

Gunthorpe Weir Hydroelectric Project

Water Framework Directive Assessment

Renewables First – Company

Renewables First is one of the UK's leading hydro and wind power specialists and has been delivering hydro and wind projects for over ten years. We provide all of the services from in-house resources to take a project from initial feasibility stage, through all of the consenting and engineering design stages and on to construction and commissioning. We use our experience of the installation and operational phases to provide feedback into the design stages of the next projects, ensuring that our customers benefit from our whole-project exposure.

We are independent of hardware suppliers, so we only recommend the most appropriate hardware to maximise energy production and return on investment, and to ensure a long and reliable operational life. We only recommend the best quality hardware from established manufacturers, and design good quality systems that will be reliable in the long-term. Our designs focus on maximising renewable energy production whilst applying best practice in regard to ecological protection or enhancement.

Document Control

Version	Date of Issue	Author(s)	Reviewed by
02	Dec 2018	Kelly Clutterbuck	William Houghton

Contents

1	INTRODUCTION	1
	BACKGROUND	1
	PURPOSE OF ASSESSMENT.....	2
	SITE DESCRIPTION	2
	CURRENT WFD STATUS	3
	PROPOSAL SUMMARY	4
	INTERACTION WITH OTHER HYDROPOWER SCHEMES.....	4
2	IMPACT ON WFD OBJECTIVES.....	5
3	DISCUSSION	8
	OVERVIEW.....	8
	MITIGATION MEASURES	9
	BIODIVERSITY AND FISH PASSAGE	10
	HYDROMORPHOLOGY	11
	SHELFORD BROOK.....	12
4	CONCLUSIONS	14

1 Introduction

Background

- 1.1 This document accompanies a planning application plus abstraction and impoundment licence applications for a proposed hydropower scheme, fish pass and adjustable weir crest at Gunthorpe Weir on the River Trent.
- 1.2 Planning consent (RBC ref: 10/00577/FUL; NSDC application ref: 10/00323/FUL) and an Environment Agency impoundment licence (MD/028/0064/007) were previously granted for a hydropower proposal on the island at the left bank of Gunthorpe Weir. The current proposal is of a smaller scale and located on the right bank.
- 1.3 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.
- 1.4 The assessment will review the potential effects arising from the proposed scheme in relation to:
 - flow patterns
 - sediment availability
- 1.5 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.
- 1.6 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.
- 1.7 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
- 1.8 In addition 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.
- 1.9 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.

1.10 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

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

1.12 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.

1.13 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.

1.14 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.

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

1.16 This assessment includes consideration of the Shelford Brook Catchment (trib of Trent) – G104028053112).

Site description

1.17 A short canal and lock (Gunthorpe Lock) sit on the left bank, separated from the main channel and weir by a man-made island. Approximately 50 m upstream of the weir a floating boom spans the main channel, meeting the right bank at the Kingfisher Wharf boatyard. Gunthorpe Marina is situated further upstream, on the left bank.

1.18 The weir was constructed in the 1920s and serves the purpose of maintaining levels for navigation between the site and Stoke Bardolph Weir.

Current WFD status

Water body name	Trent from Soar to The Beck
Water body ID	GB104028053110
Management catchment	Trent and Lower Erewash
River basin district	Humber
Hydromorphological designation	Heavily modified
Current ecological quality	Moderate
Current chemical quality	Good
Ecological quality objective	Moderate by 2015
Chemical quality objective	Good by 2015

