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Naburn Weir Hydroelectric Project

Water Framework Directive Assessment

Renewables First Ltd
The Mill
Brimscombe
Stroud, Glos, GL5 2QG

Phone +44 (0)1453 88 77 44
Fax +44 (0)1453 88 77 84
Email info@renewablesfirst.co.uk
www. renewablesfirst.co.uk

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Document Control

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1. Introduction

Introduction to assessment

1.1. This document has been produced in connection with an abstraction and impoundment licence applications for a hydropower scheme at Naburn Weir on the River Ouse.

1.2. The Environment Agency's 'Guidance for run-of-river hydropower: the Water Framework Directive, nature conservation and heritage' dated December 2013 has been followed as part of this assessment.

1.3. The assessment will review the potential effects arising from the proposed scheme in relation to:

- flow patterns
- sediment availability

1.4. The Water Framework Directive (2000/60/EC) (WFD) was passed by the European Union in 2000. It became part of UK law in 2003 with the issue of The Water Environment (Water Framework Directive) (England and Wales) Regulations 2003.

1.5. The WFD is implemented regionally by river basins. Each river basin has a River Basin Management Plan (RBMP) which is updated every six years. The RBMP documents the current status of the water bodies and the pressures affecting them. It outlines the improvements that can be made within the current management period and the programme of investigations to be carried out.

1.6. The fundamental objectives of the WFD that apply to surface water bodies are:

- Prevent deterioration of the status of water bodies
- Achieve at least good ecological status and good surface water chemical status by a set date
- Reduce pollution from priority substances and eliminate priority hazardous substances as defined by the European Commission

1.7. In additional to the objectives above there are further standards and measures to be met in areas defined as protected areas. These areas are listed in the RBMPs.

1.8. Artificial or Heavily Modified Water Bodies (AWB, HMWB) cannot achieve good ecological status as they are unable to get close enough to the required natural conditions. Instead the aim is to achieve good ecological *potential*.

1.9. The RBMPs detail the Environment Agency (EA) objectives specific to each water body that are designed to meet the WFD objectives. The proposed measures to meet the objectives are also given.

Purpose of assessment

1.10. This assessment has been undertaken to fulfil the requirements under the Water Framework Directive.

1.11. The EU Water Framework Directive requires environmental objectives be set for all surface and ground waters to enable them to achieve good status or potential for heavily modified water bodies by a defined date. One objective is to prevent further deterioration which can include changes to flow pattern, width and depth of channel, sediment availability/transport and ecology and biology.

1.12. This assessment looks at the current status of the water bodies that may be affected by the proposed hydropower system and discusses whether or not the proposal will deteriorate the ecological quality of the water bodies or prevent the water bodies from achieving good ecological status.

1.13. Any EA defined objectives and measures that are specific to the water body will be considered to determine if the proposed hydropower system will prevent these objectives and measures from being realised.

1.14. The assessment includes any cumulative or in-combination effects.

Scheme location & description

1.15. Naburn Weir is a notched, V-shaped weir that spans the main river channel and is the typical tidal limit on the Ouse. The weir was constructed in the 1770s to maintain water levels for navigation.

1.16. Approximately 135 m upstream of the weir, the channel splits to create a navigational channel along the left-hand side leading to two operational locks. The two channels are separated by small island, which extends approximately 105 m downstream of the weir.

1.17. A pool and weir fish pass is located on the right bank adjacent to the weir, alongside a newer eel and lamprey pass constructed in 2014.

1.18. The proposal comprises 3 no. Archimedes screw turbines and associated plant infrastructure located within the bank of the island, immediately adjacent to the weir as per the attached drawing 2350001 – Site Location Plan.

Other schemes

1.19. There are no known hydropower schemes within 5 km of the proposed development.

Current WFD status

Water body name	Ouse from River Nidd to Stillingfleet Beck
Water body ID	GB104027069593
Management Catchment	Swale Ure Nidd and Ouse upper
Operational Catchment	Ouse Upper Yorkshire
River Basin District	Humber
Hydromorphological Designation	Heavily Modified
Overall Classification for 2016	**Moderate**
2013 Ecological Quality	Moderate
2013 Chemical Quality	Fail
2016 Ecological Quality	Moderate
2016 Chemical Quality	Good

Classification Item	2013	2014	2015	2016
Overall Water Body	Moderate	Moderate	Moderate	Moderate
Ecological	Moderate	Moderate	Moderate	Moderate
Chemical	Fail	Fail	Good	Good

Fig. 1: Cycle 2 Classification

1.20. The upstream waterbodies are: Ouse from River Ure to River Nidd, Nidd from Crimple Beck to River Ouse, Holgate Beck to Ouse, Hurns Gutter from Source to River Ouse, Foss from the Syke to the River Ouse, The Foss.

