max	Min	Q ₅	Q ₁₀	Q ₂₀	Q ₃₀	Q ₄₀	Q ₅₀	Q ₆₀	Q ₇₀	Q ₈₀	Q ₉₀	Q ₉₅
1950	19.8	1.40	18.0	17.3	15.1	11.9	8.86	6.60	5.44	3.40	1.50	1.50	1.50
1951	22.6	1.50	17.7	15.8	12.6	10.7	8.50	6.80	5.10	3.00	1.57	1.50	1.50
1952	19.5	1.50	12.7	10.3	7.10	6.00	5.10	3.60	2.50	1.50	1.50	1.50	1.50
1953	23.4	1.50	13.6	12.4	10.7	8.60	6.94	5.40	4.00	3.30	2.08	1.50	1.50
1954	28.6	1.50	20.1	18.2	15.7	13.3	11.4	9.10	6.42	4.72	2.70	1.50	1.50
1955	28.5	1.50	13.7	11.0	8.10	6.25	5.20	4.20	3.30	2.68	1.50	1.50	1.50
1956	27.8	1.50	18.0	16.4	12.7	8.78	6.90	4.80	3.45	1.80	1.50	1.50	1.50
1957	29.6	1.50	20.6	19.0	15.6	14.1	12.7	11.0	8.20	6.88	1.86	1.50	1.50
1958	29.5	1.50	18.7	15.7	9.94	5.50	3.90	2.70	1.78	1.50	1.50	1.50	1.50
1959	30.4	1.50	21.9	20.2	17.4	14.5	11.7	8.50	4.20	1.50	1.50	1.50	1.50
1960	40.6	1.40	28.9	24.4	20.2	15.6	10.5	5.20	1.78	1.50	1.50	1.50	1.50
1961	21.3	1.50	15.3	13.7	10.9	8.68	6.14	4.60	2.30	1.80	1.80	1.60	1.50
1962	32.0	1.37	24.1	21.8	18.4	16.0	11.6	7.80	4.96	1.55	1.50	1.50	1.50
1963	30.8	1.30	21.8	19.9	16.8	13.8	10.2	6.20	2.90	1.80	1.50	1.50	1.50
1964	24.9	1.40	18.6	15.7	11.9	9.60	7.70	5.40	3.80	1.52	1.50	1.50	1.50
1965	51.0	1.40	26.9	22.2	19.8	17.4	14.1	11.3	7.92	6.10	4.28	1.60	1.50
1966	25.7	1.40	21.9	19.7	16.8	14.4	12.1	9.50	6.16	3.42	1.50	1.50	1.50
1967	24.6	1.50	19.8	17.6	14.5	10.7	7.30	4.45	1.80	1.50	1.50	1.50	1.50
1968	26.7	1.40	21.0	19.0	15.2	11.7	8.20	6.30	4.56	3.12	1.50	1.50	1.50
1969	26.2	1.40	17.7	16.2	12.1	9.50	6.90	5.40	4.12	2.42	1.50	1.50	1.50
1970	25.4	1.40	18.4	16.7	13.2	7.88	5.74	4.60	3.86	3.00	1.60	1.50	1.50
1971	25.9	1.40	19.7	17.9	14.4	12.1	9.50	7.75	5.80	4.40	1.75	1.50	1.50
1972	19.8	0.36	13.6	11.5	9.10	7.48	5.84	4.80	3.66	2.20	1.50	1.50	1.50
1973	26.6	1.40	21.3	19.7	16.8	13.4	10.8	7.80	5.40	3.02	1.80	1.50	1.50
1974	28.1	1.20	16.2	13.0	8.52	5.58	4.20	2.50	1.60	1.50	1.50	1.50	1.50
1975	34.7	1.50	17.2	13.3	7.70	4.80	3.50	1.80	1.70	1.50	1.50	1.50	1.50
1976	32.1	1.50	22.1	18.2	14.6	10.7	7.10	4.60	2.88	1.56	1.50	1.50	1.50
1977	41.7	1.40	22.8	20.0	16.5	13.1	10.7	8.20	4.50	2.28	1.50	1.50	1.50
1978	36.5	1.50	25.5	22.2	16.9	12.2	6.94	4.30	2.00	1.50	1.50	1.50	1.50
1979	27.5	1.50	19.1	14.7	10.1	7.20	5.30	4.10	2.90	1.80	1.60	1.50	1.50
1980	37.7	1.50	19.5	17.9	15.3	12.5	10.4	8.55	6.26	4.46	3.18	1.77	1.50
1981	24.7	1.50	18.6	16.3	13.2	9.43	6.07	4.10	2.53	1.55	1.55	1.55	1.50
1982	20.4	0.75	17.8	17.1	16.6	13.1	10.2	6.85	4.83	3.45	1.75	1.55	1.50
1983	17.9	1.20	16.7	15.4	13.0	10.3	8.20	5.80	4.20	2.40	1.60	1.50	1.50
1984	20.0	0.60	16.9	11.7	7.90	5.98	4.10	2.80	1.60	1.50	1.50	1.50	1.50
1985	24.2	1.50	16.9	16.5	14.2	10.4	7.00	4.40	2.90	1.60	1.50	1.50	1.50
1986	18.8	1.50	16.9	16.3	12.8	9.30	6.40	2.80	1.50	1.50	1.50	1.50	1.50
1987	18.0	0.80	17.0	16.7	13.5	9.90	7.00	4.45	1.75	1.50	1.50	1.50	1.50
1988	18.2	0.47	16.9	16.6	8.52	4.10	1.72	1.50	1.50	1.50	1.50	1.50	1.50
1989	17.5	1.42	16.5	14.5	10.2	4.00	1.50	1.50	1.50	1.50	1.50	1.50	1.50
1990	18.1	1.20	16.9	16.6	12.8	8.80	5.54	2.00	1.50	1.50	1.50	1.50	1.50
1991	17.2	1.35	16.1	12.5	9.00	5.05	1.80	1.50	1.50	1.50	1.50	1.50	1.50
1992	52.8	1.50	18.3	16.6	13.0	6.46	2.82	1.60	1.50	1.50	1.50	1.50	1.50
1993	20.3	1.50	19.3	18.0	16.6	14.1	11.5	8.10	5.26	1.92	1.50	1.50	1.50
1994	31.9	1.50	18.0	16.7	13.1	7.50	3.20	1.50	1.50	1.50	1.50	1.50	1.50
1995	20.5	1.50	19.0	17.9	11.0	6.05	1.90	1.50	1.50	1.50	1.50	1.50	1.50
1996	19.6	1.50	18.3	15.6	7.42	3.70	1.50	1.50	1.50	1.50	1.50	1.50	1.50
1997	20.0	1.50	18.1	17.2	16.0	13.2	8.70	5.80	3.40	1.50	1.50	1.50	1.50
1998	18.3	1.40	16.9	16.7	15.0	10.1	6.10	1.60	1.50	1.50	1.50	1.50	1.50
1999	17.8	0.00	16.7	16.0	11.9	6.35	1.70	1.50	1.50	1.50	1.50	1.50	1.50
2000	51.2	1.50	31.7	19.2	16.1	10.8	5.40	1.50	1.50	1.50	1.50	1.50	1.50
2001	18.1	0.75	16.6	15.6	10.1	8.10	5.00	1.55	1.50	1.50	1.50	1.50	1.50
2002	22.8	1.50	19.6	16.9	13.7	7.70	3.90	1.50	1.50	1.50	1.50	1.50	1.50
2003	17.5	1.50	14.0	11.6	8.40	4.60	1.55	1.50	1.50	1.50	1.50	1.50	1.50
2004	20.5	0.75	17.2	13.8	9.10	6.50	3.62	1.55	1.50	1.50	1.50	1.50	1.50
2005	19.2	1.40	15.5	12.9	6.12	1.68	1.50	1.50	1.50	1.50	1.50	1.50	1.50
2006	17.7	1.50	16.7	16.1	11.7	8.90	7.50	5.30	1.50	1.50	1.50	1.50	1.50
2007	19.6	1.50	16.9	15.7	9.20	7.90	6.30	3.05	1.50	1.50	1.50	1.50	1.50
2008	18.8	1.30	17.1	16.6	14.8	9.68	8.90	5.30	1.66	1.50	1.50	1.50	1.50
2009	51.8	1.40	29.3	23.3	16.3	12.4	4.00	1.50	1.50	1.50	1.50	1.50	1.50
2010	22.0	1.50	18.2	15.9	13.2	6.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
2011	32.2	1.30	21.5	17.5	15.4	12.0	8.60	3.00	1.50	1.50	1.50	1.50	1.50
2012	21.7		18.7	16.9	12.2	9.26	1.55	1.50	1.50	1.50	1.50		

