

# Uisce Éireann

## Low Flow Hydrological Estimation Report

### Nenagh River at Ballycommon

Revision Number	Description of Change	Author(s)	Approved By	Date of Approval
01	First Draft	S Waite		

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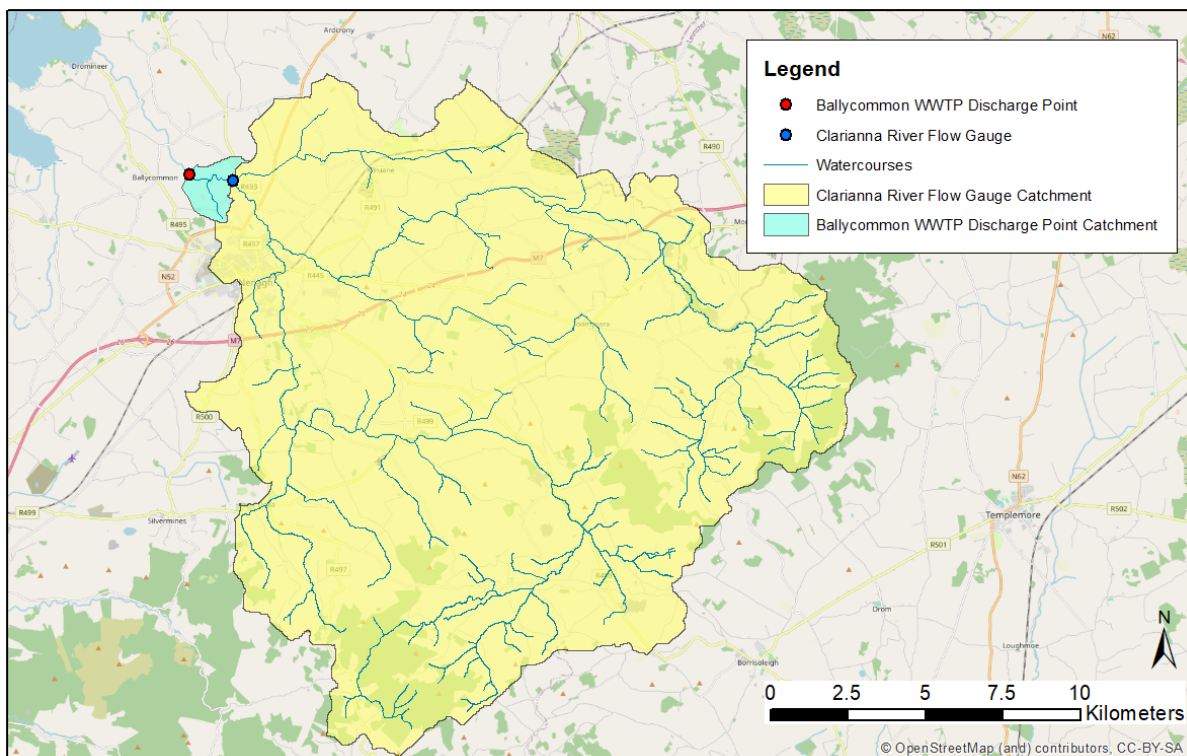
## 1 INTRODUCTION

River flow estimates are required by Uisce Éireann for the purposes of assimilative capacity calculations for the treated wastewater discharge (i.e., Primary Discharge - SW001) from Ballycommon Wastewater Treatment Plant (WwTP) to the Nenagh River. The most important flow conditions are currently the  $Q_{95}$  low flow condition and  $Q_{30}$  average flow condition and the following note sets out the calculation process followed for this site.

## 2 SITE LOCATION AND LOCAL RIVER FLOW GAUGES

Ballycommon WWTP discharges treated wastewater from Primary Discharge (SW001) to the Nenagh River at Ballycommon, at Ordnance Survey Ireland National Grid Reference 184644 182476. The Nenagh catchment area at the Primary Discharge Point (SW001) is 295.0km<sup>2</sup>.