1.21. The downstream waterbody is Ouse Still/fleet bk - Kelfield and Wharfe d/s Ryther.

2. Impact on WFD objectives

2.1. The following table reviews the RBMP plan for the 'Ouse from River Nidd to Stillingfleet Beck' water body.

Receptor	Current status (2016 C2)	Objective	Potential impact	Assessment	WFD compliance	Further assessment
Element – Biological Quality						
Overall	Good	Good 2015	No impact	The scheme will provide significant fish passage improvements, with no adverse impact on macrophytes, phytobenthos or invertebrates.	Yes	No
Element – Hydromorphological Supporting Elements						
Hydrological Regime	Supports Good	Supports good 2015	No impact	The scheme will not change any of these parameters significantly. No change – neutral impact on delivery of WFD.	Yes	No
Element – Physico-chemical quality elements						
Overall	Moderate	Moderate 2015	No impact	The scheme will not change any of these parameters significantly. No change – neutral impact on delivery of WFD.	Yes	No
Dissolved Oxygen	High	Good 2015	No impact	DO at the site is consistently high. Any minor reduction in average DO due to the screw turbines is outweighed by oxygenation within the new baffle fish pass plus the benefit of new high-DO refugia created by	Yes	No

				focused HEP and fish pass discharges. No change – neutral impact on delivery of WFD.		
Receptor	**Current status (2016 C2)**	**Objective**	**Potential impact**	**Assessment**	**WFD compliance**	**Further assessment**
Element – Specific pollutants						
Overall	High	High 2015	No impact	No change – neutral impact on delivery of WFD.	Yes	No
Element – Supporting elements						
Overall	Moderate	Good 2027	No impact	No change – neutral impact on delivery of WFD.	Yes	No
Element – Chemical – Overall						
Overall	Fail		No impact	No change – neutral impact on delivery of WFD.	Yes	No
Element – Chemical – Other Pollutants – Does not require assessment						
Element – Chemical – Priority hazardous substances						
Overall	Good		No impact	No change – neutral impact on delivery of WFD.	Yes	No
Element – Chemical – Priority substances						
Priority substances	Good		No impact	No change – neutral impact on delivery of WFD.	Yes	No

2.2. All conditions assessed above are shown to have either no impact or a positive impact on each individual WFD element.

3. Detailed review

Catchment status

3.1. Naburn Weir is located within the 'Ouse from River Nidd to Stillingfleet Beck section of the Ouse Upper Yorkshire Operational Catchment Area. The Management catchment area is Swale Ure Nidd and Upper Ouse (SUNO) within the Humber River Basin District.

3.2. Swale Ure Nidd and Upper Ouse catchment covers an area of approximately 83 km^2 extending from the heights of the North Pennine Moors and the Yorkshire Dales extending down to the low-lying Vale of York in the south. There are 114 rivers, 14 lakes and 4 groundwater bodies in the catchment. Of these, 41 are artificial or heavily modified.

3.3. The Swale Ure Nidd and Ouse upper Management Catchment Plan shows that the main reason for not achieving 'good' status is due to the catchment are due to physical modification, pollution from waste water, pollution from rural areas. The water industry, land drainage practices and pollution from towns, cities & transport are responsible for most of the changes in the physical modification.

Ecological and chemical classification for surface waters | 2016 Cycle 2

2016 Cycle 2

	Ecological status or potential					Chemical status	
Number of water bodies	Bad	Poor	Moderate	Good	High	Fail	Good
16	1	5	10	0	0	0	16

Summary of ecological status or potential and chemical status and objectives for surface water bodies (number of water bodies) including those with less stringent objectives and extended deadlines (blue shaded cells)

	Ecological status or potential						Chemical status			
	Bad	Poor	Moderate	Good	High	Total	Fail	Good	Total	
By 2015	0	0	3	1	0	4	0	16	16	
By 2021	0	0	0	0	0	0	0	0	0	
By 2027	0	0	4	8	0	12	0	0	0	Extended Deadline
Beyond 2027	0	0	0	0	0	0	0	0	0	
Total	0	0	7	9	0	16	0	16	16	
	Less Stringent						Less Stringent			

Fig 2: The Ouse Upper Yorkshire catchment summary

3.4. The Environment Agency catchment planning website states that the reasons the waterbody has not achieved a good status RNAG) is due to 'Sewage discharge (continuous)' under the classification phosphate.