4 TIERED WATER QUALITY ASSESSMENT

4.1 Introduction

A Tiered Assessment⁵ approach has been taken to first assess the significance of the Blessington WWTP discharge, then determine whether the proposed ELVs will have detrimental environmental impacts. The Tiered Assessment is carried out as follows:

- Tier 0 – state whether pollutants subject to EQS limits within the receiving watercourse are present within the effluent. If they are present, then proceed to Tier 1.
- Tier 1 – state whether the concentrations of pollutants in the effluent exceeds the EQS. If they exceed EQS then proceed to Tier 2⁶.
- Tier 2 – carry out simplified calculations to estimate the potential extent of the mixing zone and progress to Tier 3 assessment where the mixing zone estimate is unreasonably large or mixing dynamics are expected to be complex.
- Tier 3 – carry out complex detailed modelling of the outfall and receiving watercourses. This may include additional environmental monitoring and survey followed by 1D, 2D or 3D water quality modelling to understand the shape and size of the mixing zone, seasonal variation in water quality along the watercourse and the duration of impacts. If the impact is still judged to be significant then proceed to Tier 4.
- Tier 4 – Using the complex modelling techniques developed in Tier 3, investigate additional treatment or discharge location options as well as potential off-site mitigation measures to upstream water quality to increase dilution, including improvement works at upstream discharges. Other analyses that may be carried out under Tier 4 include an ecological impact assessment of the environmental receptors, including the vulnerability to contaminants in the discharge and the likely extent of actual environmental detriment which may arise from the discharge. Ecological analyses should be carried out in Consultation with the Uisce Éireann Environmental and Ecological Assessment team. These may be required where BAT approaches are considered necessary.

The following Sections provide details of approaches to be taken under Tiers 0 to 3. A Tier 4 analysis was found to be unnecessary at this site.

4.2 Tier 0 Assessment

The list of relevant pollutants in Blessington WWTP effluent has been determined based on the legislation determined to be relevant in Section 3.3. These substances are:- total ammonia, BOD,

⁵ The Tiered Assessment Process is outlined in "Technical Background Documents on Identification of Mixing Zones," December 2010, issued to support identification of mixing zones under EU Directive 2009/105/EC

⁶ In nearly all cases a minimum of a Tier 2 assessment will be required

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orthophosphate, total phosphorus, pH and dissolved oxygen. All these substances are present in the effluent, however changes in the dissolved oxygen concentration in the receiving watercourse are generally affected by the addition of nutrients (particularly orthophosphate), which can result in eutrophication, rather than the direct addition of dissolved oxygen in the effluent. Concentrations of ammonia, BOD, pH and phosphate will therefore be assessed further at Tier 1 but further assessment of dissolved oxygen is not required.

4.3 Tier 1 Assessment

The concentrations of each relevant parameter are checked against EQS values for each pollutant in Table 6. Current effluent concentrations and proposed ELV concentrations exceed the EQS for ammonia, orthophosphate, total phosphate and BOD but current and proposed pH is within the allowable range under the Surface Waters Regulations (alkalinity data for Golden Falls Reservoir show concentrations of CaCO₃ to be consistently below 100mg/l, therefore the soft water pH range has been used). A Tier 2 analysis is therefore not required for pH but is required for all other parameters.

Table 6: Tier 1 Water Quality Analysis

Parameter	Classification System	High-Good boundary	Good-Moderate boundary	Current Effluent Concentration	ELV	Tier 1 Outcome
BOD (mg/l)	Mean	1.3	1.5	9.04	20.0	Fail
	95%ile	2.2	2.6			
Total Ammonia (mg/l)	Mean	0.04	0.065	4.12	5.0	Fail
	95%ile	0.09	0.14			
MRP (mg/l)	Mean	0.025	0.035	0.30	1.00	Fail
	95%ile	0.045	0.075			
Total Phosphorus (mg/l)	Mean	0.01	0.025	0.79	None	Fail
pH	Mean	4.5-9		7.6	6-9	Pass

4.4 Tier 2 Assessment

Blessington WWTP discharges into a section of the River Liffey which is classified as a river for the purposes of the Surface Waters Directive, however at this location the hydraulic gradient of the waterbody is controlled by the impoundment at Golden Falls. As a result, at the discharge point, this section of the River Liffey will behave as a lake, with a hydrodynamic environment similar to that of the Golden Falls lake waterbody immediately downstream. A simplified Tier 2 water quality assessment process for lakes is usually made based on an assessment of mixing zone size based on the volume of water required to reduce the concentration of pollutant in the outfall to below the EQS. However, this simplified approach is not applicable to the Blessington discharge due to the limited channel width of the River Liffey/Golden Falls reservoir at the discharge point. The simplified process also does not take into account the input of flows from Poulaphouca Reservoir and the management of flows through the

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reservoirs by ESB. As a result, Uisce Éireann has adopted a Tier 3 analysis for this site.