There is a continuous river flow gauge located on the Nenagh River at Clarianna 1.8km upstream of the Primary Discharge Point (SW001). The difference in catchment area between the Primary Discharge Point (SW001) and the gauge is less than 1% and flow statistics calculated at the gauge can therefore be applied at the Primary Discharge Point (SW001), without scaling for catchment area, because the hydrological characteristics of the catchment and river flows are unlikely to change significantly between the two locations. The Primary Discharge (SW001) location, the gauge location and the river catchment area are shown in Figure 1.



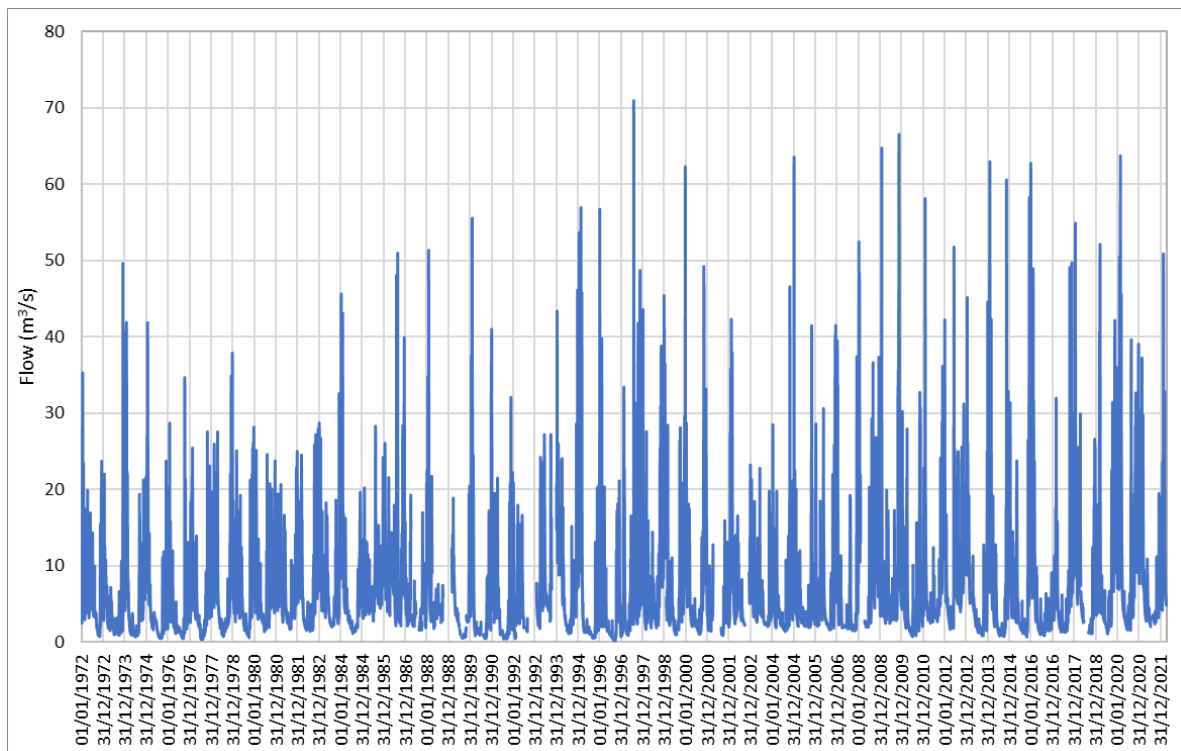
### 3 RIVER FLOW GAUGE DATA

#### 3.1 Continuous River Flow Gauge Record at Clarianna

Details of the gauged flow data at Clarianna are provided in Table 1 and the timeseries is shown in Figure 2. The annual flow data and flow percentiles at the Clarianna gauge are set out in Appendix A.

