Natural England Commissioned Report NECR184

River Eye SSSI: Strategic Restoration Plan

Technical Report

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NATURAL ENGLAND

Foreword

This report was commissioned by Natural England and overseen by a steering group convened by Natural England in partnership with the Environment Agency. The report was produced by Royal HaskoningDHV. The views in this report are those of the authors and do not necessarily represent those of Natural England.

Background

The River Eye is a semi-natural lowland river which rises at Bescaby, approximately 10km north east of Melton Mowbray. It flows for approximately 21km, becoming the River Wreake as it flows through Melton Mowbray and around Sysonby Lodge. As a result of its characteristics as an exceptional example of a semi-natural lowland river, an area covering 13.65ha and a length of approximately 7.5km was designated a Site of Special Scientific Interest. This area, situated between Stapleford (National Grid Reference [NGR] SK 802186) and Melton Mowbray (NGR SK 764188) equates to approximately 40% of the total length of the River Eye.

A survey in 2010 showed that the ecological condition of the river not improved, and the principal reasons for this were water quality and siltation. The siltation problem is exacerbated by the lack of flow and structures, which impede the river's hydrological functioning.

The water quality is being addressed, but the physical character of the river channel also needs to be restored to secure good ecological and hydrological functioning.

In 2014, a geomorphological appraisal of the River Eye was carried out by Royal HaskoningDHV, the result of this appraisal enabled Royal HaskoningDHV to produce the River Eye SSSI technical report and restoration vision; combined make up the River Eye Restoration Strategy. This report identifies and prioritises physical restoration measures that will help to achieve favourable condition and water framework objectives.

This report should be cited as:

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Further information
This report can be downloaded from the Natural England website: **www.gov.uk/government/organisations/natural-england**. For information on Natural England publications contact the Natural England Enquiry Service on 0845 600 3078 or e-mail **enquiries@naturalengland.org.uk**.

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CONTENTS

1 INTRODUCTION

1.1 Background

The River Eye is a semi-natural lowland river which rises at Bescaby, approximately 10km north east of Melton Mowbray. It flows for approximately 21km, becoming the River Wreake as it flows through Melton Mowbray and around Sysonby Lodge. As a result of its characteristics as an exceptional example of a semi-natural lowland river, an area covering 13.65ha and a length of approximately 7.5km was designated a Site of Special Scientific Interest (SSSI) **(Figure 1.1).** This area, situated between Stapleford (National Grid Reference [NGR] SK 802186) and Melton Mowbray (NGR SK 764188) equates to approximately 40% of the total length of the River Eye.

The River Eye SSSI is affected by a range of pressures including natural constraints, climate change and those resulting from both past and current management of the river channel and surrounding floodplain, which in turn are considered to compromise the condition of the habitats it is known to support. Subsequently, this means that the SSSI is currently assessed as being in Unfavourable (No Change) Condition. Restoration of the River Eye SSSI can provide numerous benefits, including the creation of more varied habitats for wildlife, the creation of improved in-channel habitats for fish, and reduced maintenance requirements by reinstating natural river processes.

1.2 Project drivers

1.2.1 Water Framework Directive (WFD) and Biodiversity 2020

The European WFD requires all EU Member States to protect and, where possible, enhance the condition of all bodies of water. As part of the WFD, surface waters such as the River Eye must reach Good Ecological Status by 2015 (or, in cases where there are significant pressures to address, 2021 or 2027). The river is not currently achieving GES, does not currently meet these targets, which means that the Environment Agency, Natural England and others are obliged to undertake work to ensure that the required standards are achieved in the future.

In addition, the UK Government's 'Biodiversity 2020' strategy includes a commitment to ensure that at least 50% of designated SSSIs (such as the River Eye) achieve "favourable condition", (i.e. the site is being adequately conserved and is meeting its 'conservation objectives) and that 95% of sites are maintained in favourable or recovering" condition by 2020. Favourable condition means that all of the targets for the mandatory attributes (population and habitat) used to assess a feature have been met. If a SSSI site is in Favourable Condition, it means that the site is being adequately conserved and is meeting its 'conservation objectives'. A 2013 report by Natural England ('Spotlight on SSSIs') states that the total area of sites in favourable condition is 37.38%, highlighting that in total more than 130,000 hectares need to improve to favourable condition by 2020. The River Eye SSSI is not currently in Favourable or "unfavourable recovering" Condition. Natural England have identified the main pressures which limit the condition of the SSSI, and are currently working with partners (including the Environment Agency and other stakeholders) to deliver measures to improve the river condition.

This report is intended to help Natural England and the Environment Agency identify pressures which affect the physical condition of the River Eye SSSI and the habitats that it supported, and develop solutions to address these pressures, with the aim of eventually achieving Favourable Condition and Good Ecological Status within the River Eye SSSI.

1.2.2 The Catchment Based Approach

The UK Government's Water White Paper and Natural Environment White Paper both place a strong emphasis on improving river ecosystems at a catchment scale. In response, the Department for Environment, Food and Rural Affairs (Defra) has led the development of the Catchment Based Approach (CaBA) to WFD implementation. The CaBA aims to balance environmental, economic and social demands on water at a catchment scale, and ensure that water management and environmental improvements are aligned in a strategic way to deliver real improvements at a river catchment scale.

The development of catchment partnerships consisting of local stakeholders is central to the approach. These stakeholders can work together to establish common ownership of the issues that affect their river catchments, including flood protection, water supply, recreation and environmental quality, and develop local solutions to address these issues and improve the water environment.

Following on from a successful pilot phase, the CaBA is currently being rolled out to all river catchments in England. The lead partners in each catchment partnership have recently been announced, and they will work together to develop strategic plans for catchment management and WFD implementation that will feed into the second round of River Basin Management Plans in 2015.

The River Eye forms part of the River Soar catchment, itself a tributary of the River Trent. As part of the approach, local stakeholders alongside the Trent Rivers Trust will develop an action plan for the River Soar, which will outline measures that could improve the water environment and deliver the aims of the WFD. The River Eye SSSI Strategic Restoration Plan will feed into the wider Soar action plan as it is developed.

1.3 Project aims and objectives

The River Eye SSSI Strategic Restoration Plan aims to improve the river by restoring the mosaic of characteristic habitats naturally found in this lowland clay river in order to better support the SSSI interest features **(see Section 2.2.2).** This will, over time, support the recovery of the designated habitats and contribute to achieving Favourable Condition in the SSSI and Good Ecological Status in the River Eye.

The specific objectives of the project are to:

1. Undertake detailed geomorphological analysis to identify the physical factors which underlie unfavourable habitat conditions, and identify the impacts that this has on the ecology of the river. This will include reference to previous work undertaken in the catchment.
2. Use the results of (1) to generate an outline restoration plan for the river on a reach-by-reach basis.
3. Identify likely delivery mechanisms for different aspects of river restoration, and provide approximate costs for the required river restoration measures.
4. Support Natural England in their engagement with landowners, fisheries groups and other stakeholders.
5. Produce a final restoration plan, incorporating the outcomes of consultation with landowners and other stakeholders.

1.4 Purpose of this report

This **Technical Report** is for use by river managers and regulating bodies (principally Natural England and the Environment Agency) as supporting information for the accompanying **River Eye SSSI Strategic River Restoration Plan.** The aim of this report is to summarise the findings of the geomorphological assessment and ecological interpretation of the impacts of physical conditions on river habitats. This specifically involves drawing together the findings of the desk based assessment and field (walkover) surveys to build a conceptual model of the geomorphological functionality of the river. This conceptual model describes the inputs, processes and outputs from the river system. The ecological assessment is then related to the geomorphological model and possible causes of unfavourable condition are identified to provide a basis for developing restoration actions at a strategic scale.

This report and the accompanying restoration plan will identify the underlying causes for unfavourable physical habitat condition and identify potential solutions to the problems, which can be used as a basis for further discussions with catchment stakeholders. The solutions recognise that many of the reasons for unfavourable condition are likely to result from pressures that have been affecting the river for a long period of time, and may pre-date the designation of the site as a SSSI. As a result, it is not assumed that the River Eye was in Favourable Condition at the time of its original designation.

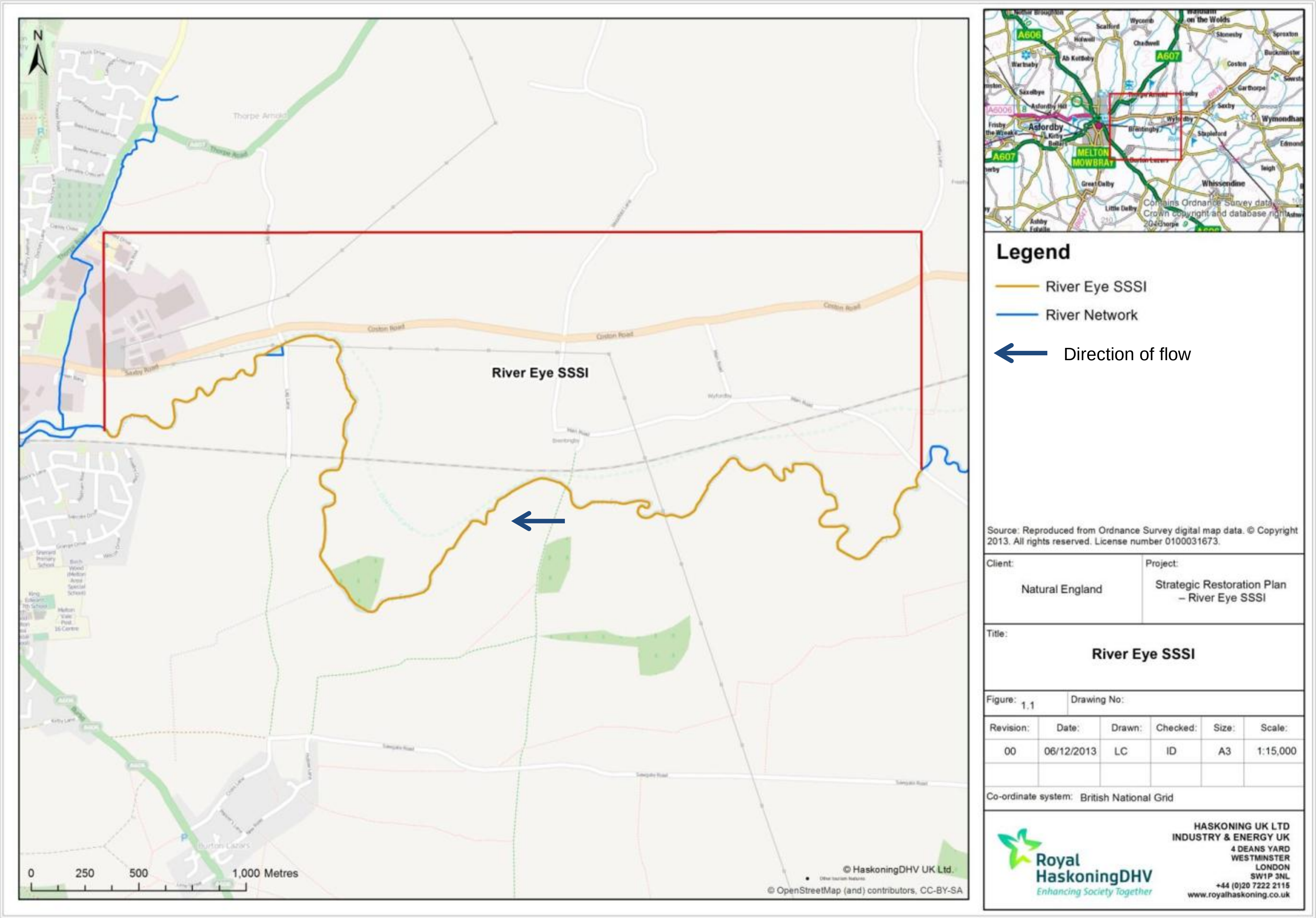
1.5 Report structure

This report is divided into six chapters, which describe the purpose of this investigation, the methods employed, the morphological and ecological functioning of the system, and a consideration of potential solutions to the key issues identified. **Table 1.1** provides details of the content of each of the chapters of this report.

