

Anglian Water Habitats Regulations Assessment: Stage II

River Trent: Hall Water Treatment Works

27 March 2020

Mott MacDonald
22 Station Road
Cambridge CB1 2JD
United Kingdom

T +44 (0)1223 463500
mottmac.com

Anglian Water Habitats Regulations Assessment: Stage II

River Trent: Hall Water Treatment Works

27 March 2020

Issue and Revision Record

Revision	Date	Originator	Checker	Approver	Description
A	07/11/2018	Amy Anderson	Celia Figueira/ Sarah Green	Peter Ede	First issue
B	28/02/2020	Philippa Cross and Emma Lancaster	Megan Rogers	Peter Ede and Stuart Smith	Revised following comments
C	27/03/2020	Philippa Cross and Emma Lancaster	Megan Shelton	Peter Ede and Stuart Smith	Revised incorporating comments from client's independent review

Document reference: 399155 | 11 | C

The preparation of Rev B and Rev C of this report includes the contribution of Atkins, who worked alongside Mott MacDonald to respond to feedback received on Rev A.

Information class: Standard

This document is issued for the party which commissioned it and for specific purposes connected with the above-captioned project only. It should not be relied upon by any other party or used for any other purpose.

We accept no responsibility for the consequences of this document being relied upon by any other party, or being used for any other purpose, or containing any error or omission which is due to an error or omission in data supplied to us by other parties.

This document contains confidential information and proprietary intellectual property. It should not be shown to other parties without consent from us and from the party which commissioned it.

Contents

Executive summary	8
1 Introduction	10
1.1 Background	10
1.2 Habitats Regulations Assessment framework	10
1.3 Scope of the Stage II Appropriate Assessment	12
1.4 Methodology	13
1.5 Structure of the report	13
2 River Trent: Newton-on-Trent Intake	15
2.1 Overview of existing abstraction licence	15
2.2 Overview of proposed drought permit	15
2.3 Summary of HRA Stage I Screening Assessment	15
3 Humber Estuary European Designated Sites	18
3.1 Site overview	18
3.2 Humber Estuary European designated sites	19
3.3 Humber Estuary SAC qualifying features	19
3.3.1 Humber Estuary Ramsar site qualifying features	19
3.4 Site condition, conservation objectives and improvement plan	20
3.4.1 Site condition	20
3.4.2 Humber Estuary European sites conservation objectives	20
3.4.3 Site Improvement Plan	20
3.5 Sensitive features of the of the Humber Estuary SAC/Ramsar site	24
3.5.1 Anadromous fish	24
4 Impact Assessment	27
4.1 Potential impacts on the River Trent	27
4.2 Potential impacts on the qualifying features of the Humber Estuary SAC/Ramsar site	27
4.2.1 Screening of potential impacts	27
4.2.2 Potential impacts on anadromous fish	28
4.3 In-combination effects	30
4.3.1 Planning applications	30
4.3.2 Environment Agency drought plans	30
4.3.3 Other water company drought plans	30
4.3.4 Water Company Water Resource Management Plans (WRMP)	31
4.3.5 Other plans and projects	32
5 Mitigation and Enhancement Measures	34

6	Conclusions	35
---	-------------	----

7	References	36
---	------------	----

Tables

Table 1: European designated sites within the Zol of the drought permit actions	16
Table 2: Humber Estuary SAC primary reasons and qualifying features for site selection.	19
Table 3: Humber Estuary Ramsar site qualifying features.	20
Table 4: Humber Estuary SIP summary	22
Table 5: Velocity and depth requirements of lamprey	26
Table 6: Potential impacts of the proposed Newton-on-Trent drought permit	27

Figures

Figure 1: Assessment process	12
Figure 2: Map of the River Trent and the Humber Estuary showing sites of nature conservation value	17

Executive summary

Anglian Water abstracts from the River Trent for Hall Water Treatment Works (WTW) at Newton-on-Trent. Under drought conditions they may seek a drought permit allowing a temporary reduction in the hands-off flow (HOF), thereby allowing abstraction to continue in conditions below the current minimum permissible flow. Anglian Water are obliged to conduct a Habitats Regulations Assessment (HRA) to determine the impact of the proposed drought permit on the interest features of European designated sites (Special Areas of Conservation, Special Protection Areas and Ramsar sites).

The first stage of the HRA process (Stage I Screening Assessment) was included in the Drought Permit Environmental Assessment (Mott MacDonald, 2018). It was concluded that there are no mechanisms by which potential impacts arising from the proposed drought permit at Newton-on-Trent (eg flow, water level, flooding, water chemistry or habitat loss) could have likely significant effects (LSE) on the interest features of the Humber Estuary SAC/Ramsar/SPA. However, given the sensitivity of sea and river lamprey to flows and the uncertainty regarding the passability of Cromwell weir, it was recommended that a HRA Stage II: Appropriate Assessment should be undertaken to verify that the proposed drought permit will not impact on lamprey populations in the River Trent or the Humber estuary. Therefore, the HRA Stage II assessment presented in this report is focused on the lamprey species of the Humber SAC and Ramsar sites only.

The following potential issues arising from the proposed drought permit are considered to be the greatest threats to lamprey populations:

- **Flow reduction:** Lamprey are thought to require specific flow conditions at certain stages of their life cycle. Implementation of the proposed drought plan is predicted to have a minor impact on river flows. However, as lamprey do not typically begin upstream migration during low flow periods (eg when the permit is most likely to be applied), it is not expected that hydrological changes resulting from increased abstraction will alter the timing of migration. Additionally, spawning is not likely to be impacted by flow reductions as it typically occurs upstream of the area influenced by abstraction at Newton-on-Trent.
- **Water level decline:** The distribution of lamprey species in the River Trent is likely related to the presence of structures and weirs that inhibit fish migration upstream. Water levels are predicted to drop by up to 0.005m close to Cromwell weir. As this reduction in water level is negligible, fish passage is not likely to be significantly impacted. However, in the absence of a dedicated study to understand the dimensions and hydraulics of Cromwell weir, there is still some uncertainty in this assumption.
- **Entrainment:** Lamprey mortalities could arise due to entrainment and trapping in the intake of the Newton-on-Trent abstraction point. However, the abstraction has licence conditions for 1-2mm screens, which are acceptable for lamprey protection. Additionally, the continuation of abstraction when the flow at North Muskham drops below the current HOF should not affect approach velocities at the abstraction point, and thus should not create conditions that are any worse in terms of potential entrainment than those for which the intake was designed.

Given the remaining uncertainty regarding the current passage of migratory fish species through Cromwell weir, and therefore the impact of predicted water level reductions during drought permit implementation, it is recommended that a survey is conducted to identify the suitability of the weir for lamprey species. It is also recommended that a formal plan is developed for the

monitoring of flows, water quality and biological elements in the Humber estuary and River Trent in the periods before, during and after drought permit implementation to identify any unforeseen impacts on the interest features of designated sites.

1 Introduction

1.1 Background

Anglian Water abstract from the River Trent at Newton-on-Trent for Hall Water Treatment Works (WTW). Under drought conditions they may seek a drought permit allowing a temporary reduction in the hands-off flow (HOF), thereby allowing abstraction to continue in conditions below the current minimum permissible flow.

The Environment Agency's Water Company Drought Plan Guidance (2017) states that a water company must ensure that its plan meets the requirements of the Conservation of Habitats and Species Regulations (UK Government, 2017) and, if necessary, must undertake a Habitats Regulations Assessment (HRA) on the effects of the drought permit on European sites, alone or in combination with other plans.

The first stage of the HRA process (Stage I Screening Assessment) was included in the Drought Permit Environmental Assessment (Mott MacDonald, 2018). It was concluded in the Stage I Screening Assessment that the proposed drought permit would not have a Likely Significant Effect (LSE) on any European designated sites. However, given the sensitivity of lamprey species and the uncertainty regarding the passability of Cromwell weir by both species, it was recommended that a HRA Stage II: Appropriate Assessment be undertaken to ensure that the proposed drought permit will not reduce the current passage of fish through this significant structure.

The main objective of the Stage II Appropriate Assessment presented in this report is to determine if implementation of the proposed drought permit would have an adverse effect on the integrity of European designated sites and, if adverse impacts are anticipated, to propose and assess potential mitigation measures to alleviate those impacts.

1.2 Habitats Regulations Assessment framework

The requirement for a HRA is established through European Council Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora, hereby referred to as the 'Habitats Directive', in Articles 63 and 64. The Habitats Directive has been transposed into United Kingdom legislation by the Conservation of Habitats and Species Regulations 2017 ('Habitats Regulations') (S.I. 2017/1012) (as amended). Under Regulations 61 and 102, any plan or project, not directly connected with or necessary to the management of a Natura 2000 site, which may give rise to significant effects upon a Natura 2000 site (either alone or in combination with other plans or projects), must be subject to a HRA to determine the implications for the site in view of its conservation objectives.