**Table 1: Clarianna Gauging Station Details**

<b>Station Number</b>	25029
<b>Station Name</b>	Clarianna
<b>Waterbody</b>	Nenagh River
<b>Site Owner</b>	Office of Public Works
<b>Grid Reference</b>	186069 182288
<b>River Basin District</b>	Shannon
<b>Catchment Area (km<sup>2</sup>)</b>	292.4
<b>Data Start Date</b>	01/01/1972
<b>Data End Date</b>	12/04/2022
<b>Daily Data Percent Complete</b>	91.3



**Figure 2: River Flow Timeseries for the Nenagh River at Clarianna (Daily Mean Flows from 1972 to 2022)**

The gauge data has been reviewed for quality, non-stationarity and the impact of missing data. This shows that the record is largely complete with no large gaps affecting specific flow ranges, although many individual water years do have more than 5% missing data. The distribution of the missing data across the whole range of measured flows means that the data gaps are not expected to skew the

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overall flow statistics. The data review also shows that the river flow has been calculated from measured water level using 3 No. ratings across the period of record, with the following flow measurement quality boundaries:

- Rating 1 (1972-1977):  
Flows up to  $9.029\text{m}^3/\text{s}$  ( $Q_{22.7}$ ) calculated with poor quality, flows from  $Q_{22.7}$  to  $16.3\text{m}^3/\text{s}$  ( $Q_{9.7}$ ) are measured with good quality and flows from  $Q_{9.7}$  to  $33.997\text{m}^3/\text{s}$  ( $Q_1$ ) are measured with fair quality. Higher flows are extrapolated.
- Rating 2 (1977-1991 and 1992-1998):  
All flows up to  $Q_1$  calculated with fair quality. Higher flows are extrapolated.
- Rating 3 (1992 and 1998-present):  
Flows up to  $Q_{22.7}$  calculated with poor quality, flows from  $Q_{22.7}$  to ( $Q_1$ ) are measured with fair quality and higher flows are extrapolated.

The Clarianna gauging station is maintained by the Office of Public Works for flood flow measurement. Review of the flow data quality shows that the Clarianna gauging station is optimised for high flow measurement and low to moderate flows are measured with poor quality when ratings 1 and 3 are used. However, the annual flow statistics in Appendix A are generally consistent across the three ratings and the changes in rating do not result in clear non-stationarity in the annual flow data. The poor quality flow data will give flow statistics which are similar to those given by fair quality flow data. The use of the Clarianna gauge in calculating low flow conditions for Ballycommon WW agglomeration Primary Discharge Point (SW001) is considered to be justified because of the close proximity to the gauge and the discharge point. Any uncertainties due to the use of poor quality flow data will be smaller than the uncertainties inherent in applying flow estimation methods for ungauged catchments to this site.

There are no known significant anthropogenic influences on gauged river flow. The upstream catchment shows no sections of impounded watercourse or reservoirs. There are no watercourse reaches which are known to experience significant abstraction pressures and only one No. WWTP discharging upstream, at Nenagh, which serves more than 500 population equivalent. Nenagh WWTP has an average flow<sup>1</sup> of  $5,262\text{m}^3/\text{d}$ , or  $0.061\text{m}^3/\text{s}$ , which is small compared with gauged river flows.

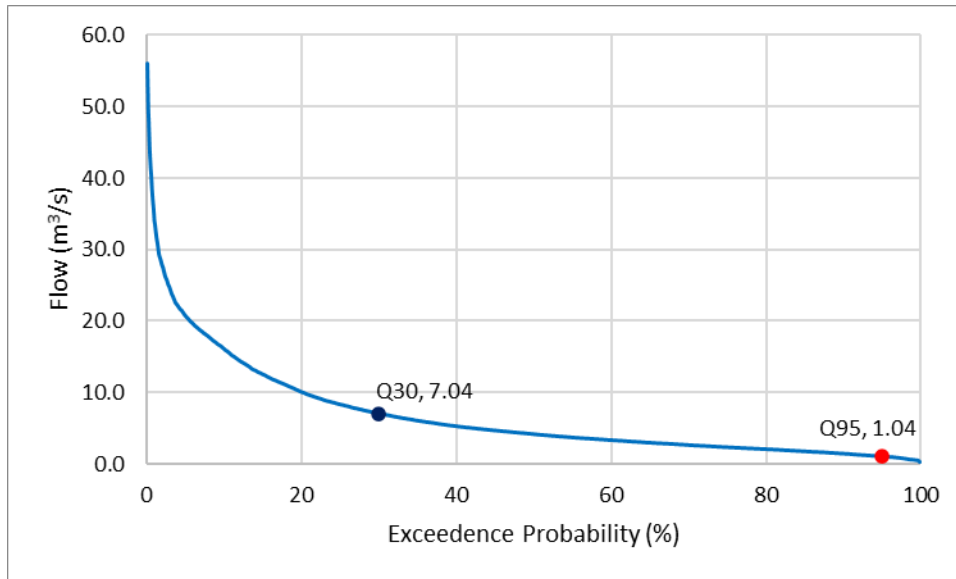
On the basis of these checks, the daily mean flow data from the entire gauge record from the Clarianna gauge has been used to produce the flow duration curve and key flow percentiles shown in Figure 3.