4.5 Tier 3 Assessment

Complex modelling has been carried out at Tier 3 to fully understand the impacts of the discharge from Blessington WWTP on receiving waters. In this case the 1-D mixing zone model CORMIX, developed by the University of Cornell and supported by the United States Environmental Protection Agency⁷, has been used to assess the size of the mixing zone when flows are being passed forward from Poulaphouca Reservoir to Golden Falls Reservoir because this takes into account jet mixing, advection and dispersion of the effluent plume within the receiving waters.

Cormix has been used to assess impacts under mean flow conditions as described in sections 5.5.1 – 5.5.3. The impact of the discharge when flows are not being passed forwards from Poulaphouca Reservoir are analysed in section 5.5.4.

4.5.1 Average Reservoir Inflow Modelling: Input Data

CORMIX uses information on the ambient conditions, effluent composition and outfall geometry to calculate the size of the mixing zone, which is the area over which the concentrations of pollutants in the effluent are diluted to below the EQS. The CORMIX input data are set out in Table 7.

Table 7: CORMIX Modelling Input Data

Input Category	Variable	Input Data														
Scenario	Current Average Flow	Uses current average effluent flow rates and quality (Section 2) to model current discharge impacts														
	Future Average Flow	Uses scaled effluent flow rates and ELV limits (Section 2) to model future discharge impacts														
	Season	Summer & Winter														
Effluent	Flow Rate	0.01m ³ /s for the current scenario, 0.015m ³ /s for the future scenario (Section 2)														
	Effluent Density	Modelled as freshwater														
	Excess Discharge Concentration (mg/l)	Excess concentration = effluent concentration – mean ambient concentration (Table 3)														
		<table border="1"> <thead> <tr> <th>Parameter</th> <th>Current Mean</th> <th>ELV</th> </tr> </thead> <tbody> <tr> <td>Ammonia</td> <td>4.96</td> <td>4.98</td> </tr> <tr> <td>BOD</td> <td>8.76</td> <td>18.91</td> </tr> <tr> <td>Orthophosphate</td> <td>0.39</td> <td>0.99</td> </tr> <tr> <td>Total Phosphate*</td> <td>0.72</td> <td>1.99</td> </tr> </tbody> </table>	Parameter	Current Mean	ELV	Ammonia	4.96	4.98	BOD	8.76	18.91	Orthophosphate	0.39	0.99	Total Phosphate*	0.72
Parameter	Current Mean	ELV														
Ammonia	4.96	4.98														
BOD	8.76	18.91														
Orthophosphate	0.39	0.99														
Total Phosphate*	0.72	1.99														
Ambient	CORMIX Adjusted Average Depth	3.96m (Appendix B)														
	Depth at Discharge	4.05m (Appendix B)														
	Flow Rate (m ³ /s)	7.24														
	Current Direction	240° (Channel flows southwest at discharge point)														
	Wind Speed	5m/s (Casement Wind Gauge, see below)														
	Appearance	Slight meander														
	Manning's Bed Friction Factor (n)	0.035 (channel is clean but winding)														
	Temperature	20°C in summer, 5°C in winter (max/min from EPA data)														
	Average Density	Modelled as freshwater														
	Outfall	Port Type	Single port													
	Nearest Bank	Left (Appendix B)														
	Distance to Nearest Bank	16m (Appendix B)														
	Port Diameter	250mm (Appendix A)														

⁷ <http://www.cormix.info/>

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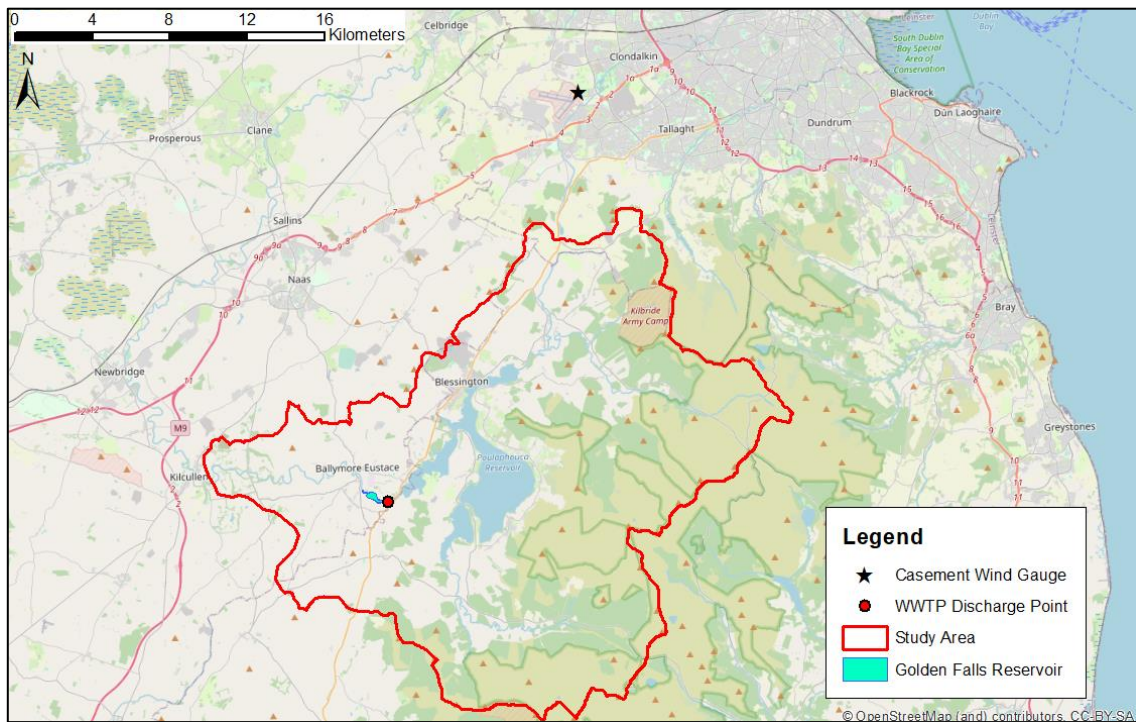
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Vertical Angle		0°	
Port Height Above Channel Bottom (m)		1.35m (Appendix B)	
Mixing Zone	Excess EQS	Excess concentration = EQS - ambient concentration (Table 3)	
		Parameter	All Scenarios
		Ammonia	0.022
		BOD	0.210
		Orthophosphate	0.013
	Total Phosphate*	0.012	
Region of Interest (m)		1000m	
Output Steps per Module		500	

*there is no ELV for total phosphorus in effluent from Blessington WWTP, but the observed effluent quality data shows that effluent total phosphate concentrations are usually double the orthophosphate concentration, therefore an ELV approximation of 2mg/l total phosphate has been used in the calculation.

The wind speed of 5m/s given in Table 7 is based on recorded wind data from the closest wind gauge, at Casement (Figure 20). The prevailing wind direction at this gauge is from the southwest and the average (50%ile) wind speed is 5m/s.