Table 1.1: Outline of report structure

Report section		Description
1	**Introduction (this section)**	Introduces the project, and outlines the main aims and objectives of the project.
2	**The River Eye SSSI**	Provides a description of the designated features of the River Eye SSSI and the condition status of each SSSI unit.
3	**Method**	Provides details of the field-based and desk-based methods used in this study.
4	**Catchment characteristics**	Provides an understanding of the main factors which control the development and condition of habitats within the River Eye SSSI.
5	**Geomorphological and ecological condition**	Provides a detailed description of the current geomorphology and ecology of the River Eye SSSI.
6	**Conclusion and further recommendations**	Provides a discussion of the links between the technical report and the restoration plan. The main Strategic Restoration Plan is provided as a separate report, which outlines potential restoration measures to address the issues identified in the technical report, restoring the SSSI to favourable condition.

Figure 1.1: River Eye SSSI overview



2 THE RIVER EYE SSSI

2.1 Purpose of this section

This section presents a description of the designated features of the River Eye SSSI and the condition status of each SSSI unit. The purpose of this chapter is to provide an understanding of why the river habitat has been designated as a SSSI and the species it supports, and the current baseline ecological and physical condition of the River Eye.

2.2 Description of the River Eye SSSI

2.2.1 Location

The River Eye SSSI is located in the north-east of Leicestershire **(Figure 1.1).** The SSSI area is approximately 13.65 hectares covering a length of approximately 7.5km between Stapleford (NGR SK 802186) and the downstream boundary within Melton Mowbray (NGR SK 764188).

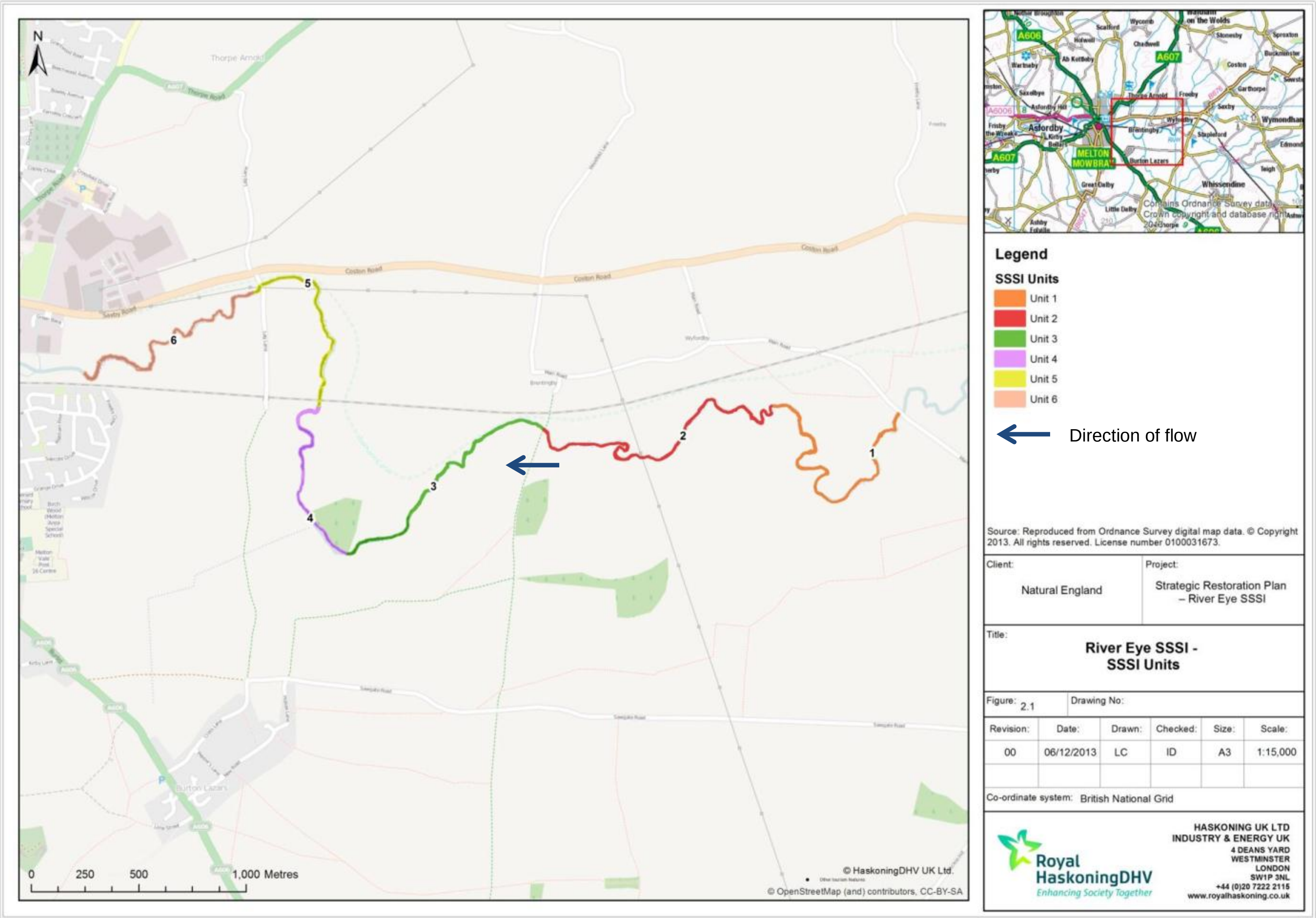
2.2.2 SSSI interest features

The River Eye SSSI has been notified as an exceptional example of a semi-natural lowland river. The habitats and species supported in the SSSI comprise diverse plant and animal communities, including rich marginal vegetation and invertebrate communities, with records of white clawed crayfish (*Austropotamobius pallipes*), water boatman (*Corixa panzeri)* and white-legged damselfly (*Platycnemis pennipes*) at the northerly limit of its British range.

2.2.3 SSSI units

The River Eye SSSI is divided into six SSSI units, which Natural England assesses and monitors. The unit locations are illustrated in **Figure 2.1.** The unit boundaries were established when the river was designated, and they are largely based on physical barriers such as field boundaries, road and railway bridges. They are therefore not necessarily representative of the geomorphology of the river.

Figure 2.1: Overview of the River Eye SSSI units



2.3 River typology

As a Joint Nature Conservation Committee (JNCC) Type II lowland, clay-dominated river, the River Eye would be expected to display the following hydromorphological and ecological characteristics, under low anthropogenic impact conditions (Natural England (2007):

- Dominant glide flow conditions, with occasional riffles.
- Bed materials dominated by silts and sands.
- Habitat variability associated with occasional impoundment upstream of woody debris jams.
- A wide variety of invertebrate and fish species associated with sections of gravel and coarse sediment habitat, including caddis flies (*Trichoptera spp*), riffle beetles (*Elmidae spp*) and mayflies (*Ephemeroptera spp*.), and fish such as dace (*Leuciscus leuciscus*), bullhead (*Cottus gobio*), stone-loach (*Barbatula barbatula*), brook lamprey (*Lampetra planeri*), minnow (*Phoxinus phoxinus*) and stickleback (*Gasterosteus aculeatus*).
- Occurrence of brown trout and some stonefly species of the *Leuctridae* and *Nemouridae* families in sections of sufficient extent of gravels.
- Gravels and swifter flows also provide rooting opportunities for species such as water-crowfoot (*Ranunculus penicillatus* subsp. *pseudofluitans*) and water-milfoil (*Myriophyllum spicatum*), with an attendant fauna.
- In quieter sections and backwaters with finer substrates, a flora and fauna more associated with still waters develops, including *Unionid* mussels and pea-mussels, *Libellulid* dragonflies, *Agrionid* damselflies, burrowing mayflies, water-snails, alder-flies, and various families of caddis-fly (such as the *Limnephilidae*). The insect fauna is heavily dependent on an active marginal and wetland fringe of vegetation for hatching, resting, feeding and mating, and as a flow refuge under spate conditions.
- On shallow bank sides (particularly the insides of meander bends), a significant zone of hydrological transition is expected, with beds of emergent species such as branched bur-reed (*Sparganium erectum*) and reed canary-grass (*Phalaris arundinacea*), and wetland species such as brook-lime (*Veronica beccabunga*), water forget-me-not (*Myosotis scorpioides*), water-mint (*Mentha aquatica*) and water-cress (*Rorippa nasturtium-aquatica*).
- Vertical cliffs provide nesting opportunities for kingfisher (*Alcedo atthis*) and sand martins (*Riparia riparia*), as well as for burrowing bees and wasps and a range of other insects specialising in bare soils. Water-voles (*Arvicola terrestris*) thrive in banksides of intermediate slopes with tall herb vegetation and an active marginal zone of emergent plants.
- Considerable meandering can be expected in Type II rivers (depending on natural sediment supply and hydraulic energy), generating sequences of alternating steep and shallow bank profiles which may lead to vertical cliffs and point bars, respectively.
- Riparian trees provide an important additional habitat dimension, generating submerged exposed root systems that provide in-channel habitat for fish and invertebrates (such as white-clawed crayfish), potential holt and resting sites for otters (*Lutra lutra*), a source of woody debris and leaf litter for the river, and varying within-channel light and temperature regimes that add further habitat diversity.
- Riparian scrub provides additional important habitat for otter and bird species such as reed buntings (*Emberiza schoeniclus*) and various warbler species.
- On the wider floodplain, natural flooding regimes can be expected to give rise to inundation wetlands, such as MG4 grasslands (a rare lowland meadow habitat characterised by seasonally inundated or waterlogged grassland), particularly alongside rivers with low base-flow, and fen and carr vegetation (a vegetational mix typical of mineral-rich wetlands), particularly alongside high base-flow rivers.

2.4 SSSI condition status

2.4.1 Current SSSI condition

The January 2010 SSSI unit condition assessment (Natural England, 2010) determined that all six SSSI units of the River Eye SSSI are in “Unfavourable-no change” condition due to pressures associated with:

- Inappropriate dredging.
- Inappropriate weirs, dams and other structures.
- Siltation.
- Water pollution – discharge.

- Water pollution – agriculture/run off.

Natural England (2010) has also noted that:

- The biological and chemical General Quality Assessment (GQA) targets have been met, as have targets for unionised ammonia and suspended solids.
- The mean soluble reactive phosphorous target (0.06 mg l^{-1}) has not been met, but there has been a significant decrease in mean annual orthophosphate concentrations since 1998. Values for the monitoring locations cited in the "Common Standards Monitoring Condition Assessment of River Eye SSSI" report (Scott Wilson, 2010) display a decrease of 65% for Melton Mowbray and 56% at Stapleford. Catchment Sensitive Farming initiatives that have recently been implemented are expected to be closely linked to the observed decrease.
- The target for bankside vegetation composition and abundance has also not been met. Ideally there should be a higher proportion of marginal macrophyte species.
- There should be areas of species rich marshy grassland, swamp vegetation and MG4 (species rich wet grassland) floodplain meadows.
- The riparian zone target has not been met due to a lack of natural and semi-natural habitats.

The 2010 assessment highlighted the need to implement river restoration measures to improve the macrophyte assemblages. No other specific recommendations were made to improve the condition of the SSSI in this assessment. The water quality targets for the site are due to be revised and negotiations are underway between Natural England and the Environment Agency.

2.4.2 Assumptions on Favourable Condition

It should be noted that there is no assumption that the River Eye SSSI was in Favourable Condition when it was first designated. Many of the pressures which currently affect the river have been present for a long period of time (for example, the impounding structures downstream of the SSSI limit), and are likely to have impacted upon the river when it was first designated. However, the river was designated on the basis that it was one of the best examples of its river type remaining in England, with the intention of preventing further deterioration, and over time addressing existing impacts.

The strategic restoration planning process therefore considers current modifications and constraints that are affecting the condition of the SSSI (including the Melton Mowbray Flood Alleviation Scheme), and aims to develop a consensus among stakeholders on the most appropriate courses of action. This is discussed further in **Section 6.**

2.5 Water Framework Directive water body information

Under the European Water Framework Directive (2000/60/EC) (WFD), the ecological status of a surface water body is assessed according to:

- The condition of biological elements, for example fish, benthic invertebrates and other aquatic flora;
- Concentrations of supporting physico-chemical elements, for example thermal conditions and concentrations of oxygen, ammonia and nutrients;
- Concentrations of specific pollutants, for example copper and other priority substances; and
- The condition of the hydromorphological quality elements, including morphological condition and hydrological regime.