<sup>1</sup> Flow taken from 2021 Annual Environmental Report available at [https://www.water.ie/docs/aers/2021/D0027-01\\_2021\\_AER.pdf](https://www.water.ie/docs/aers/2021/D0027-01_2021_AER.pdf) accessed 15 February 2023

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**Figure 3: Flow Duration Curve and Key Flow Percentiles for the Nenagh River at Clarianna (daily mean flows from 1972 to 2022)**

#### 4 RIVER FLOW ESTIMATE METHODOLOGY

The flow statistics calculated at the Clarianna gauge can be applied at the Ballycommon WW agglomeration Primary Discharge Point (SW001) without scaling for the insignificant increase in catchment area at the Primary Discharge Point (SW001). The  $Q_{95}$  flow at Ballycommon WW agglomeration Primary Discharge (SW001) is therefore  $1.04\text{m}^3/\text{s}$  and the  $Q_{30}$  flow is  $7.04\text{m}^3/\text{s}$ .

The river flow gauge used to obtain this flow estimate is not immediately downstream of the Ballycommon WW agglomeration Primary Discharge Point (SW001) and therefore the flow estimates do not need to be corrected to account for the contribution of the discharge to river flows. The calculated flow percentiles can be used in wastewater assimilative capacity (WAC) calculations to inform CoA applications.

##### 4.1 Climate Change Vulnerability

The principal effect of climate change as it pertains to assimilative capacity calculations is a predicted reduction in low river flows due to more frequent droughts and increased evaporation. Climate change impact on river flows in Ireland were reviewed as part of the National Water Resources Plan (NWRP) with additional work to identify climate sensitive catchments carried out with Maynooth University in 2020. The main outcomes of this work are a system for categorising the vulnerability of a river catchment to reductions in flow and the range of potential reductions predicted under various future emission pathways.

The method for assessing catchment vulnerability to reduced river flows first requires identification of catchment descriptors based on catchment descriptors (see Figure 4). The current recommended climate change allowances to be applied to the  $Q_{95}$  estimate are shown in Table 2.

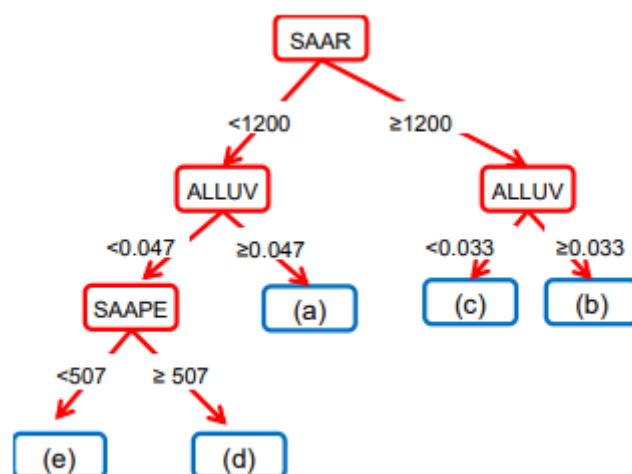


Figure 4: System for Determining Catchment Vulnerability Class for Climate Change Projections

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**Table 2: Predicted Reductions in Q<sub>95</sub> River Flow to 2080s and 2099 (Mean Central Estimates from Climate Models)**