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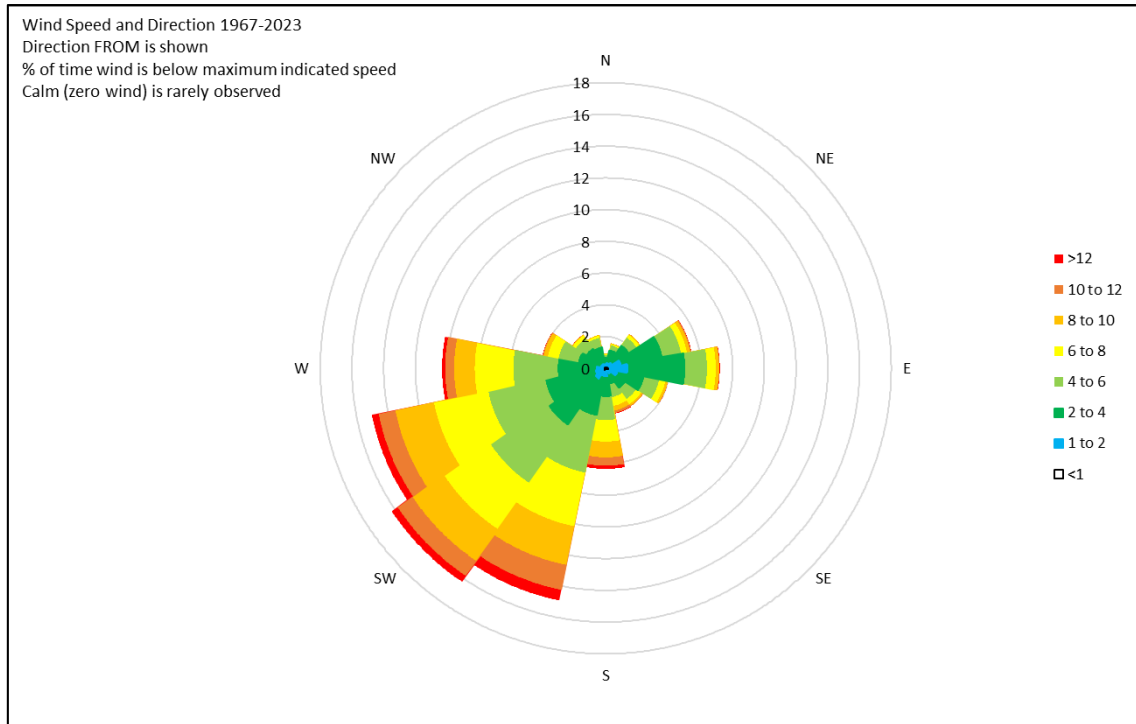


Figure 20: Casement Wind Gauge Location (Top) and Wind Rose (Bottom)

The bathymetry data (average depth, depth at discharge, distance to nearest bank and port height above the channel bottom) were informed by a bathymetric survey carried out in March 2023. The survey report is provided in Appendix B and shows that the Golden Falls reservoir occupies a submerged river valley with a deep central channel with broader, shallow areas on either side (Figure 21). The north side is shallower than the south side, with average water depths of less than 3m on the north side and 5m on the south side on the day of survey. Water depths within the central channel area reach 10m but this occurs over a fairly small area.

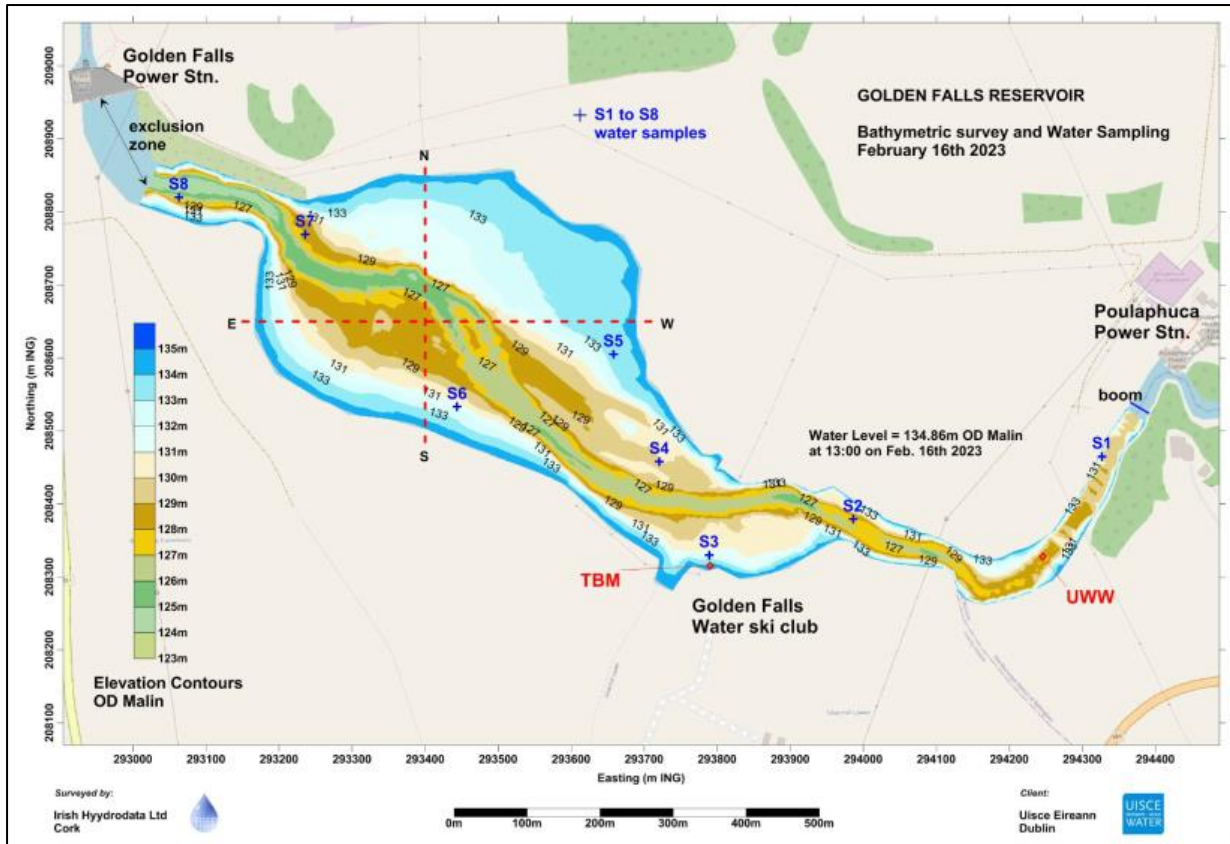


Figure 21: Golden Falls Reservoir Bathymetry
 Note: TBM = Temporary Benchmark, UWW = Blessington WWTP Discharge Location

The channel cross section at the WWTP discharge point (UWW in Figure 21) is shown in Figure 22. The WWTP outfall is approximately 1.35m above the deepest section of the channel at this location and 16m away from the left bank. The depth at the outfall is 4.05m and the average depth across the river cross section is 3.96m.