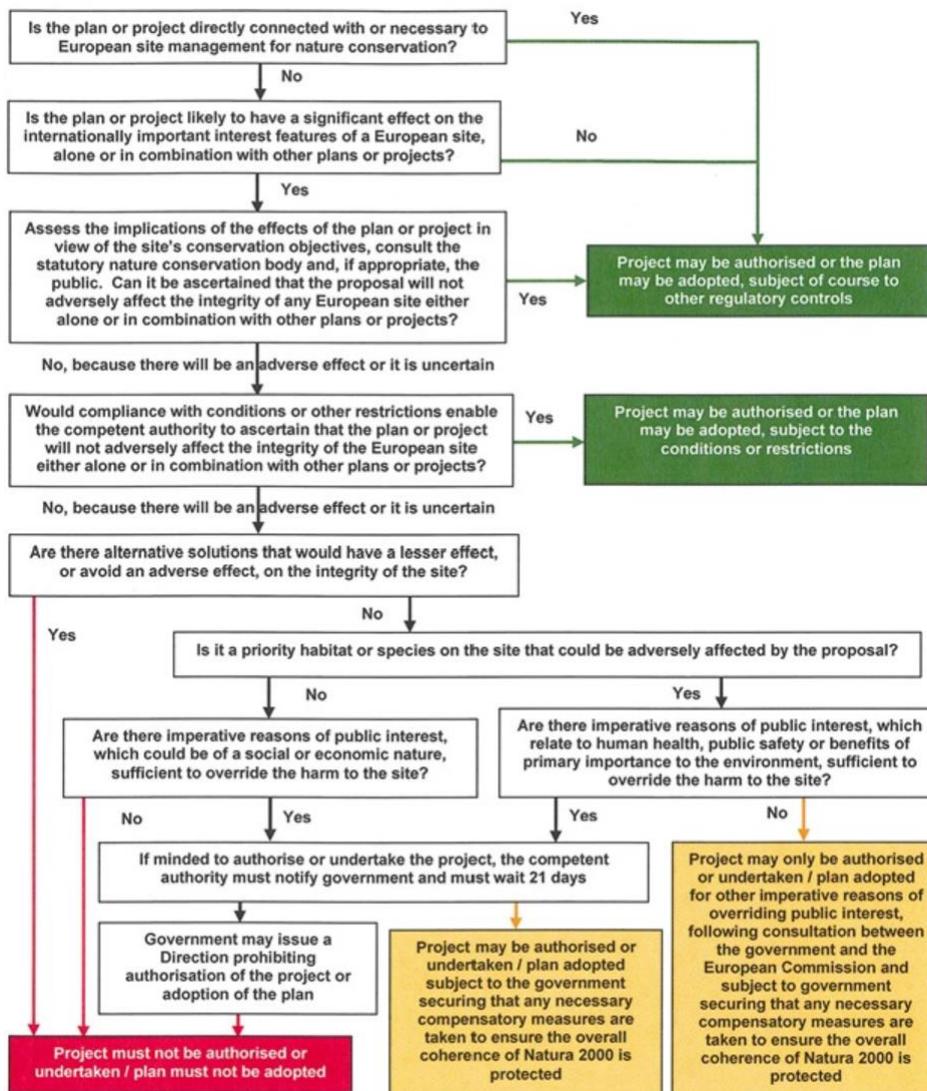
Natura 2000 sites include Special Protection Areas (SPAs), Special Areas for Conservation (SACs), candidate SACs and proposed SPAs, as well as Sites of Community Importance (SCIs) which have been adopted by the European Council, but not yet formally designated by the government of the Member State. Natura 2000 sites are hereafter referred to as European sites (or European marine site where relevant) in accordance with the Habitats Regulations. In the UK, Ramsar wetlands of international importance are also required to undergo an assessment when a plan or project is considered likely to have a significant effect upon a site (Department for Environment, Food and Rural Affairs (Defra), 2006). It should be noted that herein Ramsar sites are also referred to as European sites.

Water companies in England are required to produce a Drought Plan every five years. Specific HRA guidance is provided in the UK Water Industry Research (UKWIR) report *Strategic Environmental Assessment and Habitat Regulations Assessment - Guidance for Water Resources Management Plans and Drought Plans* (UKWIR, 2012). The plan-making authority are responsible for conducting the HRA in consultation with the appropriate nature conservation body, otherwise referred to as the competent authority. In this case the plan-making authority and competent authority are Anglian Water and Natural England (NE), respectively. According to the Habitats Regulations, the plan-making authority shall only be permitted to give effect to the Plan/Project after having ascertained that it will not adversely affect the integrity of a European site subject to Regulation 62 or 102.

The HRA is undertaken in a series of stages, which are usually referred to as 'stages' in the case of the assessment of projects and 'tasks' in the case of the assessment of plans (DCLG, 2006). However, for continuity with previous HRA reports to Anglian Water, the term 'stage' will be used in this document rather than 'task', despite it being in support of the 2019 Drought Plan. The series of stages correspond with the steps prescribed by the Habitats Regulations Assessment Handbook.

Each stage determines whether further stages in the process are required. The first stage identifies likely significant effects by identifying the presence or absence of significant indicators. If the conclusion of the Stage I assessment is that there will be no significant impacts on the European site(s), there is no requirement to undertake further stages, and so forth. Figure 1 illustrates the full HRA process.

Figure 1: Assessment process



1.3 Scope of the Stage II Appropriate Assessment

Under Regulation 63 of the Conservation of Habitats and Species Regulations 2010 (as amended) (“Habitats Regulations”), a competent authority must make an appropriate assessment of the implications of the plan or project.

As part of this plan, a Stage I Screening for the Assessment of Likely Significant Effects was undertaken to assess the environmental impacts of the proposed drought permit at the River Trent Newton-on-Trent abstraction point (Mott MacDonald, 2018). LSE in this context are any effects that may reasonably be predicted as a consequence of a plan or project that may affect the conservation objectives of the features for which a site was designated (English Nature, 1994). The Stage I Screening concluded that there are LSE of the plan on a European site, therefore requiring Stage II Appropriate Assessment.

This report details Stage II of the HRA, which is required to:

- Consider the impact of the project on the integrity of the Natura 2000 site, either alone or in combination with other projects and plans, with respect to the conservation objectives of the site and its structure and function; and
- Assess potential mitigation strategies where adverse impacts are identified, including setting out a timescale and identifying mechanisms through which the mitigation measures will be secured, implemented and monitored.

Potential impacts may be direct or indirect and are dependent on the relationship between the action (drought permit) and the receptor (the qualifying features of the European site). The significance of an impact is relative to the sensitivity, existing condition and conservation status of the qualifying features of the site and the scale of the impact in space and time.

Potential impacts on the qualifying features of the European site are evaluated with respect to the scale, extent and nature of the impact, for example the area of habitat affected, changes in hydrodynamics, potential changes in species distribution, and the duration of the impact. The sensitivities of each of the qualifying features are also assessed.

This report will be sent for consultation with the relevant nature conservation authorities and the public. If the competent authority considers that residual adverse effects remain, the next stage of HRA (Stage III Assessment of Alternative Solutions) would be required.

1.4 Methodology

This Stage II Appropriate Assessment has been formulated using the following approach:

- Detailed assessment of impacts of the proposed drought permit;
- Assessment of the European site's characteristics and identification of its conservation objectives;
- Identification of the aspects of the proposed drought permit that will significantly impact the conservation objectives of the European site(s);
- Review of relevant environmental data available from the Environment Agency to assess the significance of the threat; and
- Review of all formal and informal consultation responses.

This assessment has been undertaken in accordance with the following guidance:

- EC (2000), *Managing Natura 2000 Sites*. The provisions of Article 6 of the Habitats Directive 92/43/EEC;
- EC (2001), *Assessment of plans and projects significantly affecting Natura 2000 sites*. Methodological guidance on the provisions of Article 6(3) and (4) of the Habitats Directive 92/43/EEC;
- Tyldesley & Chapman (2013). *The Habitats Regulations Assessment Handbook*
- Environment Agency (2017). *Drought plan guideline extra information. Environmental Assessments for Water Company Drought Plans*; and
- UK Water Industry Research (2012), *Strategic Environmental Assessment and Habitat Regulations Assessment - Guidance for Water Resources Management Plans and Drought Plans*. Provision of specific guidance for conducting drought plan HRAs, aligned with the Water Company Drought Plan Guideline (Environment Agency, 2011).

1.5 Structure of the report

The structure of this report follows the recommended guidance for undertaking Appropriate Assessments as follows:

- **Section 2** presents a description of the proposed drought permit and a summary of the HRA Stage I Screening Assessment;
- **Section 3** presents a description of the Humber Estuary European designated sites, the qualifying features, conservation objectives and the sensitivity of these features;
- **Section 4** presents the predicted impacts of the proposed drought permit on features of the European designated sites;
- **Section 5** signposts mitigation measures and monitoring requirements; and
- **Section 6** includes recommendations and presents conclusions.