Classification Item	2013	2014	2015	2016
Overall Water Body	Moderate	Moderate	Moderate	Moderate
Ecological	Moderate	Moderate	Moderate	Moderate
Supporting elements (Surface Water)	Moderate	Moderate	Moderate	Moderate
Mitigation Measures Assessment	<u>Moderate or less</u>	Moderate or less	Moderate or less	Moderate or less
Biological quality elements	Good	Moderate	Moderate	Moderate
Macrophytes and Phytobenthos Combined	Good	<u>Moderate</u>	Moderate	Moderate
Invertebrates	Good	Good	Good	High
Hydromorphological Supporting Elements	Supports Good	Supports Good	Supports Good	Supports Good
Hydrological Regime	Supports Good	Supports Good	Supports Good	Supports Good
Physico-chemical quality elements	Moderate	Moderate	Moderate	Moderate
Acid Neutralising Capacity	-	High	High	High
Ammonia (Phys-Chem)	Good	High	High	High
Biochemical Oxygen Demand (BOD)	High	High	Good	Good
Dissolved oxygen	High	High	Good	Good
pH	High	High	High	High
Phosphate	Poor	<u>Poor</u>	Poor	Poor
Temperature	High	High	Moderate	Good

1.19 The upstream waterbodies are: Causeway Dyke Catchment (trib of Trent), Cocker Beck Catchment (trib of Trent), Devon from Cotham to Trent, Dover Beck Catchment (trib of Trent), Erewash from Gilt Brook to Trent, Fairham Brook Catchment (trib of Trent), Greet Catchment (trib of Trent), Leen from Day Brook to Trent, Ouse Dyke Catchment (trib of Trent), Polser Brook from Cotgrave Brook to Trent, Shelford Brook Catchment (trib of Trent), Slough Dyke

Catchment (trib of Trent), Soar from Long Whatton Brook to Trent, Trent Bifurcation Pingleu Dyke to Winthorpe , Trent from Derwent to Soar

1.20 The downstream waterbody is Trent from Carlton-on-Trent to Laughton Drain.

Proposal summary

1.21 The proposal comprises two Archimedes screw turbines, an adjustable weir crest, a new multi-species fish pass, a turbine house building, hydraulic channels, trash screening, access improvements, an electrical substation and underground cabling.

1.22 The scheme is expected to generate a peak power output of 330 kW and an average annual energy production of 2.2 GWh. This is sufficient to power 560 homes and provides an effective CO₂e saving of around 1,140 tonnes per year.

Interaction with other hydropower schemes

1.23 Currently, there are no hydropower schemes in operation within 10 km upstream or downstream of the site. The following schemes are known to be operation, consented or within development along the River Trent:

Operational

Beeston Weir, 24 km upstream

Holme Lock, 13 km upstream

Consented

Nether Weir, 23 km downstream

Cromwell Weir, 30 km downstream

Proposed

Hazelford Weir, 8 km downstream

Stoke Weir, 8 km upstream

1.24 This assessment includes consideration of the Shelford Brook Catchment (trib of Trent) – G104028053112).

2 Impact on WFD objectives

2.1 The following table reviews the RBMP for the relevant section 'Trent from Soar to The Beck'. Only those elements which have been assessed by the EA and which are relevant to the nature of the proposal are listed here.

Receptor	Current status (2016 C2)	Objective	Reasons for status	Impact	Assessment
OVERALL	Moderate	Moderate by 2015	Unfavourable balance of costs and benefits Disproportionate burdens	No adverse impact	See individual elements below
Ecological	Moderate	Moderate by 2015	Unfavourable balance of costs and benefits Disproportionate burdens	No adverse impact	See individual elements below
Ecological – biological quality elements					
Overall	Moderate	Good by 2027	Disproportionate burdens	No adverse impact	See individual elements below
Macrophytes and phytobenthos combined	Moderate	Good by 2027	Disproportionate burdens	No adverse impact	There will be no significant hydromorphological impacts of the proposal - see below. The ecological impact of changes in water level were assessed as part of the Ecological Appraisal by Fauna Forest Ecology, concluding that 'flora species are unlikely to be negatively impacted by the future increases, given that in previous years they will have been subjected to such conditions.' Overall, as there is no adverse impact on other related elements such as water quality, there will be no significant impact on macrophytes or phytobenthos.