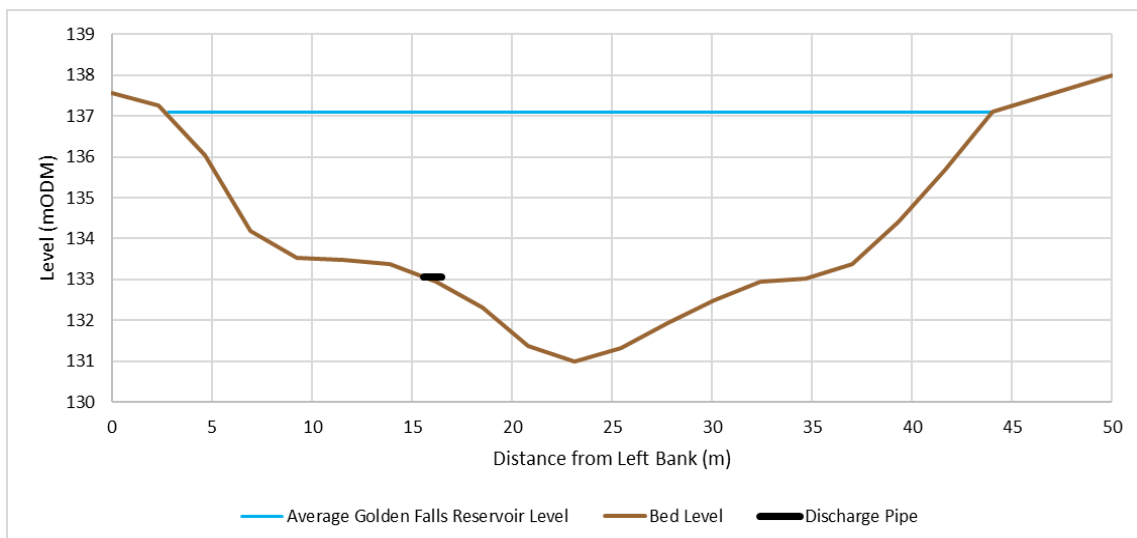


Figure 22: Golden Falls Reservoir Cross Section at Blessington WWTP Discharge Point

The water quality data taken during the survey did not show significant stratification of the water column in terms of temperature, dissolved oxygen, or chemical parameters in the deepest area of the lake. The CORMIX modelling methodology is therefore considered to be an appropriate method of assessing mixing within the reservoir. There was a slight increase in total organic nitrogen and total nitrogen (for which there are no EQSs) and total phosphate downstream of Blessington WWTP but no significant change in ammonia or orthophosphate and the change in total phosphate concentration was not sufficient to breach EQS values for lakes. Based on data presented in the survey report there were no clear impacts of the discharge observed during the survey period.

4.5.2 Average Reservoir Inflow Modelling: Modelled Scenarios

The mixing zone for Blessington WWTP has been modelled for an average flow from Poulaphouca Reservoir to Golden Falls Reservoir of 7.24m³/s (see Section 4). CORMIX modelling requires a measurable ambient flow rate, however the hydrological analysis in Section 4 shows that zero flow may be passed between reservoirs for up to 20% of the time. This will result in extremely low ambient flow velocities at the discharge point and the resulting water quality impacts are assessed using an alternative methodology in Section 5.5.4.

Both the receiving waters and the effluent are modelled as freshwater and will therefore have similar density. Mixing dynamics are likely to be similar in both the summer and winter, and therefore separate seasonal model runs are not required. Summer season mixing will be simulated based on an ambient water density of 998kg/m³. The complete list of model scenarios used in the CORMIX modelling is set out in Table 8 and the model log is provided in Appendix C.

Table 8: CORMIX Model Run Scenarios

Scenario	WWTP		Season	Reservoir Flow Rate (m ³ /s)
	Flow Rate (m ³ /s)	Effluent Quality		
1	0.010	Current average	Summer	7.24
2	0.015	Future ELV	Summer	7.24

4.5.3 Average Reservoir Inflow Modelling: Model Results

Table 9 gives the mixing zone dimensions, delineating the local area within which the EQS is exceeded. The dimensions are given in terms of the distance from the outfall and the maximum cross-section diameter (width) of the plume. The plumes are mapped in Figures 23-26.

Table 9: CORMIX Model Run Results

Reservoir Flow Condition	Average Flow (7.24m ³ /s)	
	1	2
Scenario	1	2
Effluent Flow and Concentration Scenario	Current Average	Future ELV

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Ammonia Mixing Zone Length (m)	380	236
Ammonia Mixing Zone Max Width (m)	7	11
BOD Mixing Zone Length (m)	56	127
BOD Mixing Zone Max Width (m)	3	5
Ortho-P Mixing Zone Length (m)	31	113
Ortho-P Mixing Zone Max Width (m)	2	4
Total P Mixing Zone Length (m)	104	171
Total P Mixing Zone Max Width (m)	4	8