2 River Trent: Newton-on-Trent Intake

2.1 Overview of existing abstraction licence

Anglian Water abstracts from the River Trent at Newton-on-Trent for Hall WTW. The scheme includes a bankside storage reservoir of capacity 300MI which is equivalent to a 15-day supply at the design rate of 20MI/d. The licence allows abstraction at a rate of up to 64MI/d to allow refill of the reservoir after a period of reduced or zero abstraction. The higher rate is also relevant under normal conditions when the tidally-influenced water level only allows abstraction for part of the day; by pumping at up to 64MI/d during these periods a daily total of 20MI can be achieved. The licence conditions include a HOF of 1700MI/d and a hands-off level (HOL) of 2.0mAOD. The HOF is defined at the upstream gauging station of North Muskham because the flow cannot readily be measured in the tidally-influenced reach. The HOL is designed to ensure that the abstraction does not adversely impact navigation.

2.2 Overview of proposed drought permit

The proposed drought permit comprises a reduction in the HOF (to 1450MI/d) during periods of low flow, thereby allowing abstraction to continue in conditions below the current minimum permissible flow. The HOL of the existing abstraction licence would remain in force in the event of the proposed drought permit being implemented, to prevent adverse navigational issues.

2.3 Summary of HRA Stage I Screening Assessment

The objective of the Stage I Screening was to determine whether implementation of the proposed plan will have a LSE on the conservation objectives of European designated sites. This was achieved through a desk-based review of the following information:

- European sites, the primary reasons for selection and qualifying features, conservation objectives and site vulnerabilities;
- The sensitivity of the primary reasons for selection and qualifying features to environmental change; and
- The assessment of potential impacts of the proposed drought permit on the hydrological regime, ecology and water quality of the River Trent presented in the Drought Permit Environmental Assessment (Mott MacDonald, 2018).

The study area was defined as the stretch of the River Trent from the abstraction point at Newton-on-Trent to the mouth of the Humber estuary. Given the nature of the Project, the Zol was not considered likely to extend beyond sites that are in hydrological continuity with the location of the potential drought permit. As such, European sites within terrestrial areas surrounding the river and estuary are not considered in this HRA.

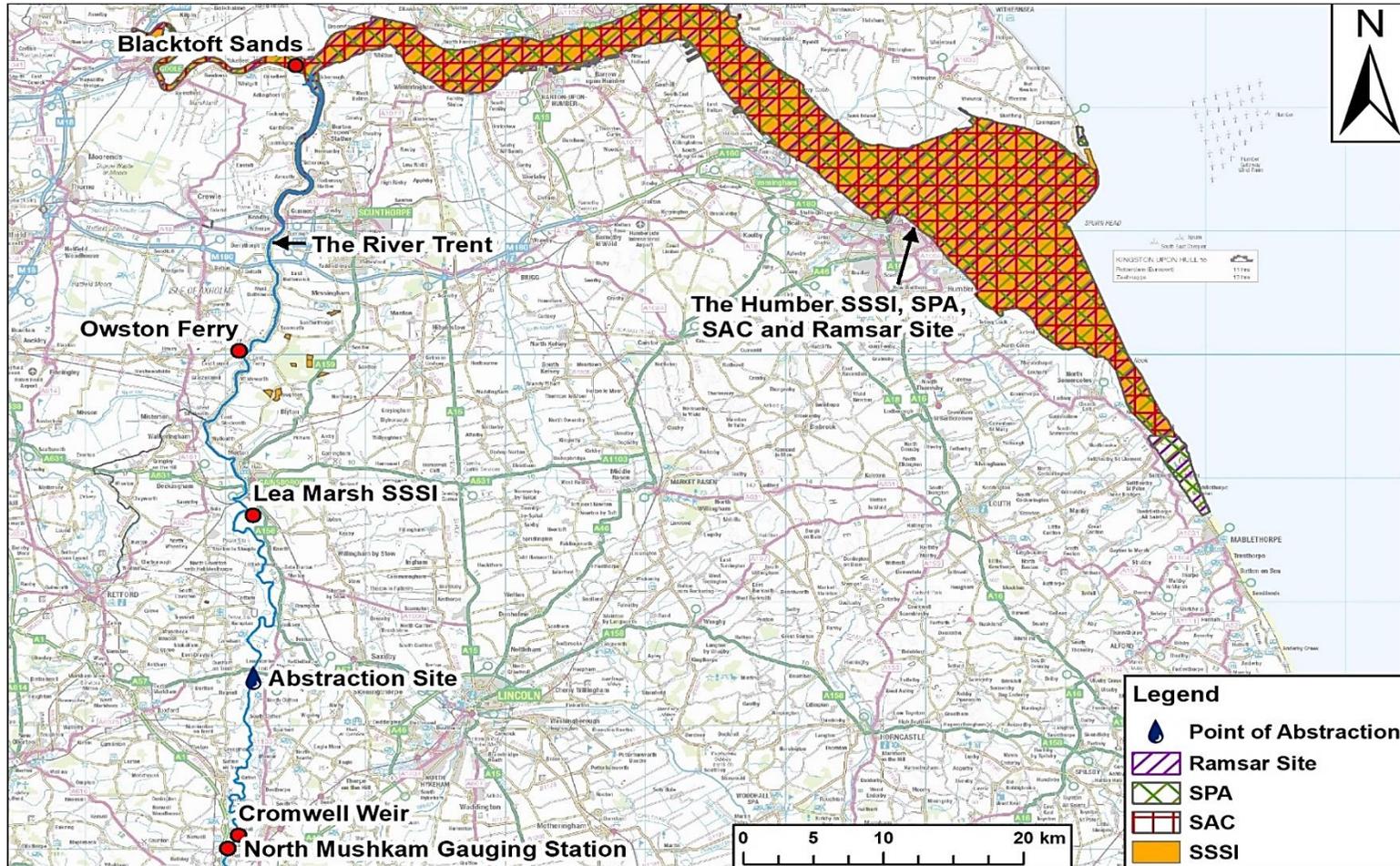
A search for European sites within the Study Area was carried out using Defra's 'Multi Agency Geographic Information for the Countryside' (MAGIC) website (Defra, 2016). It was established that the proposed drought action is not within the boundary of a European site. The European site(s) listed in Table 1 were identified within the Zol of the drought action. Figure 2 shows their location relative to the Newton-on-Trent abstraction point.

Table 1: European designated sites within the Zol of the drought permit actions

Site name	Designation	Approximate distance downstream from site
Humber Estuary	SAC	50km
Humber Estuary	SPA	50km
Humber Estuary	Ramsar site	50km

The sensitive features to the potential impacts of the proposed drought permit were identified as anadromous fish species (SAC/Ramsar site qualifying features) and intertidal, saltmarsh and subtidal habitats (SAC/Ramsar site qualifying features). It was concluded that there were no pathways by which potential impacts arising from the proposed drought permit could result in a LSE on one or more of the qualifying features of the Humber Estuary European designated sites, except for lamprey species where some uncertainty regarding the passability of Cromwell weir by both species remains. Although the reduction in water level is likely to be negligible, the absence of a dedicated study to understand the dimensions and hydraulics of Cromwell Weir means there is some uncertainty in this assumption. Prevention of lamprey from migrating upstream to access spawning ground could have an impact on the population of lamprey within the Humber Estuary SAC/SPA/Ramsar site. For this reason a Stage II: Appropriate Assessment was recommended to ensure the proposed drought permit will not reduce the current passage of fish through this significant structure.

Figure 2: Map of the River Trent and the Humber Estuary showing sites of nature conservation value



Source: Mott MacDonald (2018)

3 Humber Estuary European Designated Sites

3.1 Site overview

The Humber Estuary separates the historic counties of Yorkshire and Lincolnshire. With an area of 37,000ha it is the second-largest coastal plain estuary in the UK, and the largest on the east coast. The River Trent is one of two major contributors of flow to the Humber Estuary. It accounts for slightly less than 50% of the contributing catchment area, but only 40% in terms of average flow. The River Great Ouse is the other major contributor of freshwater flows. The Ouse sub-catchments generally have significantly higher rainfall and runoff than those contributing to the Trent. In terms of low flows, the Trent contribution is close to 50%; this reflects the artificial influences, in particular the scale of discharges to the Trent from WTWs.

The high suspended sediment loads in the estuary feed a dynamic and rapidly changing system of accreting and eroding intertidal and sub-tidal mudflats and sandflats, as well as saltmarsh and reedbeds. Approximately one-third of the estuary is exposed as mud or sand flats at low tide. Other notable habitats include a range of sand dune types in the outer estuary, together with sub-tidal sandbanks and coastal lagoons. A number of developing managed realignment sites on the estuary also contribute to the wide variety of estuarine and wetland habitats. The estuary supports a full range of saline conditions from the open coast to the limit of saline intrusion. As salinity declines upstream tidal reedbeds and brackish saltmarsh communities fringe the estuary.