Invertebrates	High	Good by 2015	-	No adverse impact	There will be no significant hydromorphological impacts of the proposal - see below. As there is no adverse impact on other related elements such as water quality, there will be no significant impact on invertebrates.
Ecological – hydromorphological supporting elements					
Overall	Supports Good	Supports Good by 2015	-	No adverse impact	The hydromorphological impacts of the proposal were assessed by APEM, with the general conclusion that 'Overall, the modelling results indicate a limited change in entrainment and transport of material at the majority of locations.' A possible impact on bank erosion at high flows (>Q10) was highlighted and suitable mitigation such as scour protection or reduced abstraction will be implemented as required. Please see the Discussion for further details, including impacts due to changes in water level. Overall, there is a minor and neutral hydromorphological impact, which is not considered to cause any deterioration in the WFD status.
Hydrological Regime	Supports Good	Supports Good by 2015	-	No adverse impact	See above. The hydropower scheme is a 'run-of-river' scheme and so will not affect the flow rate in the watercourse, except for directly at the weir.
Ecological – physico-chemical quality elements					
Overall	Moderate	Moderate by 2015	Unfavourable balance of costs and benefits Disproportionate burdens	No adverse impact	See individual elements below
Biochemical oxygen demand (BOD)	Good	-	-	No adverse impact	There will be no significant impacts on aquatic species that contribute to BOD, nor any impact due to changes in DO, see below.

Dissolved oxygen	Good	Good by 2015	-	No adverse impact	APEM concluded the following: 'it is considered highly unlikely that the scheme would cause a material adverse impact on DO concentrations at the site and no deterioration in the WFD status of the physicochemical element of the Trent waterbody would be expected.' Furthermore, the increased head at the weir is expected to improve DO levels downstream.
Temperature	Good	Good by 2015	-	No adverse impact	Any impacts on water temperature due to changes in flow distribution will be very minor and highly localised.

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

3 Discussion

Overview

- 3.1 Gunthorpe Weir is located within the 'Trent from Soar to The Beck' section of Nottingham Urban Operational Catchment Area. The Management catchment area is Trent and Lower Erewash within the Humber River Basin District.
- 3.2 The catchment of the Lower Trent and Erewash is a very large sub-catchment covering an area of approximately 2045 km², extending from the River Dove confluence with the River Trent south west of the city of Derby and finishing at Alkborough Flats where the Trent flows into the Humber Estuary. Within this area the River Trent is 174 km long with its main tributaries including the rivers Derwent, Soar, Erewash, Leen, Greet, Devon, Idle, Torne and Eau and the Dover Beck.
- 3.3 The Vision for the Lower Trent & Erewash Catchment Partnership is "A Lower Trent & Erewash catchment that has a healthy, functioning water environment including rivers, lakes and groundwater". A long term objective is that "water quality from point and diffuse sources is improved" and that "fish can move freely throughout the catchment with ample spawning and nursery areas".
- 3.4 The Humber RBMP cites not setting the 2015 ecological quality target at Good due to it 'unfavourable balance of costs and benefits' and 'disproportionate burdens'.
- 3.5 The Trent Lower and Erewash Catchment Management Plan shows that the main reason for not achieving Good status is due to the catchment is failing on ecological status.
- 3.6 Key pressures include:
 - Diffuse pollution from roads and urban areas
 - Heavily modified river channels
 - Rural point source and diffuse pollution
 - Separation of the river from its floodplain
 - Loss of riparian wetland habitats
 - Raised levels of phosphates
 - Risk of properties and roads flooding
 - Impeded fish passage

Mitigation measures

3.7 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 this catchment are: ¹

Improve modified physical habitats
<ul style="list-style-type: none">• 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
Managing pollution from waste water
<ul style="list-style-type: none">• Reduce diffuse pollution at source• 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
<ul style="list-style-type: none">• Reduce diffuse pollution at source• 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
<ul style="list-style-type: none">• Control pattern/timing of abstraction
Manage pollution from rural areas
<ul style="list-style-type: none">• Reduce diffuse pollution at source• Mitigate/remediate diffuse pollution impacts on the receptor

3.8 The Reasons for Not Achieving Good Status (RNAGS) within the water body are:

- Mitigation measures assessment
 - Confirmed physical modifications due to:
 - Navigation
 - Flood protection
 - Urbanisation
- Macrophytes and Phytobenthos Combined
 - Probable phosphate pollution from:
 - Waste water discharges
 - Urban transport drainage