Ecological status is recorded on the scale of high, good, moderate, poor or bad. 'High' denotes largely undisturbed conditions and the other classes represent increasing deviation from this natural condition, otherwise described as a 'reference condition'. The ecological status classification for the water body, and the confidence in this, is determined from the worst scoring quality element. This means that the condition of a single quality element can cause a water body to fail to reach its WFD classification objectives.

Chemical status is assessed by compliance with environmental standards for chemicals that are listed in the Environmental Quality Standards Directive (2008/105/EC). These chemicals include priority substances, priority hazardous substances, and eight other pollutants carried over from the Dangerous Substance

Daughter Directives. Chemical status is recorded as 'good' or 'fail'. The chemical status classification for the water body is determined by the worst scoring chemical.

It should be noted that it is possible for a water body to reach Good Ecological Status and Good Chemical Status, but still not be in Favourable Condition. This is because Favourable Condition targets may be more stringent than WFD-specific targets for Good Ecological and Chemical Status.

The River Eye SSSI is located in water body GB104028047550 (River Eye / Wreake from Langham Brook to River Soar). **Table 2.1** summarises the information for this water body that is published in the Humber River Basin Management Plan (RBMP) (Environment Agency, 2009). The River Eye water body was assessed in 2009 as being at Moderate Ecological Status, as a result of pressures related to high phosphate concentrations and hydrological modifications.

The location of the water bodies which drain into the River Eye SSSI are detailed in **Figure 2.2. Table 2.2** summarises the WFD classification and identified pressures of the tributaries draining into the River Eye SSSI. This demonstrates that the tributaries of the River Eye do not meet the required standards, largely as a result of high concentrations of phosphate. They are therefore likely to be a major source of phosphate to the River Eye and a contributor towards its failure to reach Good Ecological Status.

The Thorpe Brook and Scalford Brook confluences have been included on **Figure 2.2** for contextual reasons but, due to their location downstream of the SSSI limit, have been assessed as not significantly impacting the quality elements in the River Eye SSSI. They have, therefore, been excluded from **Table 2.2.**

Table 2.1: WFD classification for the River Eye SSSI (Environment Agency, 2009)

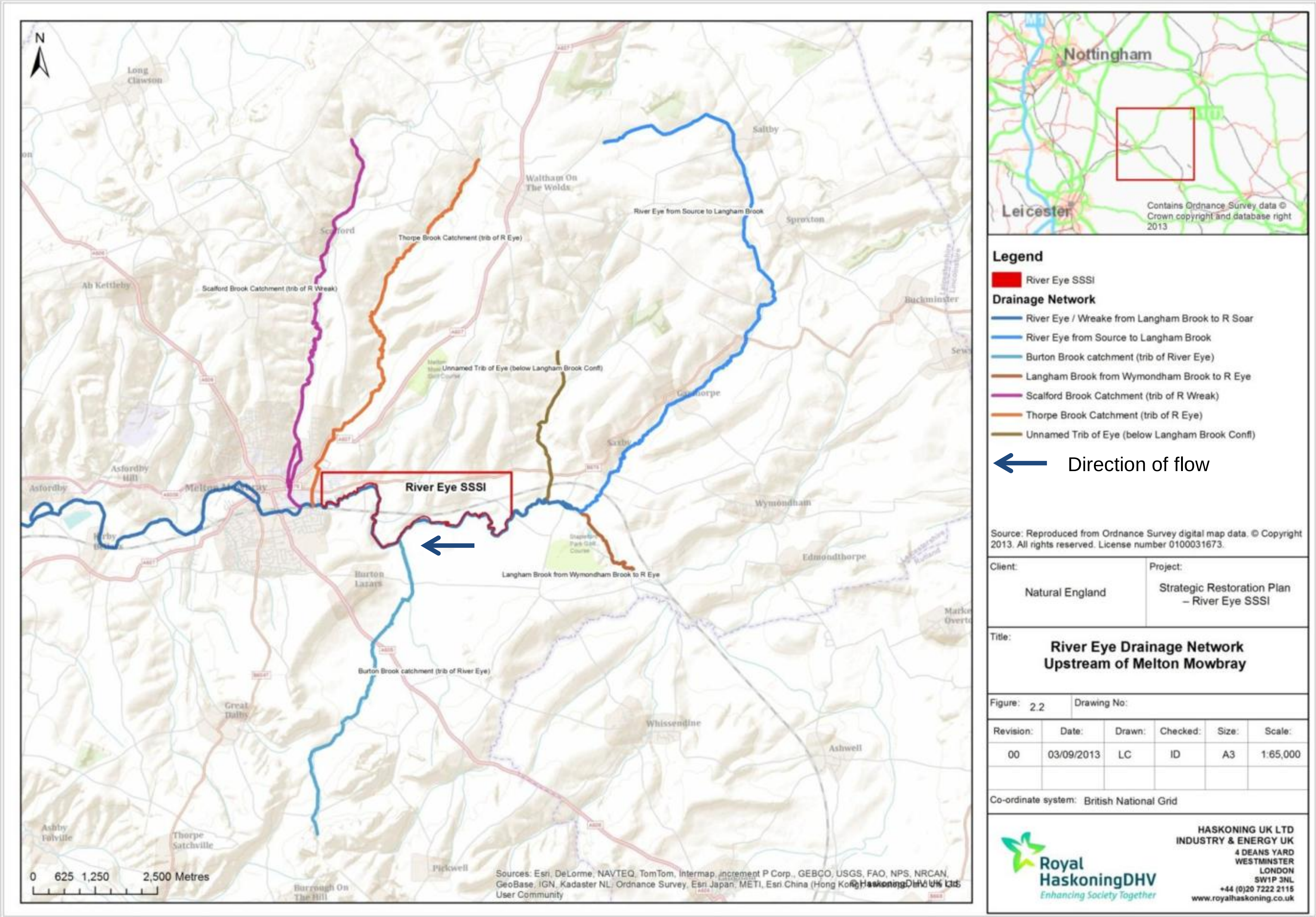
Water Body Name	River Eye / Wreake from Langham Brook to R Soar		
Water Body ID	GB104028047550		
Length (km)	40		
Classification	Not designated Artificial/Heavily Modified Water Body (A/HMWB)		
Current Overall Status	Moderate		
Current Ecological Status	Moderate		
Overall objective	Good Status by 2027		
Element	**Current Status**	**Predicted Status by 2015**	**Reason**
Physico-chemical elements			
Chemical Status	Good	High	N/A
Ammonia	High	High	N/A
Dissolved Oxygen	High	High	N/A
pH	High	High	N/A
Temperature	High	High	N/A
Phosphate	Moderate	Moderate	Disproportionally expensive (P1c)
Biological elements			
Fish	Good	Good	N/A
Invertebrates	Good	Good	N/A
Macrophytes	N/A	N/A	N/A
Phytobenthos	N/A	N/A	N/A
Hydromorphological elements			
Hydrology	Not High	Not High	N/A
Morphology	Good	Good	N/A
Mitigation measures			**In place?**
N/A			N/A
Reasons for failure			
P1c	There is not sufficient weight of evidence to confirm the need to control eutrophication risk and there are ongoing or planned improvement actions		

Table 2.2: Water bodies upstream of the SSSI (see Figure 2.2)

Water body name	WFD water body ID reference	Current status	Reasons for failure
Burton Brook catchment (trib of River Eye) (Flowing into SSSI)	GB104028047500 (Catchment area:18.9km^2)	Moderate	Phosphate or Total Phosphorus - There is currently insufficient weight of evidence[1] to confirm the need to control eutrophication risk using site specific and potentially expensive regulatory action
Unnamed Trib of Eye (below Langham Brook Confl) (Approx. 1100m Upstream of SSSI limit)	GB104028047580 (Catchment area:16.3km^2)	Moderate	Phosphate or Total Phosphorus - There is currently insufficient weight of evidence to confirm the need to control eutrophication risk using site specific and potentially expensive regulatory action
River Eye from Source to Langham Brook	GB104028047610 (Catchment area:31.3km^2)	Good	Not applicable
Langham Brook from Wymondham Brook to R Eye (Approx. 1800m Upstream of SSSI limit)	GB104028047530 (Catchment area:3.7km^2)	Poor	Phytobenthos and Phosphate or Total Phosphorus - There is currently insufficient weight of evidence to confirm the need to control eutrophication risk using site specific and potentially expensive regulatory action

[1] "Weight of evidence" is defined here in relation to Water Framework Directive Targets. This may differ from the nature of evidence required in order to identify action required to improve SSSI condition".

Fig 2.2: River Eye water bodies upstream of Melton Mowbray



3 METHOD: DEVELOPMENT OF A RESTORATION PLAN

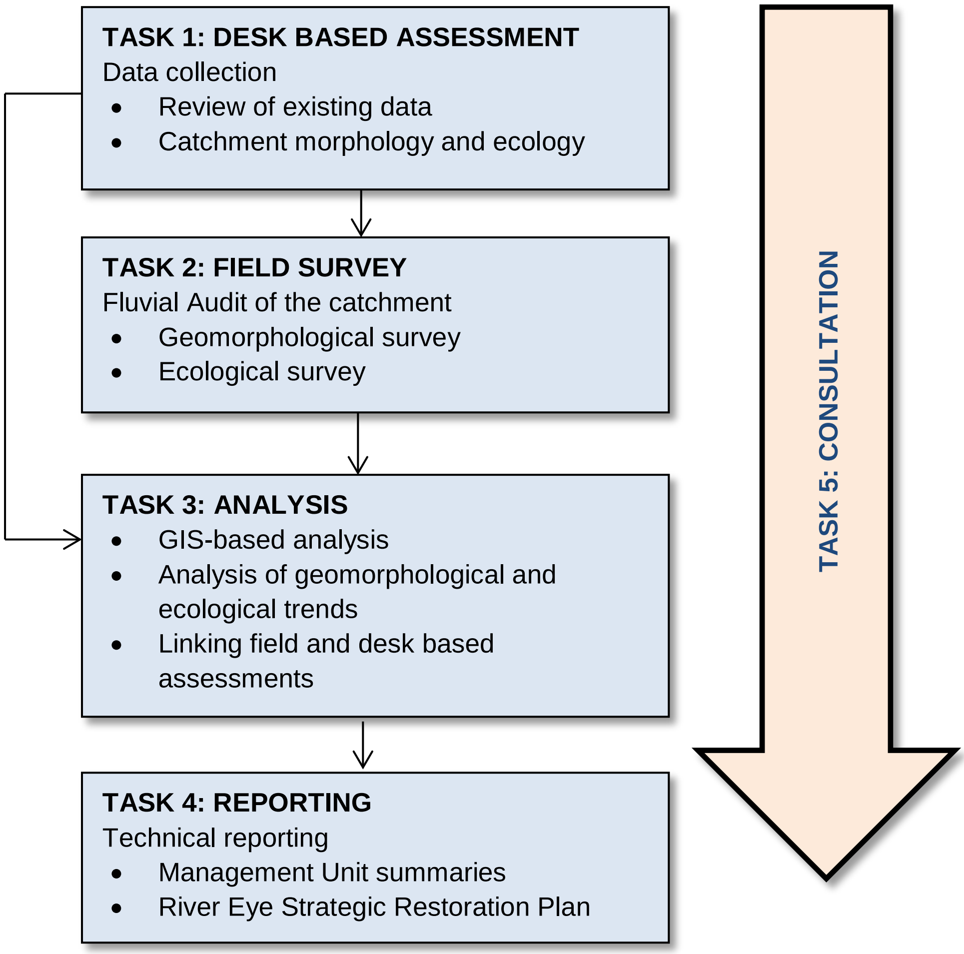
3.1 Purpose of this section

This section provides a detailed description of the approach that was used to deliver this project, including the initial desk based assessment, field surveys and subsequent data analysis and interpretation.

3.2 Overview of method

The characterisation of the geomorphological behaviour of the River Eye has followed a standardised and well-established method of gathering relevant desk and field-based data, based on the principles of a Fluvial Audit. The River Eye fluvial audit comprises four main tasks, which are outlined in **Figure 3.1.** Details of the approach used to complete each task are provided in the subsequent sections. In addition, consultation with landowners and land managers is also undertaken as a parallel task alongside the fluvial audit. This is a crucial part of the strategic restoration planning process, and is used to provide additional information and inform the development of restoration options.