The estuary is used by many species of wintering and passage waterbirds attracted by the variety of habitat types. For example, the sandy sediments of the outer estuary typically attract knot (*Calidris canutus*) and grey plover (*Pluvialis squatarola*), while waterfowl prefer the wetland zones of the upper estuary. At high tide, large mixed flocks congregate in key roost sites which are at a premium due to the combined effects of extensive land claim, coastal squeeze and lack of grazing marsh and grassland on both banks of the estuary. In summer, the site supports important breeding populations of bittern (*Botaurus stellaris*), marsh harrier (*Circus aeruginosus*), avocet (*Recurvirostra avosetta*) and little tern (*Sternula albifrons*).

Significant fish species include river lamprey (*Lampetra fluviatilis*) and sea lamprey (*Petromyzon marinus*), which migrate through the estuary to breed in the rivers of the Humber catchment. Both species are present in the estuary to some degree all year round, although numbers increase during summer and autumn periods when migration takes place. Grey seals (*Halichoerus grypus*) come ashore in autumn to form large breeding colonies on the sandy shores of the south bank around Donna Nook. The site also supports an important vascular plant assemblage and assemblages of aquatic and terrestrial invertebrates.

In addition to hosting an impressive array of habitats and species, the Humber Estuary is a major contributor to the local and national economy. It is an important industrial area and busy commercial waterway. The estuary houses the largest shipping complex in the UK, with the ports of the estuary accounting for 13-15% of the UK seaborne trade. Industries along the estuary include chemical works, oil refinery complexes and power stations, with most of this activity located on the south bank of the middle estuary and around Hull on the north bank.

3.2 Humber Estuary European designated sites

The Humber Estuary is designated as a Special Area of Conservation (SAC), Special Protection Area (SPA) and as a Ramsar wetland of international importance. This section describes the features of conservation importance that are listed in each designation.

3.3 Humber Estuary SAC qualifying features

The Humber Estuary is designated as a SAC under article 4(4) of the Directive (92/43/EEC) as it hosts Annex I habitats. It is also designated under article 4(4) of the Directive (92/43/EEC) as it hosts species listed in Annex II, present as a qualifying feature, but not a primary reason for site selection (JNCC, 2008). These are summarised in Table 2.

Table 2: Humber Estuary SAC primary reasons and qualifying features for site selection.

Annex I habitats that are the primary reason for site selection	
Estuaries	<ul style="list-style-type: none"> ▸ Habitats include: ▸ Atlantic salt meadows (<i>Glauco-Puccinellietalia maritima</i>) ▸ Sandbanks which are slightly covered by sea water all the time ▸ Mudflats and sandflats not covered by seawater at low tide ▸ Salicornia and other annuals colonising mud and sand ▸ Coastal lagoons.
Mudflats and sandflats not covered by water at low tide	
Annex I habitats present as a qualifying feature, but not a primary reason for site selection	
Sandbanks which are slightly covered by sea water all the time	
Coastal lagoons	Priority habitat
Salicornia and other annuals colonizing mud and sand	
Atlantic salt meadows (<i>Glauco-Puccinellietalia maritima</i>)	
Embryonic shifting dunes	
Shifting dunes along the shoreline with <i>Ammophila arenaria</i> (white dunes)	
Fixed coastal dunes with herbaceous vegetation (grey dunes)	Priority habitat
Dunes with <i>Hippopha rhamnoides</i>	
Annex II species present as a qualifying feature, but not a primary reason for site selection	
Sea lamprey (<i>Petromyzon marinus</i>)	
River lamprey (<i>Lampetra fluviatilis</i>)	
Grey seal (<i>Halichoerus grypus</i>)	

3.3.1 Humber Estuary Ramsar site qualifying features

The list of Ramsar criteria applied to the designation of the Humber Estuary as a Wetland of International Importance includes (JNCC, 2007):

- Criterion 1 – the site contains a representative, rare or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region;
- Criterion 3 – the site supports populations of plant and/or animal species important for maintaining the biological diversity of a particular biogeographic region;
- Criterion 5 – the site regularly supports 20,000 or more water birds;
- Criterion 6 – the site regularly supports 1% of the individuals in a population of one species or subspecies of water bird; and,
- Criterion 8 – the site is an important source of food for fishes, spawning ground, nursery and/or migration path on which fish stocks, either within the wetland or elsewhere, depend.

Details of the Humber Estuary Ramsar site citation are given below, in Table 3:

Table 3: Humber Estuary Ramsar site qualifying features.

Criterion	Notes
1	Includes the following component habitats: <ul style="list-style-type: none"> • Dune systems and humid dune slacks • Estuarine waters, intertidal mud and sand flats Saltmarshes • Coastal brackish/saline lagoons
3	Supports a breeding colony of grey seals (<i>Halichoerus grypus</i>) at Donna Nook. The dune slacks at Saltfleetby-Theddlethorpe on the southern extremity of the Ramsar site are the most north-easterly breeding site in Great Britain of the natterjack toad (<i>Epidalea calamita</i>)
5	Supports 153,934 water birds during the non-breeding season (peak mean 1998/99-2002/2003)
6	Spring/Autumn: golden plover (<i>Pluvialis apricaria</i>), red knot (<i>Calidris canutus</i>), dunlin (<i>Calidris alpina</i>), black-tailed godwit (<i>Limosa limosa</i>), common redshank (<i>Tringa tetanus</i>). Winter: shelduck (<i>Tadorna tadorna</i>), golden plover (<i>Pluvialis apricaria</i>), red knot (<i>Calidris canutus</i>), dunlin (<i>Calidris alpina</i>), black-tailed godwit (<i>Limosa limosa</i>), bar-tailed godwit (<i>Limosa lapponica</i>), redshank (<i>Tringa tetanus</i>).
8	The Humber estuary acts as an important migration route for both river lamprey (<i>Petromyzon fluviatilis</i>) and sea lamprey (<i>Petromyzon marinus</i>) between coastal waters and their spawning areas.

3.4 Site condition, conservation objectives and improvement plan

3.4.1 Site condition

The Humber Estuary SAC and Ramsar sites are legally underpinned by the Humber Estuary Site of Special Scientific Interest (SSSI). The SSSI is composed of 187 units, of which only 14 (7.5%) were assessed as being in Favorable condition by Natural England at the time of the most recent assessment (2010 - 2014). Most units (91.2%) were classified as Unfavorable-Recovering and a minority were either classified as Unfavorable-No Change (0.2%) or Unfavorable-Declining (1.1%).

3.4.2 Humber Estuary European sites conservation objectives

The conservation objectives for the Humber Estuary SAC and SPA are outlined in European Site Conservation Objectives for Humber Estuary Special Area of Conservation UK00300170 (Natural England, 2014a) / Special Protection Area UK9006111 (Natural England, 2014b). Conservation objectives are to ensure that the integrity of the site is maintained or restored as appropriate, and that the site contributes to achieving the Favourable Conservation Status of its qualifying features and the aims of the Wild Birds Directive, by maintaining or restoring:

- The extent and distribution of the habitats of qualifying species;
- The structure and function of the habitats of qualifying species;
- The supporting processes on which the habitats of qualifying species rely;
- The populations of qualifying species; and
- The distribution of qualifying species within the site.

3.4.3 Site Improvement Plan

Site Improvement Plans (SIPs) provide a high-level overview of the issues (both current and predicted) affecting the condition of the Natura 2000 features of a designated site and outlines the priority measures required to improve the condition of the features. It does not cover issues

where remedial actions are already in place or ongoing management activities which are required for maintenance.

The SIP developed for the Humber estuary, which covers both the SAC and SPA, identifies the following features as existing pressures or threats affecting the condition of the site and requiring improvement (Natural England, 2015):

- Water pollution;
- Coastal squeeze;
- Changes in species distribution;
- Under grazing;
- Invasive Species
- Natural changes to the conditions;
- Public access/disturbance;
- Fisheries – fish stocking;
- Fisheries – commercial marine and estuarine;
- Direct land take from development;
- Air pollution – impact of atmospheric nitrogen deposition;
- Shooting/scaring;
- Direct impact from third party; and
- Inappropriate scrub control.

The SIP for the Humber estuary is summarised in Table 4.