3.5. There are areas in the catchment where the water environment is recognised as being of particular importance because of the benefits they provide to society. These benefits include rare wildlife habitats, bathing waters or areas around drinking water sources. The proposed development does not fall within a 'Protected Area'.

3.6. The Yorkshire Dales Rivers Trust is developing a plan to enhance the catchment. Their visions are:

Improved water quality and biodiversity, a healthy functioning ecosystem and reduced flood risk through realistic and more integrated objectives, sustainable agricultural businesses, better coordination and effective partnerships between the public, private sector and civil society and a wider knowledge and appreciation of our watercourses and catchments.

3.7. The Ouse Upper Yorkshire Operational Catchment contains 16 water bodies, all with good chemical status. Out of the 16, 10 waterbodies have moderate ecological status, 5 poor and 1 bad (2016 cycle 2). The long terms objectives for 2027 are to work towards all 16 waterbodies achieving moderate to good objectives.

3.8. There is a need for the Environment Agency to tackle point source pollution from non-mains drainage in this catchment. Protected area measures are proposed to protect drinking water from Metaldehyde. Fish passage through sluices and flap valves will also benefit the catchment.[1]

3.9. The Groundwater Operational catchment at Naburn Weir is Wharfe and Ouse Lower Sherwood Sandstone which is part of the Humber Groundwater Management Catchment. It comprises a single failing waterbody and has a quantitative and chemical status objective as good by 2021. The Reason for Not Achieving Good Status (RNAGS) is Industry. The measure the future objective is based upon is 'Embargo on future abstraction in this aquifer to prevent further saline intrusion'.

3.10. Immediately upstream of Naburn Weir is the SUNO Sherwood Sandstone Ground Water Operational Catchment which is part of the Humber Groundwater Management Catchment. The overall classification for 2016 is Poor. The RNAGs primarily fall under agriculture and rural land management, domestic general public and natural conditions.

3.11. The proposed development at Naburn Weir is not expected to have an adverse impact on the Ground Water waterbodies as the project will not introduce any chemicals or pollutants into the waterbody and will abstract from surface water only, so will not contribute towards further saline intrusion.

Mitigation measures

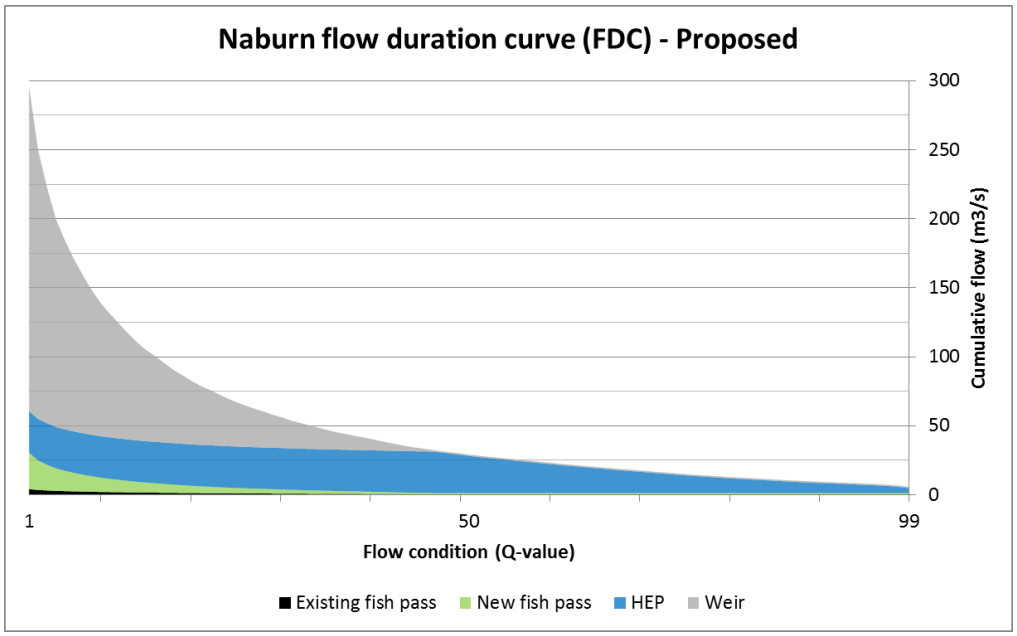
3.12. When a failure is identified, a range of measures are assessed that would be needed to improve the status of water bodies. Mitigation measures proposed for the Swale Ure Nidd and Upper Ouse (SUNO) management catchment are shown below:

Improve modified physical habitats
• Removal or easement of barriers to fish migration
• Removal or modification of engineering structure
• Improvement to condition of channel/bed and/or banks/shoreline
• Improvement to condition of riparian zone and /or wetland habitats
• Changes to operation and maintenance
• Vegetation management
Managing pollution from waste water
• Reduce point source pollution pathways (i.e. control entry to the water environment)
• Mitigate/remediate point source impacts on receptor
Manage pollution from towns, cities and transport
• Reduce diffuse pollution pathways (i.e. control entry to the water environment)
• Mitigate/remediate diffuse pollution impacts on the receptor
Improve the natural flow and level of water
• Control pattern/timing of abstraction
Manage pollution from rural areas
• Reduce diffuse pollution at source
• Mitigate/remediate diffuse pollution impacts on the receptor
Manage pollution from mines
• Mitigate/Remediate point source impacts on receptor

Geomorphology assessment

3.13. The flow duration curve for the site and hydropower scheme is shown below. During low flow conditions, the majority of flow currently passing over the weir will be diverted through the hydropower scheme. Once the hydropower scheme satiates at Q46, the weir flow quickly returns to being the dominant flow at the site.

3.14. Short sections of bank will be removed to create the new hydraulic channels, which will have an invert that is slightly raised above the bed level of the main channel.



3.15. At present during low to moderate flow conditions, the majority of flow passes over the weir, with a small proportion passing through the existing pool and weir fish pass. The average flow speed within the river is likely to be in the region of up to 5-30 cm/s, reducing to zero at the bed and bank edge. Immediately downstream of the weir is a sloped bank of rock protection, where the flow is faster and more turbulent.

3.16. In the proposed scenario, the majority of flow would pass through the hydropower scheme; flow through the existing fish pass would be slightly reduced and a flow of around 1 m3/s would pass through the new fish pass. The flow speed upstream of the intake will increase marginally due to the slightly lower water level, however this effect will not be significant. At the hydropower intake and outfall locations, the flow speed will be in the region of 10-40 cm/s. Immediately upstream of the weir and immediately downstream of the rock protection, and particularly near the right bank, average flow speeds may reduce to 1-5 cm/s.

3.17. Therefore during low to moderate flow conditions the flow speeds in the main channel will not change significantly, except for close to weir and at the bank edge near the intake and outfall locations.

3.18. With reference to the Hjulstrom curve, shown below, the change from 5-30 cm/s to 1-5 cm/s in areas close to the weir and right bank may result in some increased deposition of sands and fine gravels, along with reduced erosion of sands. There may also be a slight increase in deposition of coarse silts.

3.19. At the intake and outfall locations, the change will be approximately from 0-10 cm/s to 10-40 cm/s. This may result in reduced deposition of silts and sands along with increased erosion of sands. However the physical extent of this effect will be very limited.