1

https://circabc.europa.eu/webdav/CircaBC/env/wfd/Library/framework_directive/implementation_documents_1/20122014%20WFD%20public%20information%20and%20consultation%20documents/UK/UK04%20Humber/Lower%20Trent%20and%20Erewash.pdf

Biodiversity and fish passage

3.9 The immediate area is not subject to any statutory environmental designations.

3.10 There is an old and sub-optimal triangular fish pass at one end of Gunthorpe Weir, however this has been assessed as only partially passable to salmon and trout, and impassable to coarse fish, eel and lamprey. The new fish pass facilities will be suitable for all species and designed to latest EA guidance with an attraction flow equal to 5% of the maximum hydropower flow.

3.11 The installation of the fish passes will fulfil requirements under the Salmon and Freshwater Fisheries Act 1975 and the Eels (England and Wales) Regulations 2009.

3.12 The proposal includes lamprey passage provisions and as such will contribute to the migration of lamprey throughout the River Trent from the Humber Estuary SAC and the upper Catchment, which includes the Attenborough Gravel Pits SSSI. This is in line with the conservation objectives of the Humber Estuary SAC.

3.13 The proposed weir crest operation will stabilise upstream water levels within key fish migration windows. This makes it significantly easier to install a fish pass that operates effectively across a wide range of flow conditions.

3.14 Overall the hydropower scheme does not create any additional barrier to fish passage and with the introduction of a new fish pass facilities, fish migration at Gunthorpe Weir and along the Trent will improve significantly.

3.15 A specialist study was commissioned from APEM to assess the impact of the proposals on aquatic habitats and fish passage, based on a detailed geomorphology assessment. A summary of their findings is presented in Section 2.

3.16 Although not currently assessed by the EA, the element 'Ecological >> Biological quality elements – Fish' is of particular relevance to the current proposal. The impacts of the proposal on fisheries and aquatic habitats were assessed by APEM and outlined in their separate report.

- *Overall, the habitat assessment indicates that the proposed HEP scheme would result in a decrease in areas of suitable habitat for rheophilic and lamprey spawning at low flows (Q95/Q75), which is driven primarily by changes in velocity associated with the reduced flow over the weir. However, this is partly offset for rheophilic spawning species by predicted increases in suitability at moderate flows (Q50 – Qmean). Similarly, the scheme is likely to reduce the suitability of the weir pool for adult rheophilic species at low flows (Q95), but would remain largely unchanged at all other flows.*
- *The HEP scheme is predicted to result in an increase in areas of suitable habitat for both juvenile rheophilic species and adult and juvenile roach relative to baseline, due to a reduction in mean velocities outside of the main HEP plume. No significant changes in roach spawning habitat or juvenile lamprey habitat are anticipated given an absence of such habitat under the current conditions.*
- *Gunthorpe Weir is currently deemed a complete barrier to the upstream passage of cyprinid species and eel due to excessive head drops and high velocities over the weir face and a low impact barrier to salmon and sea trout via the existing pool and*

traverse fish pass. Despite a reduction in the passability of the main weir structure due to the addition of an inflatable weir crest associated with the HEP scheme, the overall upstream passability at the site would increase significantly following construction of the HEP scheme due to the addition of a multi-species fish pass adhering to EA (2010) best practice guidance.

3.17 The development is therefore expected to result in some changes to habitat suitability for specific species, life stages, and flow conditions, however any reductions in suitability are typically offset by improvements elsewhere. Furthermore, the significant improvements in fish passage at the site provide a clear benefit to fish across all species, life stages and flow conditions.