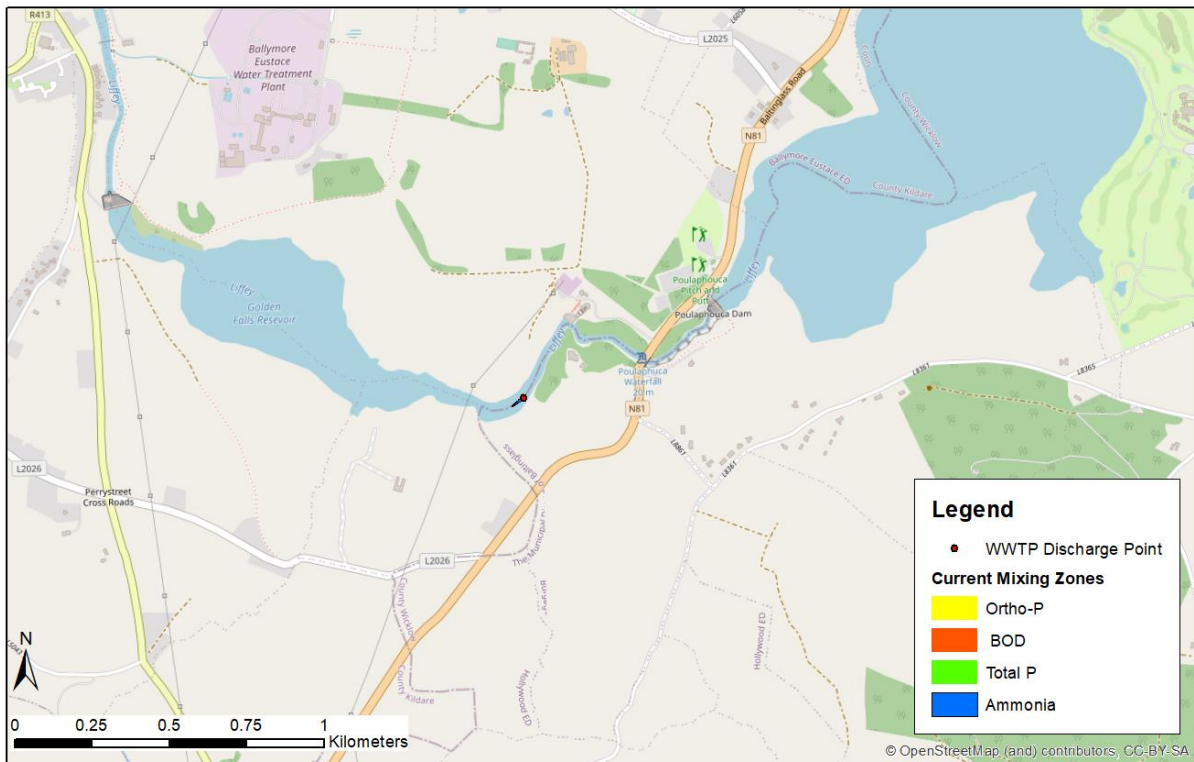


Figure 23: Effluent Mixing Zones (Current Average Effluent Flows, Average Reservoir Flows)

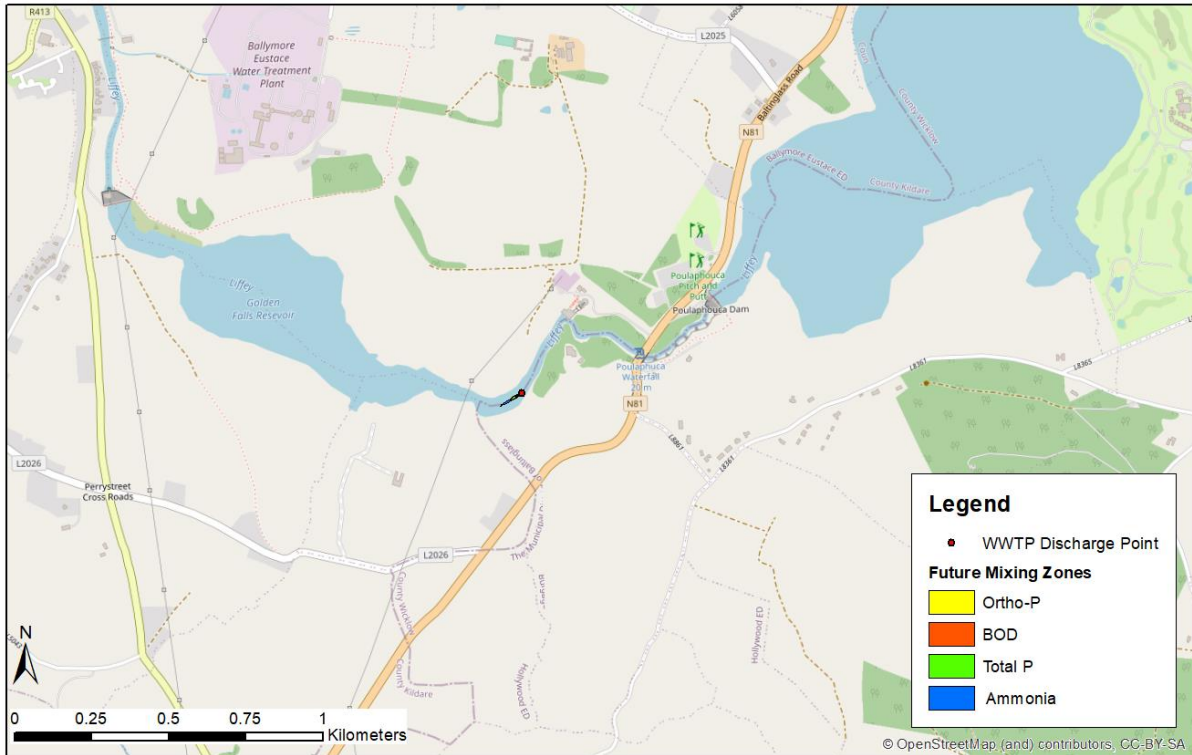


Figure 24: Effluent Mixing Zones (Future Average Effluent Flows, Average Reservoir Flows)

The modelled mixing zones are extremely narrow and extend along the deepest section of the channel. The ammonia mixing zone extends for a maximum of 47m downstream of the outfall under current effluent flow conditions and 84m under future effluent flow conditions. The current scenario mixing zones during average flow conditions are small due to rapid dilution within the receiving waters. The mixing zones extend further downstream as effluent rates increase, however the largest mixing zone extent (the future ammonia mixing zone) occupies less than 0.2% of the total Golden Falls Reservoir area. Since the mixing zone does not reach the downstream end of the reservoir for any modelled scenario, the discharge is not expected to impact on any waterbody downstream of Golden Falls.

4.5.4 Zero Reservoir Inflow Modelling

As shown in Section 4, zero flow is transferred between Poulaphouca Reservoir and Golden Falls Reservoir for 20% of the year while a minimum pass forward flow of 1.5m³/s is always maintained from Golden Falls Reservoir. The zero flow condition is usually sustained for 1 to 2 days under the current operating regime which has been in place since 1994, although on one occasion the flow from Poulaphouca Reservoir was zero for seven days (Figure 27). The water level and volume in Golden Falls Reservoir will gradually reduce during times of zero inflow from upstream.