Table 4: Humber Estuary SIP summary

Priority Issue	Feature(s) Affected	Proposed Improvement Measure	Responsible Body
Water pollution	<ul style="list-style-type: none"> • Bird assemblages • Estuaries • Intertidal mudflats and sandflats • Sea lamprey 	Investigate the effects of poor water quality on designated features	Environment Agency, Natural England, North Lincolnshire District Council, Yorkshire Water Services Ltd, Humber Nature Partnership
Coastal squeeze	<ul style="list-style-type: none"> • Bird assemblages • Estuaries • Intertidal mudflats and sandflats • Atlantic salt meadows • Glasswort and other annuals colonising mud and sand 	Identify opportunities to compensate for the loss of intertidal habitat	Environment Agency, Natural England, Landowner(s)
Changes in species distribution	<ul style="list-style-type: none"> • Bird assemblages • River lamprey • Sea lamprey 	Investigate and address the potential changes in distribution and declines of bird and fish numbers	Environment Agency, Natural England, Landowner(s)
Under grazing	<ul style="list-style-type: none"> • Bird assemblages • Glasswort and other annuals colonising mud and sand • Shifting dunes with marram • Dune grassland • Dunes with sea buckthorn 	Introduce grazing to affected areas through the delivery of the new agri-environment scheme	Natural England, Yorkshire Wildlife Trust, Landowner(s)
Invasive species	<ul style="list-style-type: none"> • Bird assemblages • Estuaries • Atlantic salt meadows 	Gain an understanding of the presence of invasive species, and how to address the issue	Environment Agency, Lincolnshire Wildlife Trust, Local Authority(ies), Natural England, RSPB, Yorkshire Wildlife Trust, Landowner(s), Humber Nature Partnership
Natural changes to site conditions	<ul style="list-style-type: none"> • Bird assemblages • Intertidal mudflats and sandflats 	Investigation to gain an understanding of the changing topography and habitats	Associated British Ports, Environment Agency, Lincolnshire Wildlife Trust, Local Authority(ies), Natural England, North East Lindsey IDB, Yorkshire Wildlife Trust, Humber Nature Partnership
Public access/disturbance	<ul style="list-style-type: none"> • Bird assemblages • Estuaries • Atlantic salt meadows 	Work with recommendations from the Footprint Ecology report to address disturbance issues	Eastern Inshore Fisheries Conservation Authority (IFCA), Environment Agency, Lincolnshire Wildlife Trust, Local Authority(ies), Natural England, North Eastern Inshore Fisheries Conservation Authority (IFCA), RSPB, Yorkshire Wildlife Trust
Fisheries: Fish stocking	<ul style="list-style-type: none"> • Bird assemblages 	Give advice and work with other organisations to control fish stocking	Environment Agency, Natural England
Fisheries: Commercial marine and estuarine	<ul style="list-style-type: none"> • Intertidal mudflats and sandflats 	Indicate where management is necessary and work with organisations to implement these measures	Eastern Inshore Fisheries Conservation Authority (IFCA), Natural England, North Eastern Inshore Fisheries

Priority Issue	Feature(s) Affected	Proposed Improvement Measure	Responsible Body
			Conservation Authority (IFCA), Marine Management Organisation (MMO)
Direct land take from development	<ul style="list-style-type: none"> • Bird assemblages • Estuaries • Intertidal mudflats and sandflats 	Indicate where management is necessary and work with organisations to implement these measures	Environment Agency, Local Authority(ies), Natural England
Air pollution: Impact of atmospheric nitrogen deposition	<ul style="list-style-type: none"> • Glasswort and other annuals colonising mud and sand • Atlantic salt meadows • Shifting dunes (with marram) • Dune grassland • Dunes with sea buckthorn 	Further investigate potential atmospheric nitrogen impact on the site	Not yet determined
Shooting/scaring	<ul style="list-style-type: none"> • Bird assemblages 	Investigate unconsented activities and agree an appropriate way forward	Natural England, Landowner(s), British Association for Shooting and Conservation (BASC)
Direct impact from third party	<ul style="list-style-type: none"> • Bird assemblages • Glasswort and other annuals colonising mud and sand 	Investigate and monitor the collection of Salicornia and implement management when required	Crown Estate (Marine), Natural England, North Eastern Inshore Fisheries Conservation Authority (IFCA), RSPB, Marine Management Organisation (MMO), Humberhead Levels, Humber Nature Partnership
Inappropriate scrub control	<ul style="list-style-type: none"> • Marsh harrier 	Implement appropriate habitat management	Natural England, Yorkshire Wildlife Trust, Landowner(s)

3.5 Sensitive features of the of the Humber Estuary SAC/Ramsar site

The Drought Permit Environmental Assessment and Stage I Screening Assessment identified the following features of the Humber Estuary European sites as being the most sensitive to environmental change:

- Anadromous fish (river lamprey and sea lamprey); and
- Intertidal, subtidal and saltmarsh habitats and associated communities.

The Stage I: Screening Assessment ruled out impacts to intertidal, subtidal and saltmarsh habitats due to implementation of the proposed drought permit. Consequently, they will not be subject to further assessment in this Stage II report.

In this section the ecological requirements, importance and sensitivities of lamprey species are described.

3.5.1 Anadromous fish

Anadromous fish species in the Humber Estuary comprise river lamprey and sea lamprey. They are members of the jawless fishes (Petromyzonidae, superclass Agnatha), the most primitive of all living vertebrate. River lamprey distribution is thought to be confined to Western Europe and sea lamprey are found over much of the North Atlantic. As anadromous species they spawn in freshwater but complete part of their life cycle in estuarine or marine environments. They are both listed on Annex II of the Habitats Directive and are Species of Principal Importance in the UK, as listed under Section 41 of the NERC Act (2006).

Lamprey general flow requirements

Rivers that support lamprey populations provide the diversity of water depths, flow regimes and substrate types necessary to meet the spawning, juvenile and migratory requirements of lamprey species. Proximity of these varied river habitats allows lamprey to move easily from one habitat to another during their life cycle (SNH, 2006).

According to Maitland (2003), like many other migratory fish species, high flows during freshets can be detrimental to populations in preventing them from accessing spawning grounds. Furthermore, low flows can be equally damaging in preventing the passage of upstream migrants over very shallow areas. A study carried out in the rivers of the Humber catchment revealed that flow was the major factor limiting lamprey numbers within the River Derwent. When Derwent flows were high relative to the Ouse, substantial numbers of adult lamprey passed the barrage to enter the Derwent. Under very low flows in the winter, when discharge from the barrage was negligible or zero, the lamprey spawned elsewhere.

Adult lamprey tend to breed in faster flowing reaches, although the actual flow rates where lamprey spawn are variable. In general, sea lamprey favour larger streams and rivers but have been observed in a wide range of habitats from small coastal tributaries with flows less than 0.03m³/s to large intake channels with flows much greater than those of the Trent (Maitland, 2003). Little data is available concerning flow requirements for river lamprey, but it is widely assumed that they require both fast and slow flowing water during various life stages. They are not especially strong swimmers and in fast flowing rivers they are usually seen moving up the edges of the main channel in relatively shallow water (Hardisty & Potter, 1971).

Lamprey migration requirements

Estuaries are considered important lamprey habitat with near-shore coastal margins being important migratory and feeding grounds. The distribution of these species is limited by the

availability of intertidal, saltmarsh and subtidal habitats, and by unimpeded upstream and downstream migration routes. Adult lamprey typically enter estuaries during autumn to begin their spawning migration.

Adult river lamprey migration into rivers mainly occurs between the beginning of October and the end of February, with some in September and March. Sea lamprey adults enter freshwaters from April until July (Maitland, 2003). Available information on the Humber tributaries indicates that adult river lamprey exhibit only limited fidelity to their natal river. Thus, a maturing adult which entered the Humber estuary from one river as a transformer might enter any of the rivers flowing into the Humber estuary to spawn.

The migration distribution of river lamprey is determined by increased flows and pheromones; adults are attracted to ammocoete larval odour during migratory phases, thus luring lamprey towards rivers which already support ammocoetes. Generally, upstream migration is also stimulated at flows substantially above the median. Durham University studies (Greaves et al., 2007) indicate that ideal conditions for good river lamprey passage into the River Derwent occurred at flows of approximately 40m³/s (which constitutes a major flow at this site) coinciding with a neap tide. For sea lamprey, the upstream migration from the estuary appears to be triggered by temperature; sea lamprey usually spawn when the water temperature reaches 15°C (Maitland, 2003).

This initial migratory phase may be largely influenced by tidal regime, with most upstream progression on flood tides. Once the vicinity of the spawning areas is reached, the lamprey tend to seek out protected areas of slack water, for instance in backwaters or amongst tree roots. Such behaviour may result in adults becoming entrained into abstraction intakes, which would be avoided during the active migration phase. In the spring, adults make relatively limited movements between their shelter areas and the spawning beds (Maitland, 2003).

Unless temporarily impeded by obstructions, upstream movement is fairly rapid until the general vicinity of the spawning areas is reached. It should be noted that lampreys are relatively poor swimmers and may be unable to ascend some obstacles or fish passes that allow the free passage of salmonids. Therefore, the distribution of the migratory sea and river lampreys in a catchment is often more restricted than that of other migratory fish, eg salmon (SNH, 2006).