Hydromorphology

3.18 The specialist study commissioned from APEM assessed the geomorphological impact of the proposals, based on bathymetric data, sediment sampling and 2D hydraulic modelling. APEM make the following concluding statements:

- *Overall, the modelling results indicate a limited change in entrainment and transport of material at the majority of locations. However, there is a possible impact from the tailrace discharge on the right hand bank a short distance downstream of Gunthorpe weir, which coincides with the narrow gravel shoal and mudstone cliff face. Given that the cliff face is composed of readily erodible sedimentary mudstone, it could be at risk of increased erosion if it is exposed to hydraulic action and elevated shear stress imparted by the turbine flow. Such events would be restricted to flows of Q10 or above, when the downstream water level reaches the base of the cliff.*
- *Erosion of the beach feature and cliff face may lead to further morphological adjustments downstream where eroded sediment is deposited. As such, some form of scour protection may be advisable at this location to minimise risk of morphological changes. Alternatively, consideration could be given to reducing the rate of abstraction above Q10 (when the base of the cliff starts to become wetted), to minimise the risk of erosion.*

3.19 The project detailed design will ensure that the areas identified by APEM are adequately protected against the risk of scour as recommended.

3.20 The APEM study also assessed the impact of changes in water level on sediment transport processes, concluding:

- *The proposed increase in weir crest height is unlikely to have a substantial impact on coarse sediment transport processes which are of most importance in influencing channel morphology. This is because the existing structure at Gunthorpe is likely to inhibit the majority of downstream sediment transport, and because the weir crest will not be raised during high flows (>Q9) which are responsible for the majority of coarse sediment transport.*

3.21 In summary, the proposed scheme will not result in any significant geomorphological changes. In addition, the ecological impacts of any minor changes have been accounted for as part of the third-party combined fisheries and geomorphology assessment. As such the WFD status will not be adversely impacted.

Shelford Brook

3.22 Shelford Brook lies 90 m upstream of Gunthorpe Weir on the right bank, with the following WFD classification:

Water body name	Shelford Brook Catchment (trib of Trent)
Water body ID	GB104028053112
Management catchment	Trent and Lower Erewash
River basin district	Humber
Hydromorphological designation	Not heavily modified
Current ecological quality	Bad
Current chemical quality	Good
Ecological quality objective	Bad by 2015
Chemical quality objective	Good by 2015

Classification Item	2013	2014	2015	2016
Overall Water Body	Poor	Poor	Bad	Bad
Ecological	Poor	Poor	Bad	Bad
Biological quality elements	Poor	Poor	Bad	Bad
Macrophytes and Phytobenthos Combined	Poor	Poor	Poor	Poor
Invertebrates	-	Poor	Bad	Bad
Hydromorphological Supporting Elements	Supports Good	Supports Good	Supports Good	Supports Good
Hydrological Regime	Supports Good	Supports Good	Supports Good	Supports Good
Physico-chemical quality elements	Moderate	Moderate	Moderate	Moderate
Ammonia (Phys-Chem)	Bad	Bad	Poor	Moderate
Dissolved oxygen	Bad	Bad	Bad	Bad
pH	High	High	High	High
Phosphate	Bad	Bad	Bad	Bad
Temperature	High	High	High	High
Specific pollutants	High	High	High	High
Chemical	Fail	Fail	Good	Good

3.23 Reasons for not achieving good status for this water body are listed as waste water discharges affecting phosphate, ammonia and dissolved oxygen levels. These are also listed as affecting two other elements:

- Invertebrates
- Macrophytes and Phytobenthos Combined

- 3.24 The impact of the proposed development on this water body will be very limited. The proposals will not result in any water levels that do not currently occur on a regular basis, with a maximum increase in water levels of 0.36 m above existing.
- 3.25 The impact of changes in water level will be as listed above for the main water body, and as such there will be no adverse ecological or hydromorphological impacts.
- 3.26 The proposed slight increase in water levels will not exacerbate the existing wastewater-related failure or any other physico-chemical elements; the flow rates and water quality within the Shelford Brook will be unchanged.
- 3.27 Overall, Shelford Brook will not be subject to any adverse impact for any of the WFD elements listed above.

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 introduction of a multi-species fish pass with eel and lamprey facilities has been independently assessed to provide a significant positive improvement to fish passage at this site, providing opportunities for improvements more widely along the Trent.
- 4.3 Overall, the proposed development will have no impact or a positive impact on each individual element of the relevant WFD classifications.