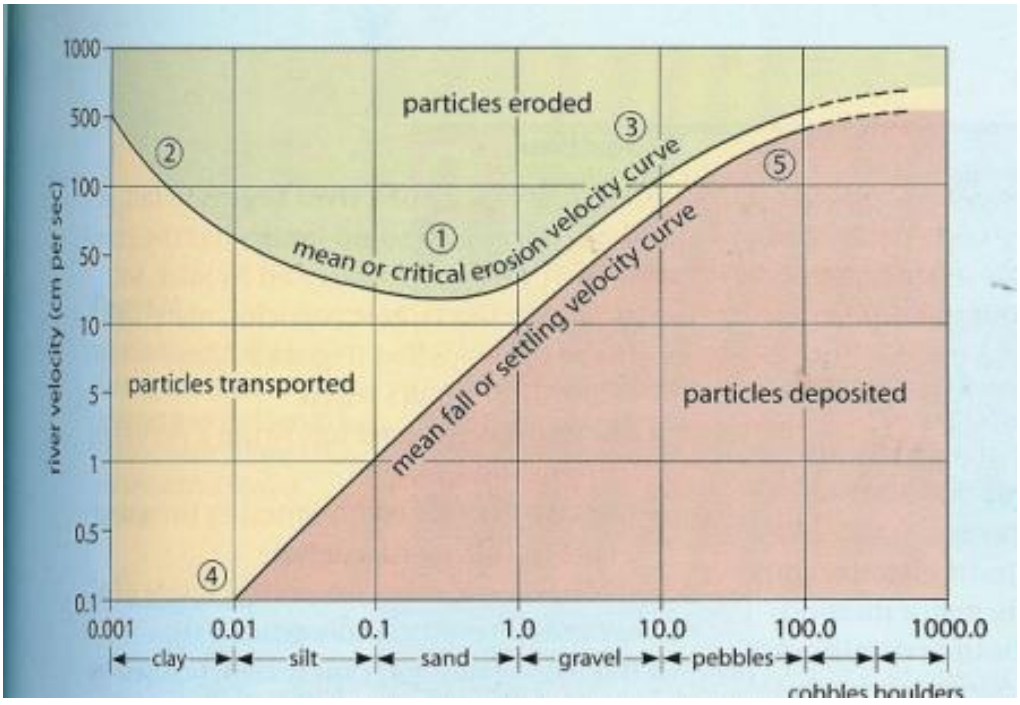


Fig. 3: Hjulstrom curve

3.20. At present during high flow conditions, the vast majority of flow passes over the weir. The flow speed within the river will typically be in the region of 30-80 cm/s, reducing to zero at the bed and bank edge.

3.21. In the proposed scenario, the majority of flow would continue to pass over the weir, however this is reduced slightly by some flow passing through the hydropower scheme and new fish pass. The flow speed upstream of the intake will increase marginally due to the slightly lower water level, however this effect will not be significant. The flow speed in the hydropower intake and outfall channels will be approximately 50 cm/s. Immediately upstream of the weir and immediately downstream of the rock protection, and particularly near the right bank, average flow speeds may reduce slightly to 15-70 cm/s.

3.22. Therefore during high flow conditions, the flow speeds in the main channel will not change significantly, except for at the bank edge near the intake and outfall locations.

3.23. The change from 30-80 cm/s to 15-70 cm/s in areas close to the weir and right bank may result in a marginal increase in deposition of fine gravels and a marginal reduction in erosion of coarse clays, silts, sands and fine gravels.

3.24. The 15-70 cm/s flow speeds remain sufficiently high to erode most sands and fine gravels, including those that have been deposited as a result of reduced flow speeds during low flow conditions.

3.25. At the intake and outfall locations, the change will be approximately from 0-40 cm/s to 50 cm/s. This may result in reduced deposition of silts and sands along with increased erosion of sands. As above, the physical extent of this effect will be very limited.

3.26. Most geomorphological change occurs during very high flow conditions, when flow speeds are sufficient to erode and transport a wide range of sediment including clays, coarse gravels, cobbles and boulders. During these conditions, the hydropower scheme will not be abstracting and will not have any impact on geomorphology.

3.27. In summary, the proposal may result in some deposition of sands and fine gravels close to the weir and right bank during low flow conditions, however this will be a short-term impact as flow speeds during high flow conditions remain sufficiently high to remove the material. During very high flow conditions, when most geomorphological change occurs, the site hydraulics will be unchanged.

Biodiversity and fish passage

3.28. The immediate area is not subject to any environmental designations. There are two SSSIs within 1 km of the proposed development; Acaster South Ings Site of Special Scientific Interest (SSSI) lies 160 m south and Church Ings SSSI lies approximately 1 km upstream. Both SSSIs are large alluvial flood meadows adjacent to the River Ouse with rich plant species grassland. The proposed scheme is not expected to have an adverse impact on the nearby SSSIs.

3.29. The proposed development aims to generate renewable electricity whilst also providing direct fish passage improvements.