Catchment Type	Reduction in Q <sub>95</sub> predicted for 2080s (emissions scenario 4.5)	Reduction in Q <sub>95</sub> predicted for 2080s (emissions scenario 8.5)	Reduction in Q <sub>95</sub> predicted by 2099
<b>A</b>	11%	12%	12%
<b>B</b>	22%	27%	24%
<b>C</b>	19%	26%	22%
<b>D</b>	14%	19%	17%
<b>E</b>	13%	17%	15%

The SAAR value for the Nenagh River catchment is 1162mm and the ALLUV value is 0.096, making the Nenagh River catchment at Ballycommon a Type A catchment in terms of climate sensitivity. The current prediction for Type A catchments is a reduction in Q<sub>95</sub> of up to 12% by 2099, which would reduce the calculated Q<sub>95</sub> at Ballycommon to 0.85m<sup>3</sup>/s. The sensitivity of the WAC calculation to this reduction in Q<sub>95</sub> may need to be assessed depending on the expected lifetime of the CoA.

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5 APPENDIX A – Annual River Flow Statistics for the Nenagh River at Clarianna

Year	% missing	Flow (m³/s)												
		Max	Min	Q <sub>5</sub>	Q <sub>10</sub>	Q <sub>20</sub>	Q <sub>30</sub>	Q <sub>40</sub>	Q <sub>50</sub>	Q <sub>60</sub>	Q <sub>70</sub>	Q <sub>80</sub>	Q <sub>90</sub>	Q <sub>95</sub>
1971	25	35.3	1.32	16.5	12.7	9.66	7.60	6.45	5.43	4.64	3.98			
1972	0	23.7	0.73	12.3	8.88	6.28	4.35	3.33	2.38	1.90	1.67	1.33	1.06	0.93
1973	0	49.6	0.72	22.0	17.1	8.54	5.51	3.78	2.36	1.70	1.28	1.10	0.94	0.85
1974	0	41.4	0.49	19.5	13.0	7.55	5.49	3.68	3.10	2.80	2.14	1.27	0.63	0.52
1975	0	28.6	0.47	10.7	6.88	4.52	3.43	2.67	2.16	1.77	1.50	1.36	0.82	0.58
1976	0	34.5	0.36	14.4	10.9	7.03	5.10	4.17	3.30	2.51	2.14	1.48	0.69	0.57
1977	0	27.5	0.78	17.1	13.4	9.49	7.06	5.97	4.71	3.29	2.75	2.29	1.45	1.09
1978	0	37.9	0.81	19.3	14.2	8.62	6.80	5.31	4.43	3.81	3.14	2.14	1.64	1.25
1979	0	28.2	0.60	18.2	14.3	9.29	7.17	5.31	4.31	3.67	3.09	2.52	2.08	1.84
1980	0	23.6	1.69	16.4	14.2	11.4	9.65	7.67	6.09	5.06	4.07	3.25	2.50	2.06
1981	0	25.0	1.41	16.5	13.2	9.36	7.13	5.40	4.02	2.92	2.39	2.02	1.78	1.68
1982	0	28.7	2.02	19.0	16.4	13.1	10.8	7.98	6.56	5.37	4.21	3.13	2.33	2.19
1983	3	45.5	1.15	22.1	16.8	11.7	6.79	4.84	3.88	3.08	2.47	1.87	1.49	1.38
1984	0.3	28.2	1.92	14.2	12.5	9.38	7.75	6.48	5.67	4.95	4.44	4.17	3.55	2.79
1985	7	50.8	2.14	18.3	15.9	11.7	10.0	8.58	7.34	6.39	5.38	4.18	2.75	
1986	17	39.8	1.59	19.7	13.7	7.42	5.04	3.88	3.28	2.78	2.27	1.72		