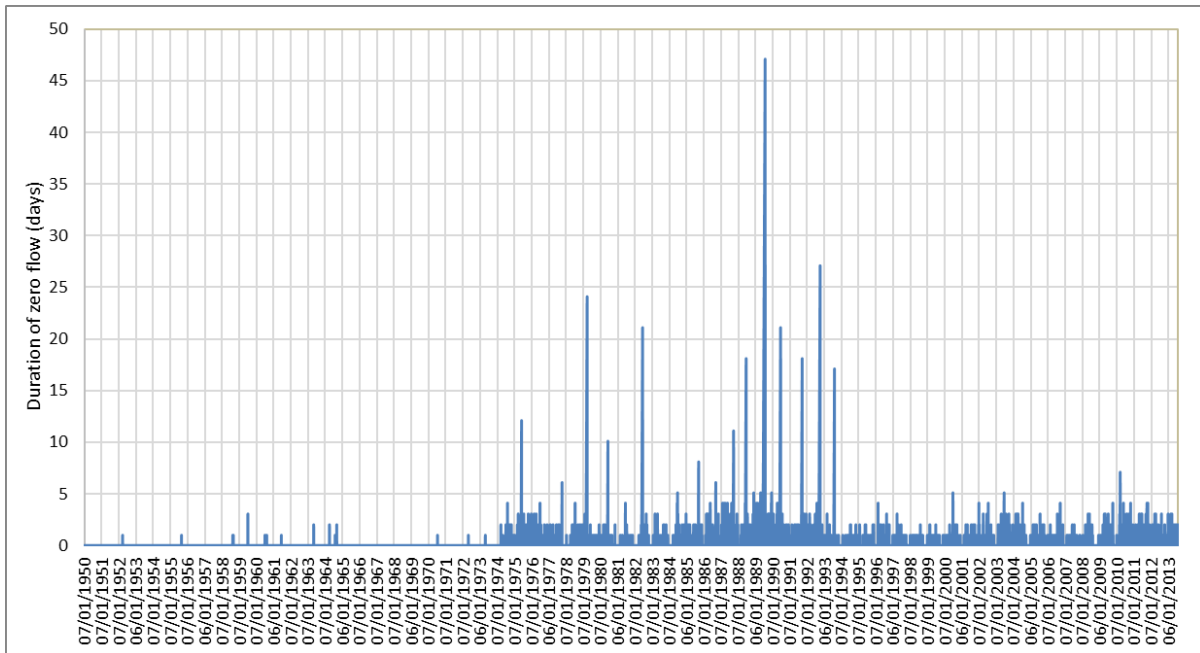


Figure 255: Duration of Zero Inflow Period to Golden Falls Reservoir

The CORMIX modelled carried out in Section 5.5.1-5.5.3 above is not representative of the zero inflow scenario because the river flow velocities at the WWTP discharge point will be extremely low. The discharged effluent will slowly spread and mix through a large area of the Golden Falls Reservoir which has an extremely large dilution volume. This is not well represented by the CORMIX model which mainly represents momentum-driven mixing in the immediate vicinity of the discharge point. The overall frequency of the zero flow condition is such that the 95%ile water quality condition may be affected by the accumulation of pollutants and reduced dilution within Golden Falls Reservoir during times of zero flow from Poulaphouca Reservoir.

A separate dynamic mass balance approach has therefore been used to assess the impacts on 95%ile water quality in Golden Falls Reservoir due to discharges from Blessington WWTP during times of zero inflow from upstream. This approach has been used to assess water quality in terms of 95%ile concentrations of ammonia, orthophosphate and BOD. Total phosphate has not been considered for this analysis because there is no 95%ile EQS value for this substance. The impacts of the discharge in terms of total phosphate are considered for average conditions only, and the average condition at Golden Falls reservoir is for flows between the two reservoirs to be sustained, as represented by the CORMIX modelling carried out above.

Analysis of the flow data shows that zero inflow to Golden Falls reservoir has only been maintained for a period of seven days on two occasions in the 28-year period from 1985 to 2013. In this case a 7 day zero flow scenario has been modelled to provide a conservative impact assessment. The return period of this assessment scenario is therefore estimated at 1 in 14 years.

The dynamic mass balance approach was applied by diluting the effluent volume discharged over full

24 hour period at the current average discharge rate of 0.01m³/s within the starting reservoir volume of 961,828m³ measured during the bathymetric survey (Appendix B). Average effluent pollutant concentrations and upstream reservoir ambient concentrations (Section 3.4) were assumed. Further mass balance calculations were carried out at daily timesteps in which the Golden Falls Reservoir volume was reduced based on a single outflow rate of 1.5m³/s, offset by the addition of flow from the WWTP, and ambient reservoir concentrations were set at the concentrations calculated for the previous timestep. This allowed pollutant concentrations to gradually rise in the reservoir as dilution volumes reduced and background concentrations increased. The future scenario impacts were modelled using a constant WWTP effluent discharge point of 0.015m³/s and effluent concentrations set at ELV values. The results are shown in Figures 26-28 and compared with 95%ile EQS values given in Table 2.

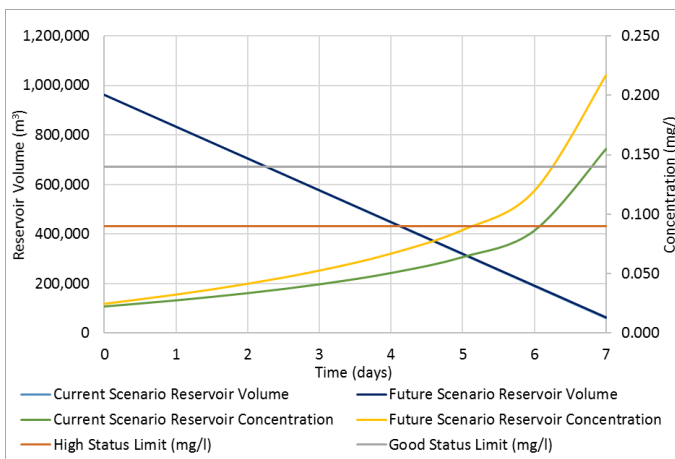


Figure 26: Zero Inflow Scenario Results for Ammonia

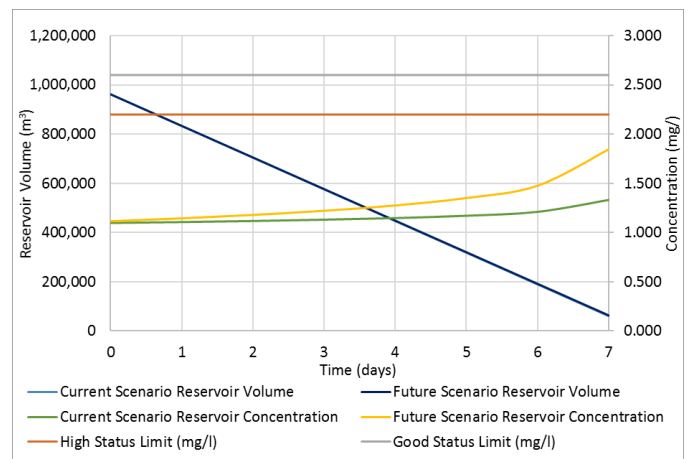


Figure 27: Zero Inflow Scenario Results for BOD

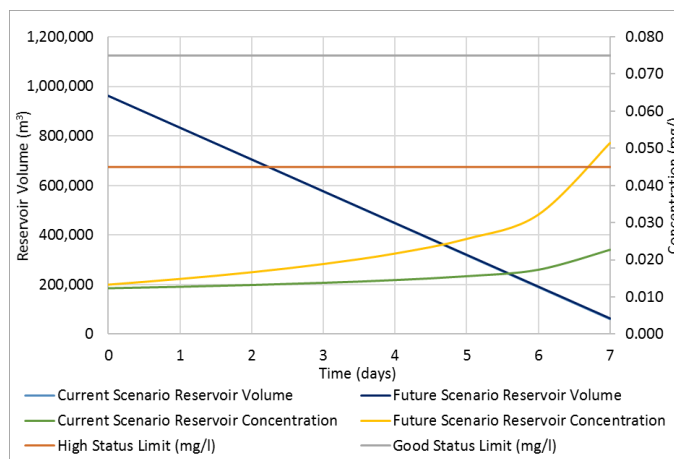


Figure 28: Zero Inflow Scenario Results for Orthophosphate

The results show that modelled concentrations of BOD increase slightly over the seven-day period for which the calculations have been carried out, but concentrations remain compatible with the achievement of high status EQS for 95%ile concentrations in rivers under both the current and future scenarios.