Lamprey spawning requirements

River lamprey typically spawn in spring, with sea lamprey spawning in early summer (Whitehead et al., 1989; Wheeler, 1969). Lamprey spawn in similar environments to salmon and trout, requiring well-oxygenated gravel beds, where they cut circular nests in which they lay their eggs. Lamprey larval nursery beds tend to be away from the main current at the edge of the river where the current is low, with substrate depths from several centimetres to 40cm. Water velocities measured by Kainua & Valtonen (1980) in the areas occupied by river lamprey larvae ranged from 1-5cm/s to about 50cm/s in midstream, with smaller larvae being proportionately more abundant in habitats where the flow was rapid. Where larvae were found in shallow water, the rate of flow was almost constantly below 10cm/s. Thomas (1962) concluded that for sea lamprey, flow rates of 0.6 to 0.8m/s represented an upper limit beyond which burrowing would not occur. However, the mean water velocity over areas of high ammocoete density was often no more than about 0.03m/s.

The larval ammocoete stage lasts for approximately five years. Following metamorphosis, the lamprey begin their downstream migration (Wheeler, 1969).

Velocity and depth requirements of lamprey species

Based on the information obtained from the literature referenced above and Entec (2000), the life cycles and velocity and depth requirements of river lamprey and sea lamprey at various life stages are summarised in Table 5.

Table 5: Velocity and depth requirements of lamprey

Life stage/habitat	Occurrence and duration	Depth criteria	Velocity criteria
River lamprey (<i>L. fluviatilis</i>)			
Spawning habitat	April to May	0.2 – 1.5m	1 – 2m/s
Nursery habitat	Eggs hatch in 15 to 30 days	0.1 – 0.5m	-
Ammocoete	5 years	-	-
Adult (migration)	Autumn to spring	-	-
Sea lamprey (<i>P. marinus</i>)			
Spawning habitat	May to July	0.13 – 1.7m	-
Nursery habitat	Eggs hatch in 17 to 14 days	0.1 – 0.5m	0.5 – 2m/s
Ammocoete	5 years	-	0.11 – 0.26m/s
Adult (migration)	Spring to early summer	-	0.3 – 1.2m/s

Source: Entec (2000), FishBase, Applegate (1950/1960), Hardisty (1986) and references above.

Physico-chemical requirements

The physico-chemical properties that influence river and sea lamprey include salinity, pH and temperature. These abiotic factors can affect the species in different ways depending on species-specific tolerances. Temperature and salinity are closely linked and can act either alone or in combination. Changes in temperature can influence lamprey behaviour, causing them to enter or leave the river at different times of the year. Entry of migratory fish into freshwater appears to be affected when high temperatures are combined with low dissolved oxygen (DO) concentrations.

There is little published information regarding lamprey sensitivity to DO levels. Both river lamprey and sea lamprey are known to require well-oxygenated gravels for spawning. Ammocoetes can tolerate low oxygen levels because of their low metabolic activity and physiological adaptations (Morman et al., 1980). However, harmful conditions such as pollution and high temperatures, which usually occur with low oxygen levels, are lethal factors. Therefore, changes in water quality could affect the spawning and migration of lamprey populations.

4 Impact Assessment

4.1 Potential impacts on the River Trent

Mott MacDonald (2018) conducted an environmental assessment to identify the potential impacts of the proposed Newton-on-Trent drought permit on the River Trent. The impact of the proposed drought permit on the hydrological regime was investigated using modelled flows for the River Trent at North Muskham, 15km upstream of the abstraction point for Hall WTW. Flow series from a severe drought period (1976) were selected as the baseline against which to assess the impact of increased abstraction on flows downstream of Newton-on-Trent. This drought period is considered to have a return period in the region of 200 years, based on analysis of both rainfall data (Met Office, 2017) and modelled flow data (Mott MacDonald, 2017).

Analysis of monitoring data from the Environment Agency was also carried-out to determine baseline ecological, water quality and physico-chemical conditions, and to identify potential sensitivities. The findings of this assessment were used to inform the HRA Stage I Screening Assessment (Mott MacDonald, 2018). Table 6 summarises the potential impacts of the proposed drought permit in the River Trent (not scoped out at Stage 1) that were considered relevant to the integrity of European sites in hydrological continuity with Newton-on-Trent abstraction point.

Table 6: Potential impacts of the proposed Newton-on-Trent drought permit

Impact	Details
Flow regime	The minimum flow in the simulated 1976 flow series was 1452MI/d. Therefore, at the average demand of 20MI/d, the average reduction in downstream river flows resulting from the proposed drought permit would be 1.4%. The maximum possible abstraction of 64MI/d represents 4.4% of the river flow, but in practice would be lower because of the drought permit water level constraint (HOL).
Water level	Water level data is not available for 1976, so it is not possible to definitively state whether the water level downstream of the Hall WTW abstraction point will be significantly impacted if the HOF is lowered by the proposed drought permit. However, available data does not show a strong relationship between water level and flow at times of low flow in the River Trent. This is due to the influence of tidal rather than fluvial conditions. Therefore, it should not be assumed that exceptionally low flows of 1976-type would be accompanied by exceptionally low water levels. Simulated water levels were reduced by 0.005m at Newton-on-Trent, 0.003m upstream at Carlton-on-Trent and 0.001m downstream at Gainsborough under conditions of a 20MI/d abstraction during a summer period (Mott MacDonald, 2018). At the highest instantaneous abstraction rate of 64MI/d the impact would be higher, possibly in the range 0.02 to 0.03m at Newton-on-Trent and around 0.005m close to Cromwell weir.
Entrainment	There is a risk of fish entrainment at the abstraction point and subsequent mortalities. The Hall abstraction has licence conditions for 1-2mm screens, which is acceptable for lamprey protection. The continuation of abstraction when flow falls below the current HOF should not affect approach velocities at the abstraction point, and thus should not create conditions that are any worse in terms of potential entrainment than those for which the intake was designed.

4.2 Potential impacts on the qualifying features of the Humber Estuary SAC/Ramsar site

4.2.1 Screening of potential impacts

Most of the environmental impacts described in Table 6 above were screened out of further assessment at Stage I as they were not considered to have a LSE on the interest features of the Humber Estuary European designated sites (Mott MacDonald, 2018). Below is a discussion

of potential effects that could directly or indirectly affect the lamprey species for which the sites are designated.

The minimum flow in the simulated 1976 flow series was 1452Ml/d. Therefore, the reduction in flows resulting from the proposed drought permit is expected to be up to 1.4% of the contributing flows from the River Trent, and up to 0.6% of overall flows from freshwater sources entering the Humber estuary. Additionally, estuarine processes are the dominant influence on the flow regime below the tidal limit of the river. As the tidal limit is 16km upstream of the Hall WTW abstraction point, it is not expected that the drought permit actions will have a significant impact on the flow regime of the Humber estuary or the freshwater load. This statement is also valid in relation with variation in flow velocity. Consequently, the impact of the proposed drought permit on the salinity regime of the estuary will also be negligible.

It is possible that the dilution of nutrients and other pollutants discharged to the River Trent downstream of the abstraction point will be reduced under the conditions of the proposed drought permit, leading to water quality deterioration. As the drought permit impact on flows will be temporary and is predicted to be minimal, the impact on water quality should be likewise. Additionally, the impact will be mitigated downstream by the input of flows from tributaries and discharges, which serve to increase the dilution capacity of the river. Therefore, it is not expected that water quality changes due to the drought permit will be detectable in the Humber Estuary SAC and Ramsar site.

Suspended sediment concentrations are high in the Humber estuary and are derived from a variety of sources, including fluvial sources. A reduction in River Trent flow under the proposed drought permit could lead to a reduction in sediment discharge to the estuary. However, suspended sediments from marine sources (the North Sea) constitute the most significant load to the estuary, with over 1,500 tonnes carried in per tide compared to an average of 320 tonnes from riverine sources. Furthermore, abstraction is likely to be reduced during periods of high flows, during which suspended sediment concentrations tend to be high. Therefore, a decrease in River Trent suspended sediment concentrations resulting from the implementation of the proposed drought permit would not significantly affect estuarine concentrations. Consequently, the physical loss of inter-tidal, sub-tidal and saltmarsh habitats due to changes in sediment deposition and erosion can also be discounted.

The only outstanding issue is the impact of the proposed drought permit on fish migration and spawning. It was concluded in the Stage I Screening Assessment and the Drought Permit Environmental Assessment that the implementation of the proposed drought permit will not present a threat to lamprey, however some uncertainty remains regarding the passability of Cromwell weir and the access to spawning grounds in the middle reaches. An assessment of impacts on river and sea lamprey is given in the following section.

4.2.2 Potential impacts on anadromous fish

Potential impacts on the river lamprey and sea lamprey populations of the Humber Estuary SAC/and Ramsar site are investigated in this section.