Figure 3.1: Overview of the Fluvial Audit process



3.3 Study area

The development of a restoration plan for the River Eye SSSI is based on a review of available data for the entire river catchment, since processes in any given reach of a river are influenced by those that operate elsewhere in the catchment (i.e. upstream and, to some extent, downstream). The field elements of this investigation are focussed on the River Eye SSSI between Ham Bridge and Brentingby Junction, with a new survey of the upper and middle parts of the SSSI undertaken specifically for this project. This complements earlier surveys undertaken at the downstream end of the SSSI (see **Section 3.5** for further information).

3.4 Desk based assessment

3.4.1 Data collation

All available data on the River Eye catchment were provided by Natural England and the Environment Agency. This data can be grouped into three main categories **(Table 3.1).** All data were logged on receipt to form a master data register. Where appropriate, all spatially-referenced data were incorporated into a Geographic Information System (GIS) so that spatial trends could be analysed.

An overview of the condition of the River Eye SSSI was obtained using Natural England's website (https://designatedsites.naturalengland.org.uk/), supplemented by detailed condition assessment reports provided directly by Natural England (Natural England, 2010b).

Table 3.1: Data analysed during the desk-based assessment

Data	Description
Empirical data	• Current and historical mapping. • Aerial photography. • Geomorphological and ecological survey data.
Existing reports	• River Trent Catchment Flood Management Plan – Environment Agency, 2010. • Development of an ecologically based vision for the River Mease SAC and River Eye SSSI – Natural England, 2010a. Report produced by APEM on behalf of Natural England. • Common Standards Monitoring Condition Assessment of River Eye SSSI - Natural England, 2010b. • River Eye SSSI Diffuse Water Pollution Plan - Natural England, 2012. • Additional unpublished data from the Natural England Catchment Sensitive Farming Officer in support of the DWPP, including phosphate source identification and apportionment information. • Site specific targets and definitions of favourable condition for designated features of interest, River Eye – Natural England 2011. • Weir Removal Feasibility Study for the River Eye SSSI – Natural England, 2012. Report produced by Royal HaskoningDHV on behalf of Natural England. • Soar Abstraction licensing strategy – Environment Agency, 2013. • River Eye SSSI An assessment of the impacts of weir modifications - Natural England 2013. Report produced by JBA on behalf of Natural England. • Seddon, E. L., Wood, P. J., Mainstone, C. P., Greenwood, M. T. and Howard, L. C. (2011) The Use of Palaeoecological Techniques to Identify Reference Conditions for River Conservation Management. *IN: Boon, P. and Raven, P. (Eds) (2012) River Conservation and Management. John Wiley & Sons*.

3.4.2 Review of existing data

The available data were reviewed and analysed in order to determine:

- Key ecological interest features of the River Eye SSSI and their physical habitat requirements.
- The present hydrological and flow regime in the River Eye and the major factors that influence its function.
- The current sediment regime and how it is influenced by geomorphological and ecological factors.
- Where data is available, analysis of past geomorphological conditions and how these have changed through time.
- The relation between the baseline elements of the River Eye and site-specific targets for favourable condition in the River Eye SSSI.

The main methods used to undertake the desk-based assessment were:

- Initial review of existing reports to extract relevant information relating to the objectives listed above.
- GIS-based analysis of aerial photography, map data and key structures to identify the key geomorphological characteristics of the river channel, tributaries and surrounding floodplain.
- Historical trend analysis: Ordnance Survey First Edition Maps were compared with current map sources and contemporary land use records to identify changes in channel planform, land use, and sediment supply.

The results of the desk-based assessment are presented in **Section 4** of this report, which detail the baseline geomorphology, ecology, and key geomorphological issues for ecology, respectively.

3.5 Field survey

3.5.1 Field survey sheet development

The field survey sheet used for the River Eye Fluvial Audit was developed in consultation with Natural England and the Environment Agency. The sheet was based on an established approach previously used for catchment-scale fluvial audits for the River Derwent, River Hull and River Frome SSSI Restoration Plans.

The existing survey sheet was modified to incorporate recording of additional geomorphological and ecological parameters relevant to favourable condition of the River Eye SSSI. This included habitat features of specific relevance to the interest features of the SSSI. Other parameters were removed as they were less applicable to the river type. Additional sections were also added to facilitate initial assessment of the links between geomorphology and ecology on site, together with potential river rehabilitation measures.

3.5.2 Geomorphological and ecological survey

The field survey of the catchment (undertaken in August 2013) included a walkover survey of the SSSI between Ham Bridge and Brentingby Junction (approximately 5.3km in length, which constitutes 70% of the total SSSI length). During the survey, visual observations of key geomorphological and ecological parameters were recorded from the top of the banks. The survey did not involve intrusive investigations or in-channel surveys.

Key geomorphological and ecological parameters were recorded at 35 “checkpoints”. At every change of hydromorphological character in the river, flow type, bed and bank material, channel geometry, sediment dynamics and vegetation character were recorded. Assessment of differences in these parameters was used to highlight spatial trends throughout the SSSI. Changes to the predominant geomorphological, ecological and land use characteristics of the river were then used to determine the limits of the Management Reaches.

The remainder of the SSSI, from Brentingby Junction downstream to the MARS weir complex, was surveyed by JBA Consulting in 2012 (JBA Consulting, 2013), Royal HaskoningDHV in November 2011 (Royal HaskoningDHV, 2012) and APEM in 2009 (APEM, 2010). Given the availability of recent data for this reach, it was not re-surveyed at this stage. This report is based on analysis of the data from all the three previous field surveys as well as the data from the new survey undertaken to inform this report.

The main field survey was undertaken during summer low flow conditions, and as such it is acknowledged that it may not be fully representative of channel geomorphology during higher flow conditions. However, we are confident that the predominant geomorphological characteristics of the river channel have been captured adequately to allow a robust assessment of the form and function of the watercourse and the factors which limit SSSI condition to be made (particularly given the data available from the winter survey undertaken by Royal HaskoningDHV in 2011).

3.5.3 Recording of field data

Sediment sources, sediment sinks and flow types were continuously tallied for each reach, and overall morphological parameters relating to valley form, channel geometry, and boundary conditions of the reach were recorded. Grid references for key features were recorded using a hand held GPS.

The ecological characteristics of each reach were recorded and the presence of riparian vegetation and invasive species were also noted. Key habitat requirements for SSSI interest species were also assessed along with observations as to where the channel appeared to be recovering from previous modifications.

The field data collected were based on visual observation and therefore to some extent dependant on the conditions found on the day of survey.

3.6 Data management and analysis

3.6.1 GIS development

Data gathered from the field surveys were exported and used in ArcGIS to create GIS shapefiles containing the field data collected for the surveyed length of river. The GIS data available from Natural England, generated as part of the restoration vision produced by APEM (APEM, 2010), was updated where applicable and incorporated into subsequent analysis. Where grid references of particular features were taken, additional point shapefiles were created.

3.6.2 Classification of river management reaches

The SSSI unit boundaries were found to not fully reflect the specific geomorphological, ecological, land use and topographic regimes within the SSSI. Therefore, the physical characteristics observed during the field surveys were used to divide the study area into distinctive management reaches. A total of eight individual management reaches, numbered sequentially from 1 to 8, form the basis of the Strategic Restoration Plan and the analysis presented in this report. Management Reaches 1 to 6 were surveyed under the current field survey while Reaches 7 and 8 were informed by the data collected from the earlier studies undertaken in the catchment (APEM, 2012; Royal HaskoningDHV, 2012; JBA Consulting, 2013). The limits of each management reach are displayed in **Figure 2.1.** It should be noted that the management reaches are a sub-division of the single WFD water body that makes up the SSSI.

3.6.3 Analysis of spatial trends

Spatial patterns in the data were identified through detailed GIS analysis. Geomorphological and ecological data were considered together so that potential linkages and inter-relationships could be identified. The GIS-based data were also used to assist in the identification of the primary geomorphological and ecological issues that affect the condition of the SSSI within each of the management reaches. The results of the field survey and subsequent analysis are presented in **Sections 5 and 6,** although other chapters may also contain field observation information to complement available literature.

3.7 Results and analysis

The results of the previous three stages are presented in the subsequent sections of this report. Potential restoration actions are detailed in the accompanying **River Eye SSSI Strategic Restoration Plan.**

3.8 Consultation

Consultation is an important part of developing potential restoration actions for the river. Details of the consultation process can be found in the **River Eye SSSI Strategic Restoration Plan.** Draft copies of both the River Eye SSSI Technical Report (i.e. this report) and the River Eye SSSI Strategic Restoration Plan were issued to landowners/land managers in December 2013 to request feedback and comments on the proposals. These consultees included:

- National Farmers Union.
- Countryside Landowners Association.
- Leicestershire County Council.
- Melton Borough Council.
- Trent Rivers Trust.
- Network Rail.
- Ashfordby and Melton Society of Anglers.
- River Eye Specialist Group (Angling Club).

Follow up landowner meetings were held in January 2014. Copies of the final reports will also be made available to them. Copies of both draft reports were also issued to other interested stakeholders in December 2014.

4 CATCHMENT CHARACTERISTICS

4.1 Purpose of this section

The purpose of this section is to provide an understanding of the main factors which control the development and condition of habitats within the River Eye SSSI. This includes a description of the baseline physical factors (e.g. topography and geology), hydrology, land use and physical modifications (e.g. in-channel structures and channel modifications) which combine to control the functioning of the river system and its supported habitats.

4.2 Topography and drainage network

The River Eye catchment is a lowland river system with an area of approximately 180km^2. The catchment has a typical elevation of between 70 and 80m above Ordnance Datum (AOD) **(Figure 4.1).** The river flows within a wide, flat floodplain, and with the exception of a small area downstream of Brentingby, it is largely disconnected from the valley sides.
The topography of the catchment is slightly steeper than the wider River Soar catchment which it drains into, particularly in its upper catchment where it drains the Leicestershire Wolds from a maximum elevation of approximately 200m AOD.

The topography of the area means that the River Eye catchment has a relatively dense drainage network **(Figure 4.2).** The catchment includes a number of large tributaries which drain into the main river within or upstream of the SSSI, including Burton Brook Whissendine Brook, Wymondham Brook, Langham Brook and Freeby Brook. These tributaries drain the higher ground in the upper catchment, as such are considerably steeper than the main River Eye. They are therefore likely to be a potentially significant source of sediment to the main river system, given their greater energy. This is discussed further in **Section 4.3.** Several other tributaries such as Thorpe Brook and Scalford Brook enter the channel immediately downstream of the SSSI. Further details of main tributaries classified under the WFD are included in **Section 2.5.**

In addition to the natural channels, the drainage network in the River Eye catchment has been augmented by a series of artificial drainage ditches and land drains. These are likely to have been installed to improve the drainage of agricultural land on impermeable soils and bedrock.

The topography and drainage network demonstrate that, although the main River Eye is a lowland system which flows in a relatively flat floodplain, the upper reaches of the river and its main tributaries drain higher ground with much steeper slopes. These areas are likely to respond to rainfall events much more rapidly that the main river. When combined with the locally steeper slopes, this means that the headwaters of the River Eye and its tributaries are likely to have increased energy and will therefore cause greater amounts of sediment erosion and transport in comparison to the lower energy reaches further downstream. The presence of artificial land drains helps to further increase the hydrological responsiveness of the catchment and increases the connectivity between the drainage network and surrounding land.