The modelled concentrations of orthophosphate increase slowly for the first 4-5 days before rising more

quickly after 6 days as reservoir volumes approach the minimum, however these also remain compatible with the achievement of Good Status EQS for 95%ile concentrations in rivers. The High status EQS would be exceeded after 7 days under the future scenario only.

The concentrations of ammonia increase slowly for the first 4-5 days before rising more quickly after 6 days as reservoir volumes approach the minimum. The modelled concentrations exceed the good status EQS after 6-7 days under both current and future scenarios. Modelled concentrations exceeded the High Status 95%ile EQS after 5 and 6 days under the future and current scenarios respectively.

Analysis of the flow data shows that zero inflow to Golden Falls reservoir has only been maintained for up to seven days on two occasions in the 28-year period from 1985 to 2013. This is therefore an extreme condition and the occasional transient exceedance of EQS values under these very rare conditions would not result in a deterioration of status as the modelling demonstrates the impacts do not persist for long enough to affect compliance with long term 95%ile water quality standards.

4.5.5 Discharge Impact Significance

The water quality modelling carried out above shows that, where there is flow between Poulaphouca and Golden Falls Reservoir, the mixing zone for effluent discharged from Blessington WWTP is extremely small. The area over which concentrations of ammonia, orthophosphate and BOD are exceeded the high status EQS for mean concentrations occupies less than 1% of the total area of Golden Falls Reservoir, and future increases in effluent discharge rates will not significantly increase the size of the mixing zone. Similarly, the area over which the good status EQS for mean total phosphate is exceeded is less than 0.5% of the Golden Falls Reservoir area (the high status EQS for mean total phosphate is exceeded upstream of the discharge point). The mixing zone does not extend to the downstream limit of Golden Falls reservoir and will therefore have no significant impact on waterbodies downstream.

Flows are not transferred between reservoirs for 20% of the time and this may impact the 95%ile concentrations of ammonia, BOD and orthophosphate as the volume of water contained within Golden Falls Reservoir is reduced. Dynamic mass balance calculations of a 7-day zero flow event show that reservoir concentrations will increase during times of extended zero flow, however the modelling has demonstrated that EQS exceedance of Good Status only occurs after a period of 6.25 days of zero flow.

Analysis of the flow data shows that zero inflow to Golden Falls reservoir has only been maintained for a seven day period on two occasions in the 28-year period from 1985 to 2013. This is therefore, statistically, an extreme condition and the occasional transient exceedance of EQS values under these very rare conditions would not result in a deterioration of status as the modelling demonstrates the duration of any EQS exceedances under these conditions would not persist for long enough to affect compliance with 95%ile water quality standards.

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Furthermore, the modelling method for the zero inflow scenario is considered to be conservative as it does not take into account addition of water and dilution capacity due to two small tributaries entering Golden Falls reservoir downstream of the WWTP discharge point.

Blessington WWTP primary outfall is the only known discharge point to Golden Falls Reservoir. The discharged effluent will therefore not have cumulative impacts due to contributions from other outfalls downstream. The cumulative impact arising from upstream discharges are taken into account in the above impact assessment by the use of ambient monitoring data measured at an appropriate location.

The assessment of the impact of the Blessington WWTP on receiving waters has demonstrated that the recent upgrade of the treatment works has had a positive impact on receiving water quality. Modelling has been carried out under both mean and zero flow conditions and has demonstrated that the existing and future (9,000PE) wastewater discharges from treatment works are compatible with the achievement of the WFD objectives of the receiving waters.

5 SUMMARY AND CONCLUSIONS

A water quality assessment has been carried out to assess the impacts of the proposed increase in effluent flow from Blessington WWTP and to determine whether the existing ELVs will remain appropriate in future.

A Tiered Assessment has been carried out to assess the current and potential future impacts of WWTP discharges on water quality in Golden Falls Reservoir. The Tier 0 assessment identifies that the contaminants of concern are ammonia, BOD, orthophosphate and total phosphate. The Tier 1 assessment confirms that these substances are present in the effluent at concentrations which exceed the EQS. A simplified water quality impact assessment at Tier 2 is inappropriate in this location due to the complex hydrology, reservoir morphology and the need to consider different modes of mixing within the reservoir. A more complex Tier 3 modelling study has therefore been carried out.

The modelling has been carried out to reflect the request for information made by the Environmental Protection Agency concerning the minimum flows in the vicinity of the discharge. A detailed review of the available ESB flow data show that there is significant variation in flow between Poulaphouca and Golden Falls Reservoirs, however zero flow is passed between the reservoirs for up to 20% of the time. Under these conditions the ambient flow velocities at the discharge point would approach zero. The impact of the discharge has therefore been assessed using two methods: CORMIX modelling has been used to analyse mixing zone extents during times of inflow from Poulaphouca Reservoir, and a mass balance approach has been used to analyse impacts on 95thile water quality during times of zero inflow. In line with existing upstream water quality, the mixing zone extents in CORMIX were defined where concentrations of ammonia, orthophosphate and BOD locally exceed the applicable high EQS values and where total phosphate concentrations locally exceed the good status EQS.

The CORMIX results show that the mixing zones will be small when water is flowing from Poulaphouca Reservoir to Golden Falls Reservoir. The future increase in effluent flow rate will result in a slightly longer mixing zone, however the mixing zone still occupy less than 1% of the reservoir area and will not approach the Golden Falls Dam.

The results of the dynamic mass balance calculations show that the transient increases in concentrations under zero flow periods are not sustained long enough to allow reservoir concentrations of BOD, ammonia or orthophosphate to approach the relevant 95thile EQS for lakes or rivers except under extreme conditions which have a frequency in the order of 1 in 14 years. A continuous flow at the discharge point is not required to allow the receiving water quality to meet EQS limits under the current reservoir operating regime.

Blessington WWTP primary outfall is the only known discharge point to Golden Falls reservoir. The discharged effluent will therefore not have cumulative impacts on reservoir water quality due to contributions from other outfalls downstream. The impact of the Blessington WWTP discharge point on

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water quality in Golden Falls reservoir is not expected to cause problems for municipal water treatment. The discharge is not considered to have significant impact on water quality under the current or future scenario based on the current ELV values. Changes to ELVs or further investigation of the water quality impacts at Tier 4 are not required.