Flow reduction: Migration and spawning impeded

There are no conclusive studies that indicate preferred flow conditions for lamprey entering freshwater systems. It is thought that migration is initiated at moderate to major flows. Therefore, lamprey species will not begin migration during low flow periods when the proposed drought permit is most likely to be applied, regardless of hydrological changes resulting from abstraction. This assumption is most applicable to sea lamprey, which migrate between March and July. As river lamprey migrate from October until spring, flows entering the Humber estuary

are typically higher and a reduction in flows due to drought permit implementation would be negligible.

Lamprey species are most likely to spawn in the middle reaches of the River Trent, which will not be affected by the proposed drought permit. Furthermore, this study has found that there would only be a marginal difference between the current and impacted flows in the River Trent at and downstream of the abstraction point (average reduction in flows 1.4%; maximum reduction 4.4%). Therefore, in the event of spawning in locations affected by the permit, it is assumed that such minimal reduction in flows would still fall within the range for spawning lamprey given in Table 5 unless the baseline flow was at the bottom limit of this range. Without identifying specific spawning locations and analysing flow data specific to these locations, it is only possible to give a limited appraisal on the impact on lamprey spawning. However, given the unlikelihood of spawning downstream of the abstraction, no adverse effects on the qualifying feature are anticipated..

Water level reduction: Passage at Cromwell weir

The distribution of lamprey species in the River Trent is likely related to the presence of structures and weirs that inhibit fish migration upstream. There is conflicting evidence about the ability of lampreys to pass various types of obstructions, including weirs. This is likely due to the focus on specific factors at study sites, such as velocities and the availability and connectivity smooth substrate areas where lampreys can successfully attach themselves to aid progress. Durham University studies (Greaves et al., 2007) revealed substantial adult river lamprey runs up the River Trent, although relatively few penetrated upstream of Cromwell weir (situated just downstream of North Muskham). However, Environment Agency fish data from the last five years show positive recordings of lamprey ammocoetes (larvae) upstream of Cromwell weir, indicating that lamprey do spawn in the River Trent. Therefore, this report must assume that the structure is passable by adult lamprey and spawning occurs.

Simulated water levels were reduced by 0.005m at Newton-on-Trent, 0.003m upstream at Carlton-on-Trent and 0.001m downstream at Gainsborough under conditions of a 20MI/d abstraction during a summer period (Mott MacDonald, 2018). Upstream of Carlton-on-Trent there may be a marginal impact as far as Cromwell weir. At the highest instantaneous abstraction rate of 64MI/d the impact would be higher, possibly in the range 0.02 to 0.03m at Newton-on-Trent and around 0.005m close to Cromwell weir. As this reduction in water level is negligible, fish passage is not likely to be significantly impacted in the event of implementation of a drought permit. However, in the absence of a dedicated study to understand the dimensions and hydraulics of Cromwell weir, there is still some uncertainty in this assumption. Prevention of lamprey from migrating upstream to access spawning ground could have adverse effects on the population of lamprey within the Humber estuary SAC/SPA/Ramsar site.

Entrainment at Hall abstraction point

Lamprey mortalities could arise due to entrainment and trapping in the intake of the Newton-on-Trent abstraction point. The occurrence of this scenario is supported by the presence of two adult lamprey in the screens at Keadby Power Station. The Hall abstraction has licence conditions for 1-2mm screens, which are acceptable for lamprey protection. Additionally, the continuation of abstraction when the flow at North Muskham drops below the current HOF should not affect approach velocities at the abstraction point, and thus should not create conditions that are any worse in terms of potential entrainment than those for which the intake was designed. No adverse effects on lamprey species are therefore anticipated.

4.3 In-combination effects

Article 6(3) of the Habitats Directive requires that “*any plan or project not directly connected with or necessary to the management of the site but likely to have a significant effect thereon, either individually or in combination with other plans or projects, shall be subject to appropriate assessment of its implications for the site in view of the site’s conservation objectives*”.

Therefore, the potential impacts on the interest features of the Humber Estuary European sites due to the proposed drought permit must be assessed in combination with other plans/projects relevant to the area.

4.3.1 Planning applications

A number of planning applications have been submitted to North Lincolnshire Council since the start of 2016 for sites that could be in hydrological continuity with the River Trent and/or the Humber Estuary. It is possible that some of these planned developments could be under construction during the period that the proposed drought permit is applicable (2019 to 2024). Construction activities at sites in hydrological continuity with the river or estuary could have an impact on water quality within the European designated sites. At this stage it is not possible to identify if any of these schemes could result in water quality deterioration in the drought permit ZOI and result in in-combination effects. It is likely that any scheme of significant scale with potential to affect the Humber estuary designated sites will also undergo a HRA and in-combination effects will also be considered at that stage.

4.3.2 Environment Agency drought plans

4.3.2.1 East Anglia Area (Cambridgeshire and Bedfordshire)

There is no overlap in European Sites considered for the Hall WTW and East Anglia Area Environment Agency drought plan.

4.3.2.2 Lincolnshire and Northamptonshire

There is potential for the Environment Agency to apply for a drought order to increase the peak transfer of water from the River Trent as part of the Trent Witham Ancholme (TWA) scheme, but this would only be considered in extreme circumstances. The level of detail in the plan does not allow consideration on the effects of this on European sites, however, it does state that further assessment would be needed on the impacts of this on the Humber SPA/SAC. As a result, there is potential for in-combination LSEs with the drought permit for Hall WTW on the River Trent. This would need further consideration at an appropriate time.

4.3.2.3 East Anglia (East)

There is no overlap in European Sites considered for the Hall WTW and East Anglia (East) Environment Agency drought plan.

4.3.3 Other water company drought plans

4.3.3.1 Cambridge Water

There is no overlap in European Sites considered for the Hall WTW and Cambridge Water’s drought plan.

4.3.3.2 Affinity Water

There is no overlap in European Sites considered for the Hall WTW and Affinity Water's drought plan.

4.3.3.3 Yorkshire Water

Both Yorkshire Water's and Anglian Water's Trent Hall WTW drought plan consider the likely significant effects on Humber Estuary SAC/SPA and Ramsar sites. The Stage 2 assessment for Hall WTW concludes that the predicted water level decreases, potentially impacting on lamprey population, could not be determined as not significant, therefore further survey and monitoring is required before, during and after permit implementation. Although the effect on the European sites of Yorkshire Water's drought plan is not considered to be significant, a reduction in freshwater flows could potentially affect river and sea lamprey. Due to the uncertainty in the effect on the European sites of Anglian Water's drought plan and the potential of both plans to have an effect on lamprey populations, in-combination LSEs cannot be ruled out.

4.3.3.4 Severn Trent Water

The updated Severn Trent Water Drought Plan is not currently available.

4.3.3.5 Essex and Suffolk Water

A screening exercise to determine if a SEA was required was undertaken and concluded that the supply-side actions would not have a significant effect on the environment. As a result, no in-combination likely significant effects are anticipated between Hall WTW drought plan and Essex and Suffolk Water drought plan.

4.3.4 Water Company Water Resource Management Plans (WRMP)

4.3.4.1 Anglian Water WRMP 2019

Anglian Water's final WRMP 2019 includes HRA screening assessment for three plans; the Best Value Plan (BVP), the Least Cost Plan (LCP) and the adaptive strategy. Six options across the three plans were identified as having Likely Significant Effects on European sites and taken forward to Stage 2 appropriate assessment. These were: ESU1 Felixstowe Desalination, ESU2 Ipswich Water Reuse, NFN1 Kings Lynn Desalination, SHB2 Pyewipe Water Reuse for non-potable use, NFN2 Kings Lynn Water Reuse and NFN3 Fenland Reservoir. All of these options express a potential LSE on European Sites that overlap those considered in Anglian Water's Drought Plan.

There is no overlap in European Sites considered for the Wansford Intake and the Felixstowe Desalination, Ipswich Water Reuse, Kings Lynn Desalination, Kings Lynn Water Reuse and Fenland Reservoir options.

The Pyewipe Water Reuse for non-potable use option in the WRMP considers the LSE on the Humber Estuary SPA/Ramsar/SAC as does the drought plan for Hall WTW on the River Trent. The impacts outlined in the WRMP are in relation to possible disturbance to qualifying bird species during construction, pollution events affecting water quality and air pollution affecting aquatic habitat, bird and fish species across the European Sites and are considered to not induce any LSEs due to appropriate mitigation. The assessment of the drought plan at Hall WTW on the River Trent concludes that the temporary hydrological and physico-chemical effects of the permit are likely to be negligible downstream of the abstraction, including the European Sites. There is, however, uncertainty surrounding the passability of two Lamprey species at Cromwell Weir. Both assessments screened out the likelihood of LSEs on the

European Sites, and due to the nature of the impacts no in-combination LSEs are anticipated. However, this assumes that appropriate mitigation is used to minimise the impact of the WRMP option of the European Sites.

4.3.4.2 Affinity Water WRMP19

There is no overlap in European Sites considered for the Hall WTW and Affinity Water's WRMP.