Figure 4.1: Topography of the River Eye and the wider Trent catchment

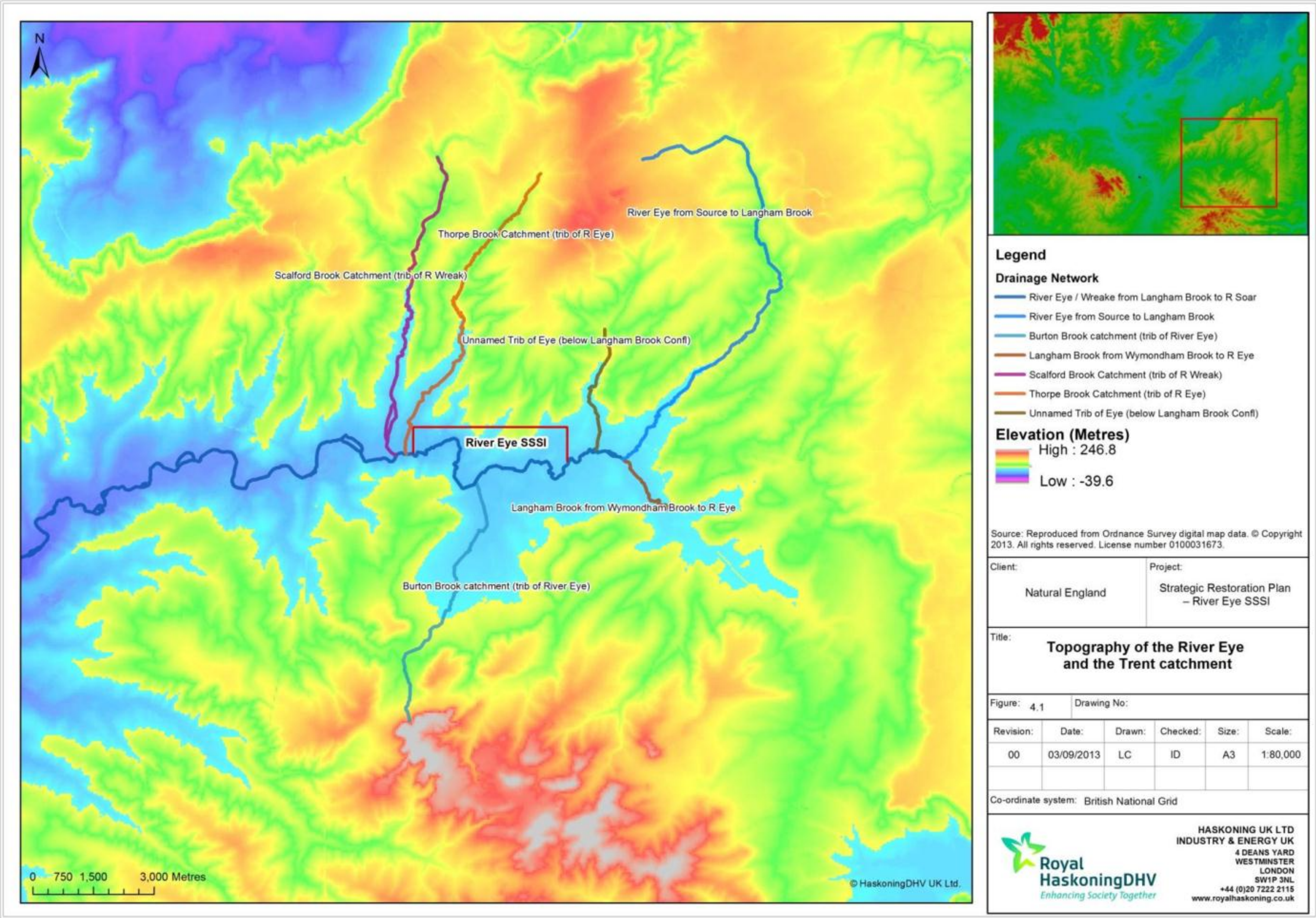
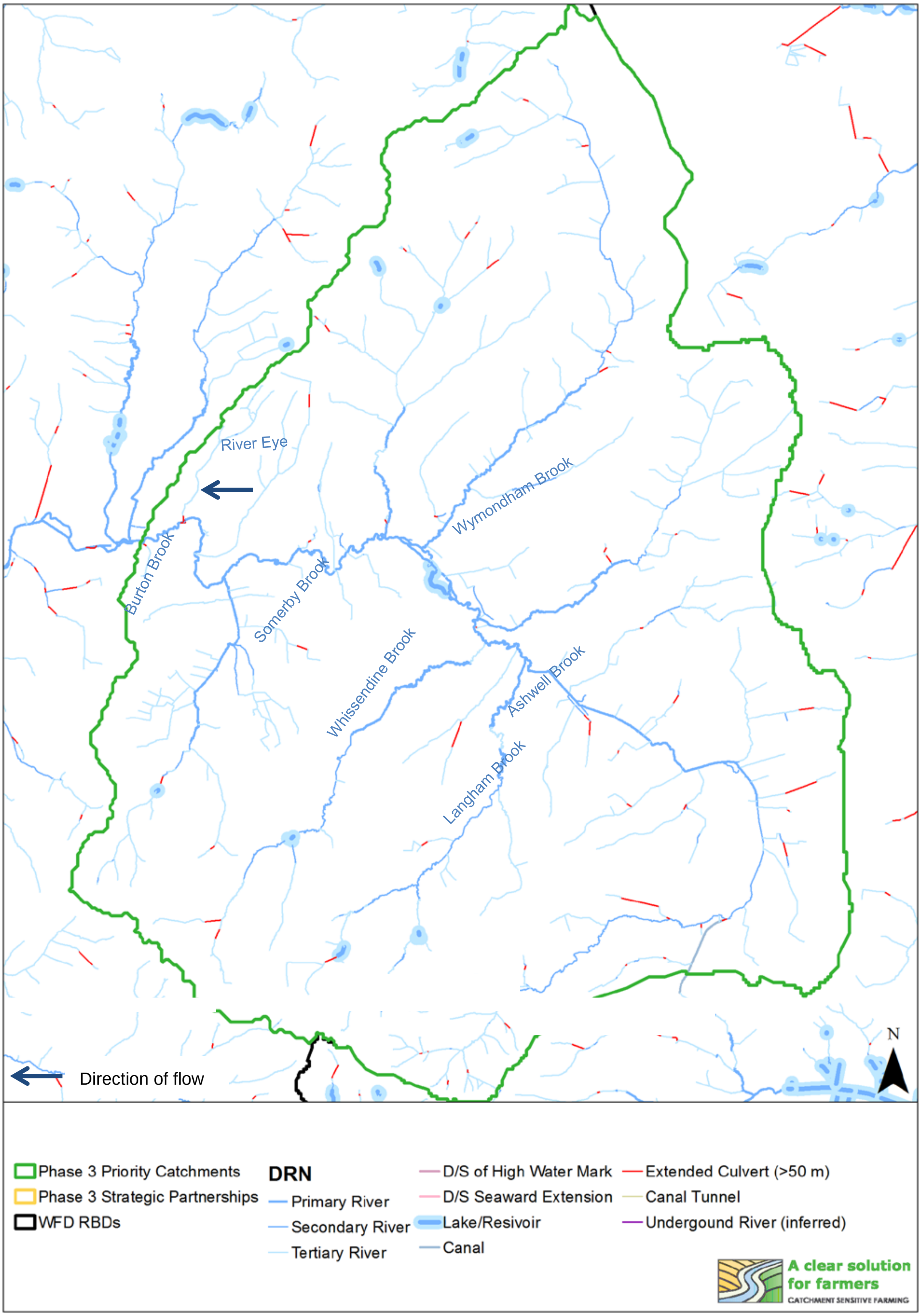


Figure 4.2: River Eye drainage network (after Natural England CSF initiative, undated)



4.3 Geology and soils

4.3.1 Bedrock geology

The underlying bedrock geology is comprised of Blue Lias Formation Mudstone, which is formed of predominantly siliclastic mud, silt, sand and gravel, with small amounts of limestone (British Geological Society, undated). Immediately surrounding this bedrock to the north, east and south is Charmouth Mudstone formation, another fine grained sedimentary bedrock which was also formed during the Jurassic period (British Geological Society, undated).

The underlying bedrock in the catchment suggests that sediment supply to the river will be dominated by fine-grained material such as silts and clays. However, the presence of gravels in the Blue Lias Formation suggests that there may be a natural supply of coarser material to the river.

The main river appears to be largely isolated from the solid bedrock by the presence of superficial deposits in the valleys of the main river and its tributaries. This means that direct erosion of material from bedrock as a result of fluvial action is unlikely to be a significant source of sediment. However, hillslope erosion processes operating on valley slopes **(cf. Section 4.2)** present a potential pathway for the transfer of coarse and fine sediment from bedrock sources into the drainage network.

4.3.2 Superficial geology

The River Eye flows over a superficial deposit of alluvium, which consists of clay, silt, sand and gravel. The alluvium was formed during the Quaternary Period, where sand and gravel detrital material deposited in the channel formed river terrace deposits and fine silt and clay from overbank floods formed floodplain alluvium (British Geological Society, undated). There is a layer of head which is located immediately below the surficial alluvium. These deposits, which were also formed during the Quaternary Period, consist of clays, silts, sands and gravels. The head is most frequently observed in the headwater tributary system, in smaller channels where alluvium has not developed.

These alluvium and head deposits separate the river from the glacial diamicton which dominates most of the catchment. This is comprised of rock fragments with lenses of gravel, sand, silt and clay (British Geological Survey, undated).

The superficial deposits are dominated by clays and silts, which suggests that fine grained sediments are likely to be naturally dominant in the river system. However, the presence of gravels and coarser material in the alluvium, head and diamicton suggest that coarser material can be sourced by natural fluvial erosion.

The River Eye and its tributaries flow directly over the superficial deposits which are located at the base of the valley network. This means that these deposits are likely to be a direct source of both fine and, in the case of the tributaries, coarse sediment into the river channel as a result of fluvial erosional processes. The alluvium and head deposits are subject to direct fluvial erosion and as such are likely to be significant natural sources of sediment into the river system. In particular, the head deposits that are exposed in higher energy upstream tributaries such as Whissendine Brook and Wymondham Brook are likely to be subject to proportionally greater fluvial scour than the deposits which underlie the main river further downstream, and as such are likely to be a continuing source of coarse sediment to the SSSI river system **(cf. Section 4.2).** The diamicton is generally isolated from direct fluvial action, but as with the underlying bedrock, it is likely that it can provide sediment to the river network through hillslope erosion processes.

4.3.3 Soils

The general character of the soils across the catchment is associated with the prevalence of seasonally wet clay. A belt of loamy and clayey floodplain soils adjoins the river along its length. This is predominantly surrounded by slowly permeable seasonally wet slightly acidic but base-rich loamy and clayey soils. The soils reflect the composition of the bedrock and superficial geology, and as such are dominated by fine grained sediments.

The soils are likely to provide a plentiful source of fine grained sediments into the river system through hillslope erosion in the upper parts of the catchment **(cf. Section 4.2)** and particle entrainment by surface runoff in parts of the catchment with a lower elevation.

4.4 Hydrology and hydrogeology

Data included in the River Eye SSSI Diffuse Water Pollution Plan (Natural England, 2012a) characterises the River Eye catchment as "very flashy with high run off characteristics and is quick to respond to rainfall events", particularly under scenarios of high soil moisture saturation and during summer rainfall events, given low soil porosity associated with "capped" soils. This reflects the relative steepness of the upper parts of the catchment **(cf. Section 4.2),** and the lack of permeability in the underlying solid and superficial geology and soils **(cf. Section 4.3).**

In addition, hydrological data for the catchment (Environment Agency, 2010 and Natural England, 2012a) suggests that there are considerable seasonal variations, characterised by low flows during the summer and higher flows during the winter when rainfall is higher and the ground is more saturated. This is consistent with a small flashy catchment with rapid runoff characteristics.

Observations during the field survey were consistent with low levels of energy expected during low flows in a river dominated by a shallow channel gradient and a wide valley floor.

Data available for the River Soar Catchment Flood Management Plan (Environment Agency, 2010) characterises the geology of the River Eye as moderately permeable. However, surface permeability is limited given the abundance of loamy clay in the soil top layers. Approximately 40% of rainfall (average 650mm) is estimated to become runoff. There is therefore likely to be rapid runoff and plentiful supply of erodible fine sediments into the River Eye. The rapid runoff into the river network is exacerbated by the prevalence of drainage ditches in parts of the catchment, which were originally constructed to improve land drainage. This means that the river is well connected to the surrounding land, and that a large proportion of surface runoff enters the drainage system.