1987	27	51.4	1.58	19.1	15.6	7.40	5.13	4.33	3.52	2.87	1.93			
1988	48	18.9	0.55	9.8	7.11	3.56	2.73	0.78	0.59					
1989	14	55.5	0.49	22.2	13.9	4.62	2.87	1.73	1.29	1.17	0.91	0.60		
1990	12	40.9	0.43	18.5	12.7	7.64	5.06	3.92	2.85	1.70	1.03	0.77		
1991	23	31.9	0.55	14.8	8.98	5.89	4.12	3.38	2.80	1.90	1.18			
1992	38	27.2	1.79	17.1	10.1	6.40	5.17	4.58	3.15	2.18				
1993	39	43.4	1.14	19.2	17.1	10.6	4.81	2.45	1.58	1.17				
1994	2	56.0	0.52	24.5	19.2	12.5	7.64	3.98	2.44	1.66	1.41	1.23	0.91	0.57
1995	4	56.6	0.22	20.1	13.0	6.88	3.80	2.51	1.89	1.22	0.86	0.60	0.27	0.22
1996	0	70.9	0.58	18.8	12.7	7.89	5.43	4.20	3.24	2.62	1.97	1.47	1.08	0.98
1997	2	48.6	1.68	21.4	15.7	8.74	6.19	5.10	4.36	3.69	3.20	2.63	2.20	1.98
1998	11	45.3	0.99	25.4	20.9	13.3	8.79	5.80	4.18	3.25	2.55	1.66		
1999	0.3	62.2	1.02	21.4	15.2	9.88	6.80	4.54	3.57	2.88	2.52	2.19	1.57	1.30
2000	37	49.2	0.89	20.7	14.9	7.76	5.11	3.62	1.90	0.98				
2001	1	42.3	1.83	22.1	14.2	8.52	6.70	5.21	4.22	3.52	3.18	2.89	2.59	2.38
2002	19	23.2	2.28	11.7	8.85	6.92	5.59	4.69	3.96	3.39	2.59	2.32		
2003	0	28.3	1.41	14.0	9.39	5.34	4.20	3.52	2.87	2.38	2.23	2.09	1.81	1.60
2004	0	63.5	1.93	17.1	11.6	7.38	5.29	4.30	3.62	2.98	2.63	2.32	2.18	2.13
2005	0	41.4	1.63	16.1	11.4	6.66	4.97	4.16	3.53	3.04	2.61	2.35	1.94	1.75
2006	0	41.5	1.53	24.3	17.6	9.05	5.84	4.30	2.85	2.25	2.11	2.03	1.88	1.79
2007	19	52.5	1.51	24.5	19.4	12.5	6.71	3.55	2.59	2.06	1.73	1.55		
2008	0	64.5	2.47	20.6	17.2	12.4	9.53	7.32	5.75	4.62	3.99	3.54	3.19	2.89
2009	0	66.4	0.75	28.7	18.7	9.55	6.32	4.47	3.55	2.83	1.98	1.44	1.09	0.91
2010	2	57.9	1.48	18.7	12.0	6.57	4.96	4.39	3.91	3.56	3.28	2.96	2.51	1.76
2011	0	51.4	1.69	22.1	19.1	13.8	10.2	7.88	6.59	5.63	4.70	3.32	2.43	1.93
2012	9	45.0	0.85	19.3	17.4	12.4	9.33	6.45	4.85	2.89	1.73	1.34	0.90	
2013	0	62.8	0.76	29.6	21.6	12.1	6.28	4.77	3.09	2.19	1.58	1.17	0.98	0.90
2014	0	59.7	0.74	17.5	14.3	9.29	6.49	4.53	3.63	2.96	2.25	1.78	1.50	1.32
2015	0	62.7	0.81	31.5	24.5	15.4	7.78	4.50	2.81	2.11	1.65	1.37	1.07	0.94
2016	0	31.9	1.31	10.5	7.49	5.42	4.38	3.29	2.55	2.11	1.88	1.72	1.56	1.48
2017	22	54.7	1.16	24.0	19.6	13.1	9.42	7.26	5.30	4.07	2.24			
2018	0	51.9	1.09	20.9	16.1	8.27	5.79	4.75	3.90	3.05	2.57	2.06	1.57	1.21
2019	2	63.7	1.56	33.8	24.6	17.7	13.8	8.75	7.44	4.85	3.55	2.74	2.11	1.84
2020	9	38.9	2.05	25.9	20.5	16.6	12.8	9.44	7.03	4.25	3.40	2.94	2.14	
2021	47	50.6	2.67	17.8	13.4	8.10	5.36	4.34	3.17					