4.3.4.3 Severn Trent Water WRMP19

There is no overlap in European Sites considered for the Hall WTW and Severn Trent Water's WRMP.

4.3.4.4 Yorkshire Water WRMP19

There is no overlap in European Sites considered for the Hall WTW and Yorkshire Water's WRMP.

4.3.4.5 Cambridge Water WRMP19

There is no overlap in European Sites considered for the Hall WTW and Cambridge Water's WRMP.

4.3.4.6 Essex and Suffolk Water WRMP19

There were no supply schemes in Essex and Suffolk Water's WRMP19 so no in-combination LSEs are anticipated.

4.3.5 Other plans and projects

4.3.5.1 Water Resources East (WRE)

The WRE programme is not due to start until 2045 as it is part of longer term planning and is an entirely non-statutory plan, whereas Anglian Water's Drought Plan is only active for another year. There is currently no Habitats Regulations Assessment for the WRE plan, therefore any in-combination effects cannot be assessed at this time.

4.3.5.2 Anglian River Basin Management Plan (RBMP)

The level of detail in the plan does not allow consideration of the effect on individual European Sites, but the HRA determines that the RBMP is not likely to have any significant effects on any European sites, alone or in combination with other plans and projects. Therefore, no in-combination LSEs with the Hall Intake are anticipated.

4.3.5.3 National Policy Statement – Sizewell C

There is no overlap in European Sites considered for the Hall WTW and Sizewell C construction or operation.

4.3.5.4 A14 upgrade

There is no overlap in European Sites considered for the Hall WTW and the A14 upgrade.

4.3.5.5 Cam-MK-Ox corridor

No further details are available on this scheme at present.

4.3.5.6 East West Rail

There is no HRA for East West Rail as there are no European Sites that could be impacted by the scheme.

5 Mitigation and Enhancement Measures

Anglian Water are committed to minimising any potential impacts that could occur due to implementation of the proposed drought permit at Newton-on-Trent abstraction point on the River Trent. Detailed information on the monitoring requirements and proposed mitigation measures to ensure the integrity of the Humber Estuary European designated sites is provided in the Environmental Assessment Report.

6 Conclusions

Lamprey populations in the River Trent and Humber Estuary were identified in the Stage I Screening Assessment as being potentially sensitive to the impacts of the proposed Newton-on-Trent drought permit. This Stage II Appropriate Assessment further investigated the effects of the predicted drought permit on lamprey populations, specifically the impacts of flow and water level changes, and entrainment at the Hall WTW intake.

Impacts due to flow changes and entrainment were determined not to be significant. The upstream migration of lamprey is unlikely to occur in the low flow conditions that typically precede drought permit application, therefore the reduction in flow due to increased abstraction would not alter their natural migration pattern. Spawning is not likely to be impacted by flow reductions as it typically occurs upstream of the area influenced by abstraction at Newton-on-Trent. Mortalities due to entrainment at the abstraction point are not considered to be significant as screens of an appropriate gauge are in place for lamprey protection.

The predicted water level decrease could not be satisfactorily eliminated as a potential threat to lamprey populations. The distribution of lamprey species in the River Trent is likely to be related to the presence of structures and weirs that inhibit fish migration upstream. Water levels are predicted to drop by up to 0.005m close to Cromwell weir. As this reduction in water level is negligible, fish passage is not likely to be significantly impacted. However, in the absence of a dedicated study to understand the dimensions and hydraulics of Cromwell weir, there is still some uncertainty in this assumption.

Given the remaining uncertainty regarding the current passage of migratory fish species through Cromwell weir, and therefore the impact of predicted water level reductions during drought permit implementation, it is recommended that a survey is conducted to identify the suitability of the weir for lamprey species. It is also recommended that a formal plan is developed for the monitoring of flows, water quality and biological elements in the Humber Estuary and River Trent in the periods before, during and after drought permit implementation to identify any unforeseen impacts on the interest features of designated sites.

7 References

- Department for Communities and Local Government (DCLG) (2006). Planning for the Protection of European Sites. Guidance for Regional Spatial Strategies and Local Development Documents.
- Department for Environment, Food and Rural Affairs (Defra) (2006). Ramsar Sites in England – A Policy Statement.
- Department for Environment, Food and Rural Affairs (Defra) (2016). MAGIC Maps: Nene Washes Area, 1:30,000. Available at: <http://magic.defra.gov.uk/MagicMap.aspx>
- English Nature (1994). Habitats Regulations Guidance Note 3: The Determination of Likely Significant Effect Under the Conservation (Natural Habitats &c.).
- Entec (2000). Generically acceptable Flows for British Lamprey. Report to the Environment Agency, Penrith.
- Environment Agency (2017). Drought plan guideline extra information. Environmental Assessments for Water Company Drought Plans.
- European Commission Environment Directorate General EC (EC, 2000), Managing Natura 2000 Sites. The provisions of Article 6 of the Habitats Directive 92/43/EEC.
- European Commission Environment Directorate General (EC, 2001). Assessment of Plans and Projects Significantly Affecting European Sites. Methodological guidance on the Provisions of Article 6(3) and (4) of the Habitats Directive 92/43/EEC.
- FishBase *Lampetra fluviatilis* River Lamprey. Available at: <http://fishbase.org/summary/4480>
- FishBase *Petromyzon marinus* Sea Lamprey. Available at: <http://www.fishbase.se/summary/2530>
- Greaves R.K., Bubb D.H. and Lucas M.C. (2007). Adult River Lamprey Occurrence and Migration in the River Trent in Relation to Barriers and Environmental Conditions. Final Report. Durham University.
- Hardisty, M.W. and Potter, I.C., (1971). The Biology of Lampreys. Academic Press.
- Hardisty, M.W. (1986). *Lampetra fluviatilis* (Linnaeus 1758). In: The freshwater fishes of Europe, *Petromyzontiformes* Vol.1. Part 1. (Ed.) J. Holcik AULA-Verlag, Wiesbaden, Germany: 249-278.
- JNCC (2007). Information Sheet on Ramsar Wetlands: Humber Estuary. Site Code: UK11031. Completion date: August 2007.
- JNCC (2008). Humber Estuary SAC Natura 2000 – Standard Data Form. EU Code: UK0030170. Compilation date: July 2008.
- Kainua K. & Valtonen T. (1980). Distribution and Abundance of European River Lamprey (*Lampetra fluviatilis*) Larvae in Three Rivers Running into Bothnian Bay, Finland. Canadian Journal of Fisheries and Aquatic Sciences, 37 (11), 1960-1966.
- Maitland, P.S. (2003). Ecology of the River, Brook and Sea Lamprey. Conserving Natura 2000 Rivers Ecology Series No. 5. English Nature, Peterborough.
- Met Office (2017). Extreme Value Analysis of long duration droughts using Bayesian methods, for Anglian Water Services, October 2017.

- Morman RH, Cuddy DW & Rugen PC (1980). Factors influencing the distribution of sea lamprey (*Petromyzon marinus*) in the Great Lakes. *Canadian Journal of Fisheries and Aquatic Sciences* 37,1811–1826.
- Mott MacDonald (2017). Estimated return periods of River Trent drought flows, Technical Note for Anglian Water Services, November 2017.
- Mott MacDonald (2018). Drought Permit Environmental Assessment. River Trent at Hall WTW
- Natural England (2014a). European Site Conservation Objectives for Humber Estuary Special Area of Conservation (UK0030222). Available at:
<http://publications.naturalengland.org.uk/publication/5009545743040512>
- Natural England (2014b). European Site Conservation Objectives for Humber Estuary Special Area of Conservation UK9008031. Available at:
<http://publications.naturalengland.org.uk/publication/5382184353398784>
- Natural England (2015). Site Improvement Plan: Humber Estuary. Available at:
<http://publications.naturalengland.org.uk/publication/5427891407945728>
- Scottish Natural Heritage (2006). Guidance for competent authorities when dealing with proposals affecting SAC freshwater sites. Natural Heritage Management.
- Thomas, M.L.H. (1962). Observations on ecology of ammocoetes *Petromyzon marinus* L. and *Entosphenus lamottei* (Le Sueur). Thesis, University of Toronto, Canada.
- Tyldesley, D. and Chapman, C. (2013) The Habitats Regulations Assessment Handbook. UK: DTA Publications Limited.
- UK Government (2017). The Conservation of Habitats and Species Regulations 2017.
- UKWIR (2012). Strategic Environmental Assessment and Habitats Regulations Assessments - Guidance for Water Resources Management Plans and Drought Plans (WR/02/A).
- Wheeler, A. (1969). The Fishes of the British Isles and North West Europe. MacMillan Press, UK.
- Whitehead P.J.P., Bauchot, M.-L., Hureau, J.-C., Nielsen, J. & Tortonese, E., eds. (1989). Fishes of the North-eastern Atlantic and the Mediterranean: Volume I. Second edition. Paris: United Nations Educational Scientific and Cultural Organization (Unesco), pp. 1-510.