The hydrological regime of the River Eye has been further modified by the installation of flood detention measures downstream of Brentingby. Further details of this scheme are provided in **Section 4.7.6.**

4.5 Land use

The River Eye catchment is characterised by a predominance of wet pasture arable and pastoral agricultural land uses **(Figure 4.3).** Within the Leicestershire and Nottinghamshire Wolds National Character Area (NCA), the majority of holdings are cereal growing and grazing for livestock which represent 30% and 27% of the agricultural sector respectively (Natural England, 2012). Agricultural land uses such as these can potentially have a large impact on river sediment loads; for example, significantly disturbed land may cause an increase in sediment yield unless catchment sensitive farming approaches are used. There does not appear to be a clear relationship between topography and land use, which is likely to reflect the general lowland characteristics of the catchment. There are no large scale urban or industrial areas within the SSSI, although the town of Melton Mowbray is located at the downstream end. The upper catchment contains several large villages and numerous smaller settlements.

4.6 Historic landscape

There is limited evidence of prehistoric activity in the region, although a potential occupation site has been discovered towards the north of the Belvoir escarpment and a significant Iron Age occupation has been found in the Knipton Valley (Natural England, 2012). The Fosse Way of the Roman period that cuts across the western edge of the Leicestershire and Nottinghamshire Wolds National Character Area (NCA), today the A46, is still a prominent feature of the landscape (Natural England, 2012).

The medieval landscape is likely to have been dominated by intermittent woodland within large areas of rough pasture. This landscape progressively became dominated by small villages surrounded by open fields, and tree cover declined as the population grew. In the 14^{th} Century, many of these villages were deserted, leading to a sparsely-populated landscape dominated by sheep grazing. In the post-medieval period, Melton Mowbray developed into a substantial market town (Natural England, 2012).

As agricultural cultivation began to increase in the late 18th and early 19th Centuries many farmsteads were rebuilt, leading to large scale arable cultivation in the 19th and 20th Centuries. Industrialisation was furthered by the development of ironstone and gypsum quarries and deep coal-mines at Asfordby. The legacy of this activity, such as spoil heaps and disused pits are now widely characterised by a complex mosaic of grassland, scrub and woodland vegetation (Natural England, 2012). The Melton to Oakham Canal, constructed between 1793 and 1802 (Tew, 1984), aided the transportation of coal (see **Section 4.7** for further information on the canal).

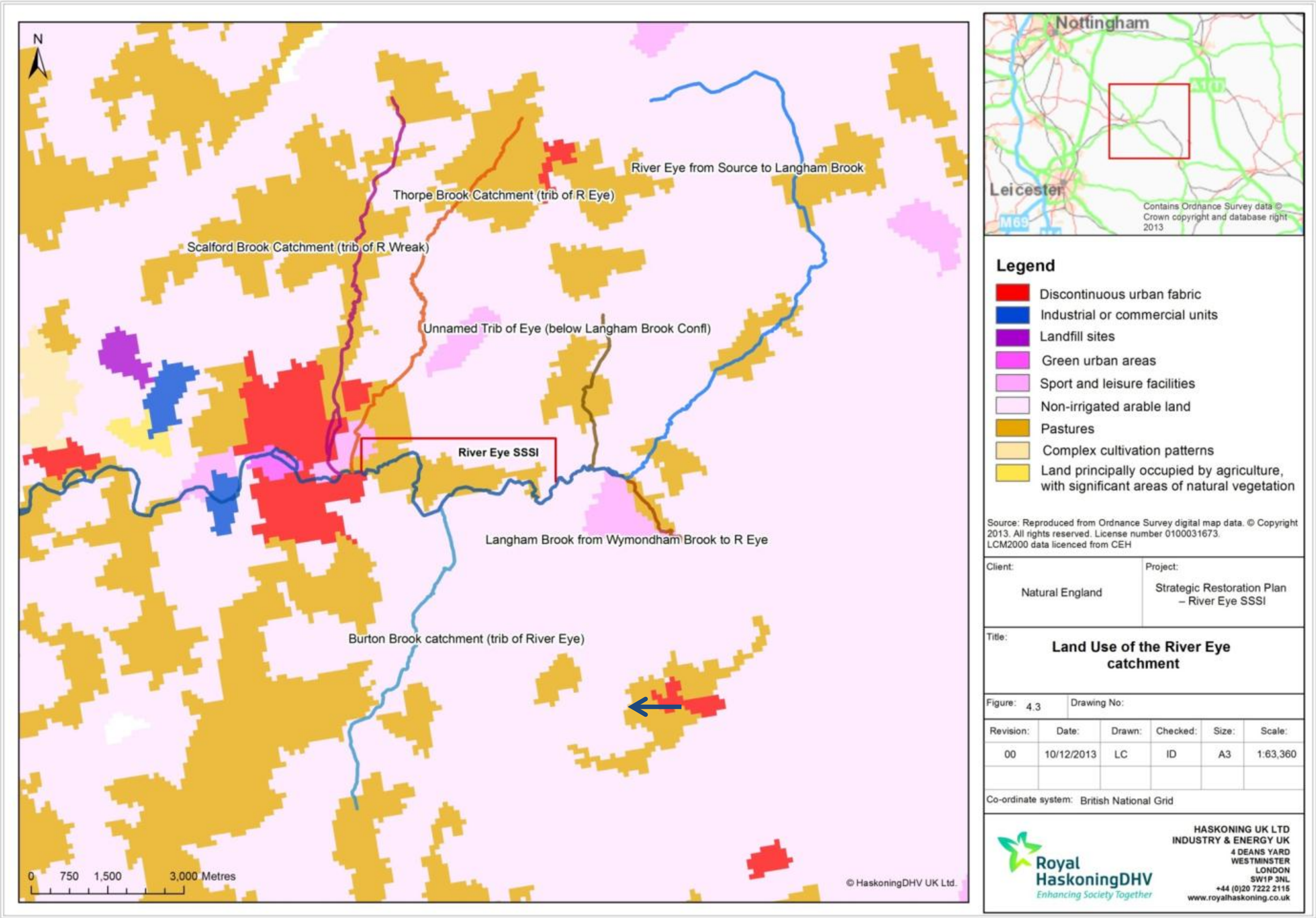
Large areas of grassland were ploughed up following food shortages after the Second World War. This trend of intensive farming practices continued after the adoption of the Common Agricultural Policy and led to a dramatic change in the landscape and a resultant loss of biodiversity (Natural England, 2012).

Current landscape character

The Leicestershire and Nottinghamshire Wolds National Character Area (NCA) states the following aspects as key features in the current character of the area:

- A range of rolling hills, with elevated plateaux, narrow river valleys and distinctive scarp slopes.
- Jurassic mudstones (towards the west), limestone, sandstone and ironstone overlain by glacial till throughout much of the area.
- Sparse woodland cover, except for some wooded scarps and in the Wreake Valley and adjacent to Rutland Water. Elsewhere, spinneys, fox coverts, hedgerows, hedgerow trees and streamside trees provide moderate cover.
- Agricultural land use dominates with arable farming on the plateaux tops and pasture on steep sloping valley sides.
- Agricultural land use has diminished semi-natural habitat although important habitats do remain, including species rich neutral grasslands, wet meadows, parkland, reservoirs, rivers and streams.
- The centrally elevated Wolds form a watershed between the rivers Wreake, Soar and Trent, draining streams downwards in a radial pattern to each of these rivers, which together with Rutland Water, provide significant biodiversity and recreation assets.
- The establishment of Rutland Water reservoir has created a major wetland of international importance for water birds that combines open water, lagoons, islands, mudflats, reed swamp, marsh, old meadows, pastures, scrub and mature woodland.
- Evidence of many deserted and shrunken settlements, as well as extensive areas of ridge and furrow separate small villages and farms linked by country lanes with wide verges.
- Red brick buildings with pantile roofs are widespread and most abundant clustered around churches, which are constructed from ironstone and limestone contributing to the local vernacular.
- Urban influences include overhead lines, mineral extraction sites, airfields and the busy A46 and A60 although these do not weaken the rural character.

Figure 4.3: Land Use of the River Eye catchment



Today the rural landscape retains a mixed land use **(see Figure 4.3),** although there is an increasing trend of agricultural production that is resulting in a loss of hedgerows and hedgerow trees and damaging areas of ridge and furrow and other earthworks. Despite having limited expansion of the settlements in the recent years, there has been a proliferation of new, large scale agricultural buildings. Recent road improvements to the A46 have impacted the wider countryside, but have provided an opportunity for roadside planting of native tree and shrub species (Natural England, 2012).

The traditional riparian character along the Wreake and Eye valleys has been eroded in part by flood protection works; however stewardship schemes now manage sections of the valley with an aim to combine flood management with environmental protection and enhancement (Natural England, 2012).

A review of the Heritage Gateway (http://www.heritagegateway.org.uk) and the Multi-Agency Geographic Information for the Countryside (MAGIC) websites (www.magic.gov.uk) identified several historic finds within the vicinity of the River Eye. These sites of historic interest are presented in **Table 4.1** and **Figure 4.4.** This demonstrates that, although there are a significant number of archaeological remains in the catchment, the majority of these are not located on the river floodplain. Those that are located in the vicinity of the river are generally small artefacts rather than significant archaeological remains. They are therefore unlikely to pose a significant constraint to any river restoration measures identified for the SSSI, although care will need to be taken to ensure that potential archaeological constraints are considered in more detail when detailed restoration measures are developed.

Table 4.1: Finds of historic interest near the River Eye SSSI

Map reference	Monument Type	Grid reference	Summary
1	Roman coin found at 16 Willoughby Close	SK 760 187	In 1978, a Roman coin of Magnentius (350-3) was found in a private garden.
2	Worked flint and Iron Age pottery found on land adjacent to Lag Lane	SK 772 186	A sherd of Iron Age pottery and several pieces of worked flint including two cores, five flakes and one retouched flake, but no features, were found during an evaluation in 2001.
3	Mesolithic and worked flint from the embankment site and from the Haul Road	SK 776 186	Excavation in 2001/2 recorded a shallow linear feature running north-east to south-west, downstream to the river valley. 12 sherds of handmade pottery and worked flint were recovered from the feature, and a large amount of unstratified flint material representing Mesolithic activity. Also, unstratified scatter of flints dating from both the Mesolithic and the late Neolithic/early Bronze Age were found.
4	Crop marks west of New Covert	SK 771 180	Double ditch crop marks leading down towards the River Eye, with a sub-circular enclosure to one side.
5	Crop marks north of Gravel Hole Spinney	SK 783 183	Crop marks of a rectangular enclosure, c.70m square, with other smaller features nearby.
6	Medieval village earthworks at Brentingby and Brentingby historic settlement core	SK 783 187	West, south and east of Brentingby Hall are earthworks, probably of old village closes. When the manor of Brentingby was purchased in 1318 it included a windmill, which is not shown on any known maps. Also, medieval and post-medieval pottery was recovered from an 'old kitchen garden' (exact location unknown).
7	Former Church of St. Mary, Roman pottery from St. Mary's Church, and Possible garden features at Hall Farm	SK 784 187	Brentingy Chapel was a small C14th building with a saddle-back tower topped by a spirelet and a simple aisleless nave whose east wall is dated 1660. In 1979 it was converted although the tower remained in church ownership. Three sherds of Roman pottery were found during small scale excavation in advance of conversion works in 1972. A watching brief in 2012 recorded the shallow stone footing for a wall associated with a layer of building rubble and the remains of a cobbled path to its east.

Map reference	Monument Type	Grid reference	Summary
8	Medieval village earthworks south of Wyfordby Church	SK 791 187	Old village closes, hollow ways etc. survive as earthworks representing the shrunken medieval village.
9	Bronze Age/Iron Age remains, Mesolithic flint, and Roman pottery south of Wyfordby	SK 793 187	Excavation in 2001/2 recorded a curvilinear gully 7-8m in diameter - a possible roundhouse. Late Bronze Age/early Iron Age pottery was also recovered, along with a quantity of Mesolithic flint and 11 sherds of Roman pottery.
10	Roman pottery found at Phase II Flood Alleviation Scheme near Melton	SK 796 187	During a watching brief in 2000, two sherds of Roman pottery and fragments of animal bone were found in the spoil of a trial pit with very deep topsoil.