3.30. An existing pool and weir fish pass and a separate eel and lamprey pass are located on the right bank of the main channel, adjacent to the weir.

3.31. The existing pool and weir fish pass was constructed in the 1930s and comprises 7 pools plus steps at the inlet and outlet. The large drop between each pool makes the pass unsuitable for coarse fish, whilst the energy densities are in excess of current EA guidance for salmonids for all flows above Q95.

3.32. At Naburn the weir length is relatively short for the flow rate of the river, so the upstream water level varies considerably. As the flow increases, this quickly results in extremely high energy densities within the existing fish pass.

3.33. The hydropower abstraction will stabilise upstream water levels by increasing the overall flow capacity at the site. As a result the hydropower scheme is expected to significantly improve the operation of the existing pool and weir pass to become suitable for salmonids up to around Q40.

3.34. In addition to this improvement, the proposal includes a new multi-species Larinier fish pass co-located with the hydropower scheme, with hydraulic width 3.6m. A Larinier pass has been chosen because it is not prone to blockage and is suitable for a wide range of species.

3.35. Optimising the new fish pass for a wide range of flow conditions is challenging given the highly variable upstream water levels. The use of two sections with different crest levels allows passage at optimal or near-optimal conditions for all flows up to around Q20 for coarse fish, Q15 for salmonids.

3.36. Finally, the fish-friendly Archimedes screws offer a significant improvement to downstream fish passage for all species by providing a low-energy alternative route to passing directly over the weir crest. The screws will comply with EA guidance on compressible bumpers and maximum tip speed. The new fish pass also provides an additional route for downstream passage.

3.37. The existing eel and lamprey pass situated on the far bank, constructed in 2014, will also not be adversely affected by the hydropower scheme. Access to the eel pass entrance will remain the same as downstream water levels will be unaffected; in addition the hydropower scheme will be shut down during very high tides due to loss of head. The hydropower intake approach velocity will be limited to a maximum of 0.5 m/s only, so any impact on flow velocities at the eel pass exit will be negligible.

3.38. Dissolved oxygen (DO) upstream of the weir has been measured as being consistently above 60% saturation for the last 13 years and is typically in the 90-95% range. This will increase further as water passes over the weir. The site is therefore not considered to be at risk of unacceptably low DO levels. Nevertheless, the hydropower scheme may in principle have an impact on DO downstream of the weir.

3.39. At present DO levels downstream of the weir are dictated by DO levels upstream of the weir, mixing occurring as water passes over the weir and through the existing fish pass, and combination with tidal inflow.

3.40. The lowest DO levels occur during low flow conditions, when mixing is low and the water temperature is high. During these flow conditions, the most important feature for fish and aquatic species is the availability of refugia of relatively high DO levels within the weir pool.

3.41. As proposed, during low flow conditions, water that currently passes over the weir would instead pass through the hydropower scheme and new Larinier fish pass. Flow through the screw turbines may provide less mixing than passing over the weir, resulting in a slightly lower average DO. This will be partly compensated for by the Larinier fish pass flow, as the turbulent flow across the fish pass baffles will result in a high level of mixing.

3.42. Although the overall impact on average DO downstream of the weir may be a marginal reduction, the focused flow of the hydropower outfall and new fish pass will provide new refugia of relatively high DO. This provides an additional benefit that outweighs the marginal average DO reduction.

3.43. The geomorphology assessment indicates that the proposal may result in some short-term deposition of sands and fine gravels close to the weir and right bank during low flow conditions. However, since no significant silt deposition or gravel erosion was anticipated, any impact on fish spawning habitats is considered negligible.

3.44. Terrestrial ecology surveys have been carried out as appropriate, with full details provided in the main supporting statement.

3.45. In summary, the proposed scheme provides significant fish passage improvements with no significant adverse impact on fish or biodiversity. The introduction of effective fish passage at this site will have a wide-reaching positive impact throughout the Ouse catchment. The hydropower scheme is therefore in line with WFD mitigation measures and will help to improve the biological status of the water body.

4. Conclusions

4.1. The proposed development will not impact negatively on the current status of the water body and will not have an adverse impact on meeting future WFD objectives.

4.2. The development will provide a significant improvement to fish passage at the site, which will help to improve the biological status of the water body.

4.3. Overall, the proposed development will have no impact or a positive impact on each individual element of the relevant WFD classifications.