Figure 4.4: Finds of historic interest close to the River Eye

Direction of flow

4.7 Channel modifications

4.7.1 Historical planform change

Historical planform change throughout the area of the River Eye SSSI has been very limited over the last century. Analysis of historical OS mapping (1887-1890 and 1930) has indicated no significant changes associated with realignment or straightening of the channel **(Figure 4.5).** Areas of local channel adjustment have been identified in the outer bends of meanders downstream of Brentingby Dam (cf. JBA, 2013) but the general planform has remained stable.

Although there is very little evidence of significant changes to the river channel planform between 1887 and the present day, the channel has been modified through the construction of artificial land drains in parts of the catchment. These have helped to increase the connectivity between the river system and surrounding floodplain. Further details are found in **Section 4.2.**

4.7.2 Historical modifications to channel cross section

Both the desk-based assessment and the previous field surveys have demonstrated that there have been considerable changes in the channel and the bank profile in the River Eye SSSI. This enlargement in the channel's capacity in many reaches may be attributable to dredging activities. Confirmed instances of channel dredging within the SSSI are limited to the vicinity of Ham Bridge (C. Mainstone & S. Hobson, *pers. comm.*, cited in APEM, 2010), although it is also reported to be undertaken adjacent to the abstraction point in Scalford Brook (JBA Consulting, 2013).

Furthermore, considerable modifications to the River Eye are recorded to have taken place during the construction of the Melton to Oakham Canal between 1793 and 1802 (Tew, 1984). Unlike the River Wreake downstream, the River Eye was never directly modified to allow navigation to take place in the channel. However, the river was diverted into a culvert beneath the new canal at Saxby (upstream of the SSSI), as was Wymondham Brook at Wymondham (Tew, 1984).

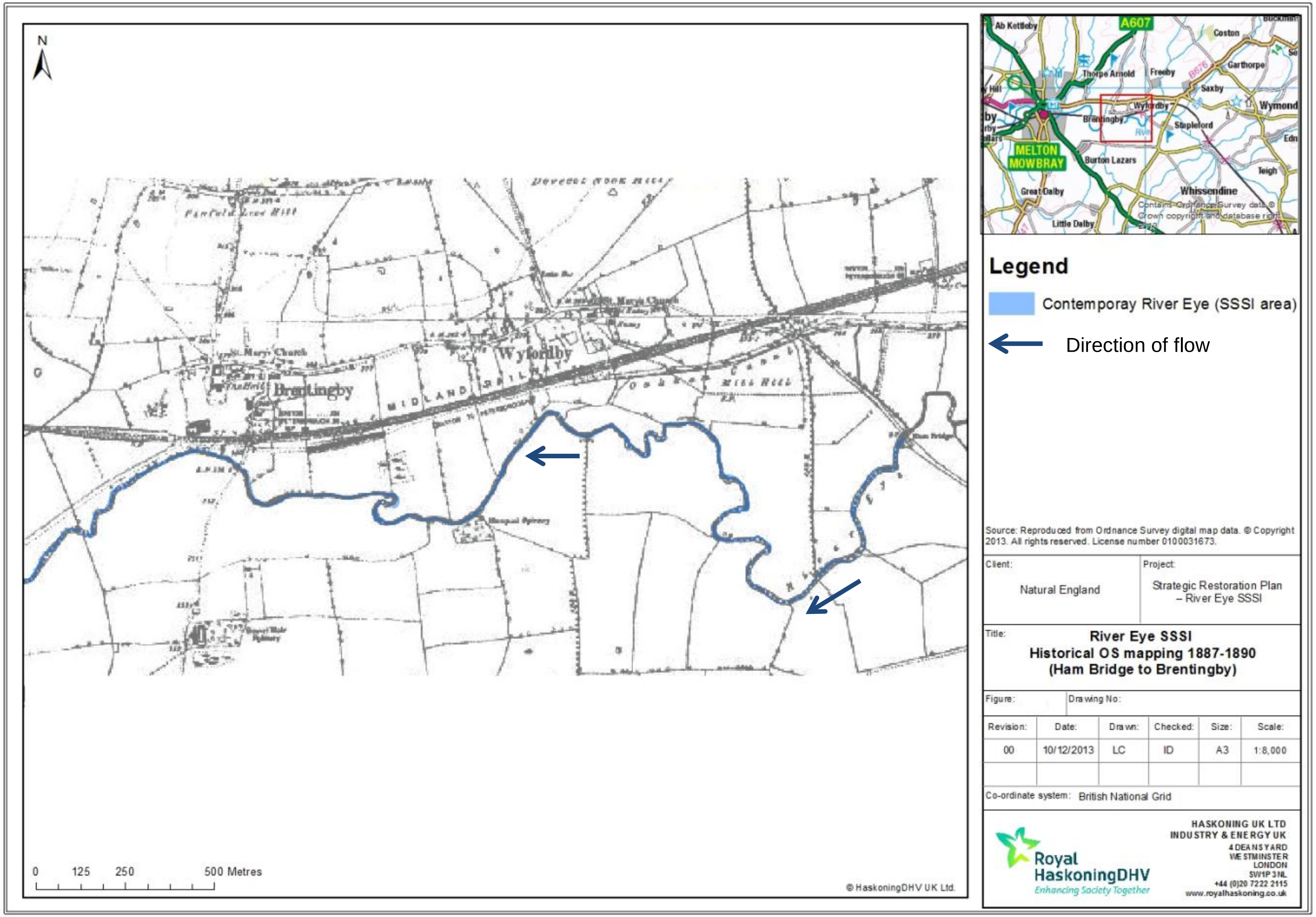
There was rarely sufficient water for the canal when it was completed, and the canal was regularly dredged during the 1830s in an attempt to maintain capacity (Tew, 1984). In addition, modifications to the river channel were undertaken in an attempt to increase conveyance through the river in order to increase the supply of water to the canal during dry summer periods. The canal was ultimately commercially unsuccessful, leading to its closure in 1847 (Tew, 1984). No further modifications were undertaken to improve navigation after this time.

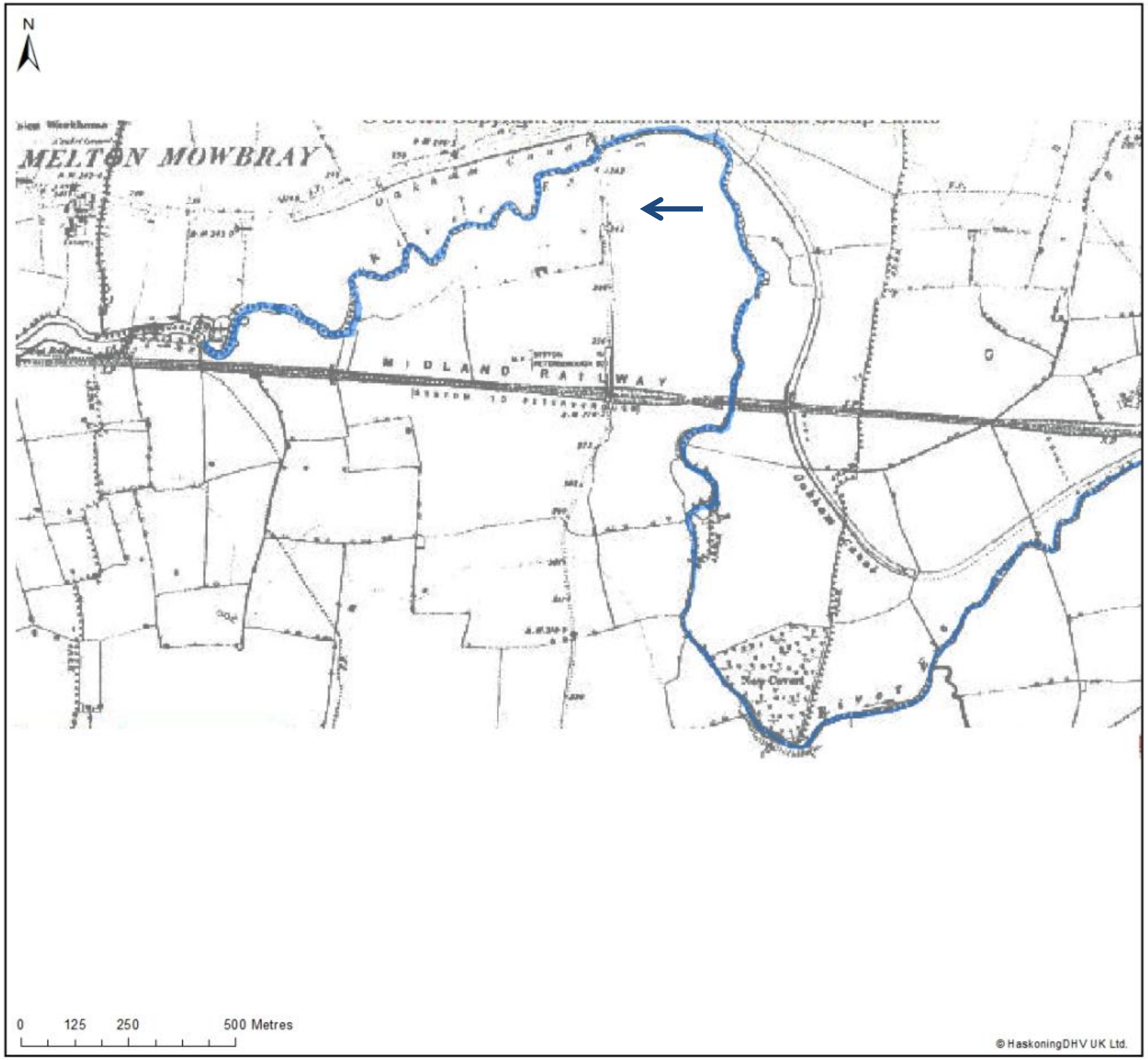
It may also be possible that channel capacity has enlarged as a result of the erosive pressures of frequent high flow events creating incision rather than lateral channel adjustment. This is likely to have occurred over long time periods, and could be strongly influenced by the increased connectivity between the catchment and river network as a result of the creation of artificial drainage channels **(cf. Section 4.2),** and likely long-term land use changes associated with deforestation and a corresponding increase in agriculture **(cf. Section 4.10).** The lack of marginal deposits in along the majority of the SSSI suggests that any material eroded as a result of long-term natural channel evolution in response to man's influence on catchment hydrology and land use has been transported and deposited downstream. This process is likely to have occurred to some extent, and may have exacerbated the impacts of dredging if it is found to have occurred.

Although the relative importance of the different mechanisms cannot be differentiated, it is clear that there is widespread disconnection from the floodplain and abrupt transitions between the aquatic and terrestrial environment in response to direct channel modifications and indirect responses to anthropogenic changes to the catchment. Significant sections of the SSSI display evidence of an enlarged channel, resulting in abrupt separation between the channel and the riparian zone. Although there are no recent cross sectional data available for the majority of the SSSI, a survey undertaken in 1993 (on behalf of the National Rivers Authority in January 1993) clearly demonstrates that the channel does not support a natural gradual transition between aquatic and terrestrial habitats **(Figure 4.6).** Although these cross sections pre-date the construction of the flood alleviation scheme at Brentingby Junction, the channel does not appear to have changes significantly (with the exception of increased geomorphological activity downstream of the flood alleviation scheme; **(cf.**

Section 4.7.7). Channel enlargement is, therefore, likely to be a significant control over the geomorphological and ecological dynamics of the SSSI.

Figure 4.5a and 4.5b: Historical planform change in the River Eye SSSI (based on OS mapping 1897-1890)





Legend

Contemporay River Eye (SSSI area)

Direction of flow

Client: Natural England

Project: Strategic Restoration Plan – River Eye SSSI

Title: **River Eye SSSI**
Historical OS mapping 1887-1890
(Brentingby to Melton Mowbray)

Figure: | Drawing No:

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
00	10/12/2013	LC	ID	A3	1:8,000

Co-ordinate system: British National Grid

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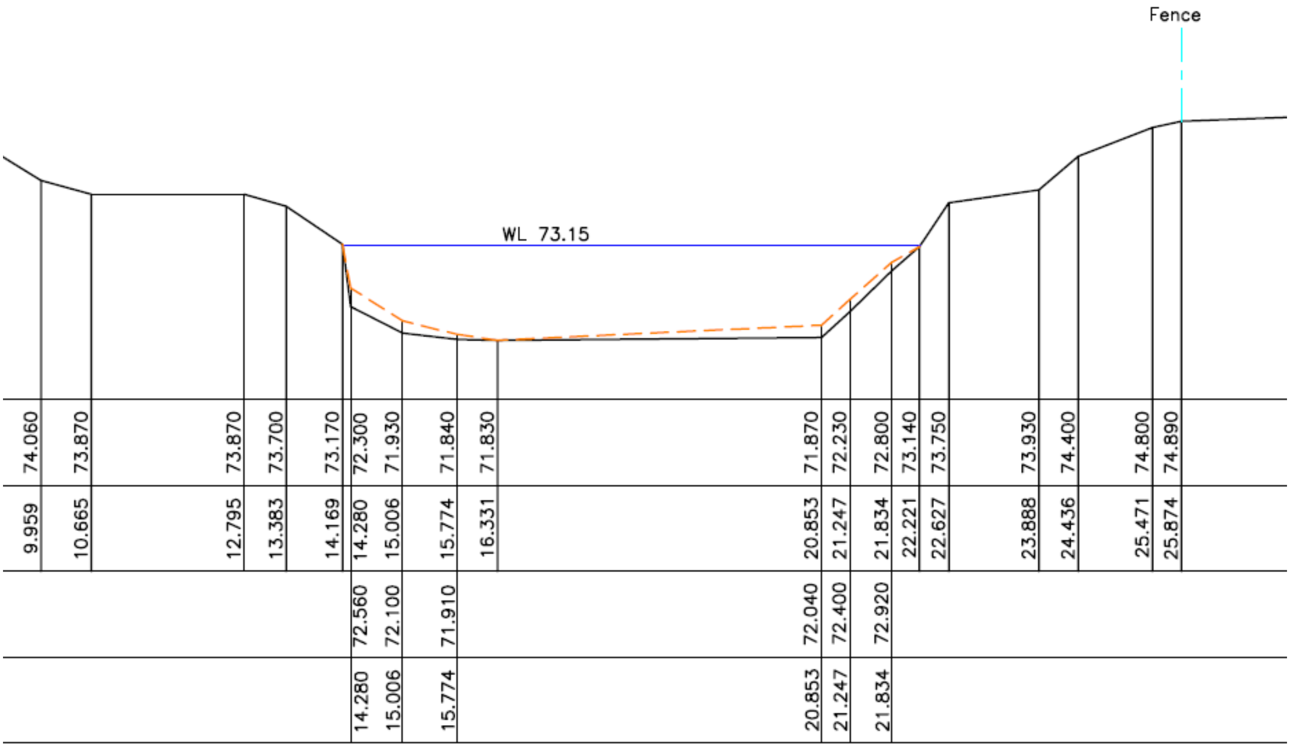
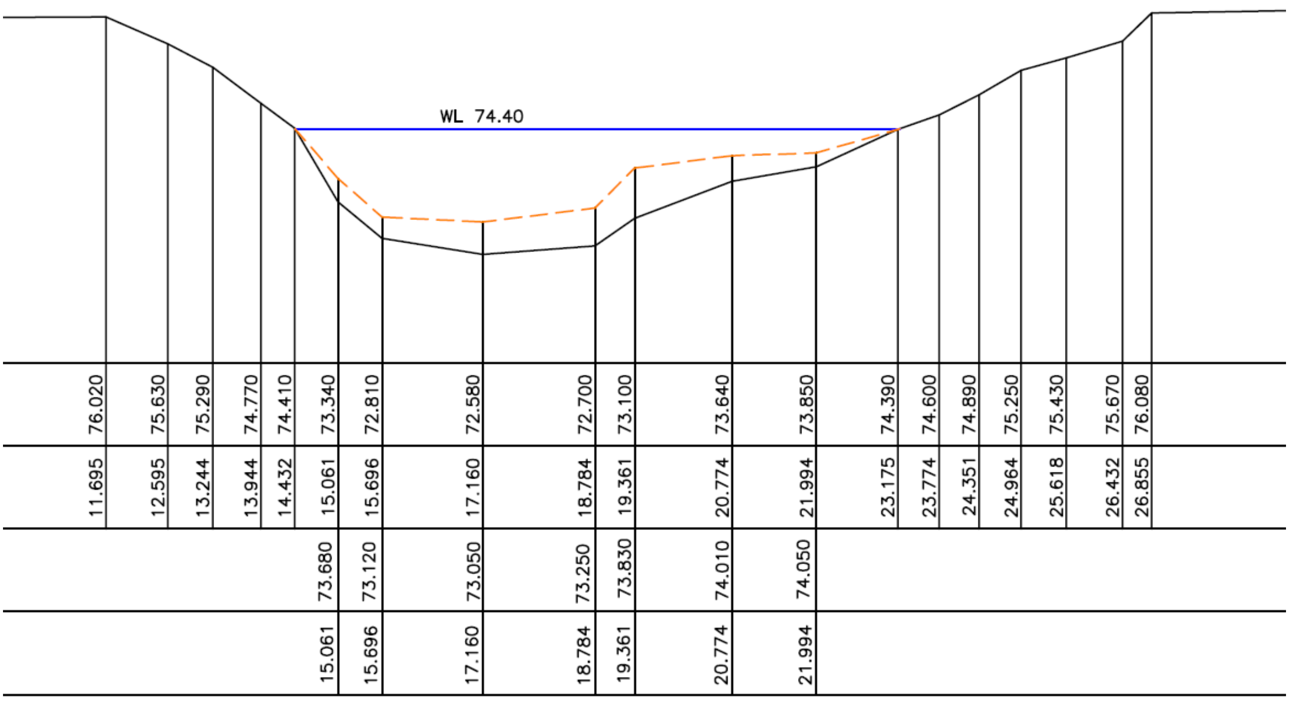
Figure 4.6: Typical cross section of the River Eye (survey undertaken for the National Rivers Authority, January 1993)

a) Cross section of the River Eye downstream of Lag Lane



b) Cross section of the River Eye downstream of Ham Bridge



Note that the dotted line denotes soft bed level and the solid line denotes hard bed level. Considerable bed sedimentation can be observed in cross section (b).

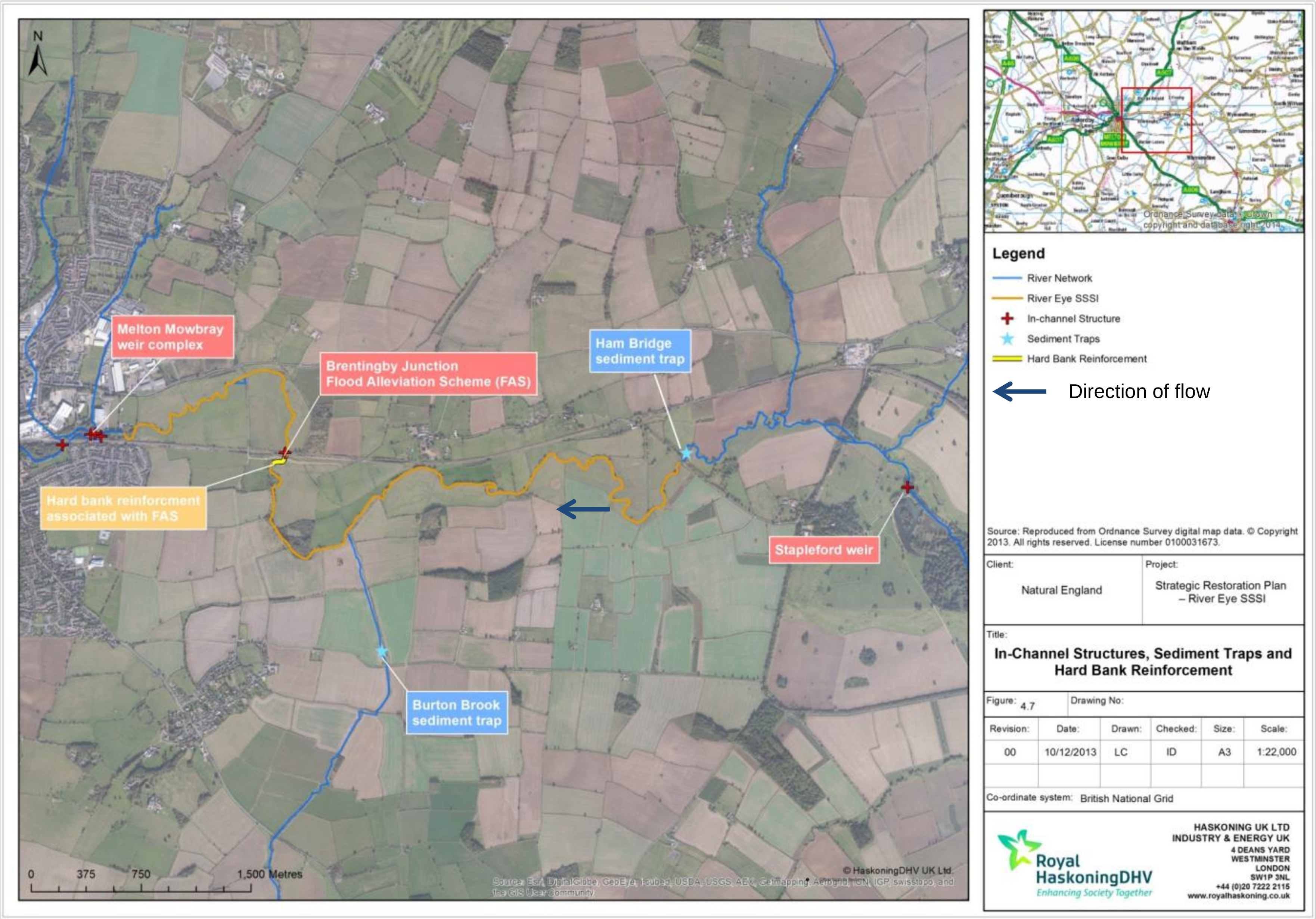
4.7.3 In-channel structures

The only structures within the SSSI are the short culverted section at Brentingby Junction (associated with the railway bridge and the Melton Mowbray Flood Alleviation Scheme (FAS); see **Section 4.7.6**), one road and pipe crossing at Lag Lane and the Ham Bridge road crossing at the upstream limit of the SSSI (APEM, 2010) **(Figure 4.7).** While the pipe road crossings have not been observed to impose significant controls over the SSSI interest features, the structures associated with the Melton Mowbray FAS (i.e. culverts, undershot sluice gates and weir) have the potential to significantly impound flows during flood events thus impacting the geomorphology, in-stream biology, and riparian and terrestrial ecology of the River Eye SSSI. The restriction in flows caused by the sluices may also reduce the conveyance of coarse sediment to downstream reaches, although no accumulations of gravel were observed upstream of these structures at the time of the walkover survey.

Downstream of the SSSI limits, at the confluence of the River Eye and Scalford Brook, a set of four structures which pre-date historical OS mapping raise water levels to provide a depth and storage volume to enable abstraction for industrial purposes. Water is currently abstracted at the Mars Petcare UK Ltd factory, which is located at the site of a previous industrial unit which would also have required river water (a sewing-thread mill). Impoundment associated with this complex of structures was observed until over 1km upstream of the SSSI downstream boundary (approximately 1.2km upstream of the first impounding weir structure, representing approximately 15% of total SSSI length) (JBA Consulting, 2013). Given the extent of impoundment and the size of in-channel barriers, these are considered to significantly impact the flow and sediment regimes as well as the passage of fish and aquatic invertebrates. Therefore, the historical construction of in-structures downstream of the SSSI limit is considered to be a significant control over the geomorphology and ecology of the downstream sections of the SSSI.

In addition to these structures, there is also another weir on the main River Eye channel at Stapleford. This structure is located less than 1km downstream of the confluence between the upper River Eye and the major headwater tributaries which drain the eastern parts of the catchment (with the exception of Whissendine Brook, these are unnamed on Ordnance Survey 1:25,000 scale mapping of the catchment). These tributaries are likely to be significant sources of both fine and coarse sediment into the lower catchment **(cf. Section 4.3).** Since fine sediment is predominantly transported in suspension, the weir is unlikely to be a significant permanent barrier to fine sediment supply (although it is likely to locally increase fine sedimentation as a result of upstream impoundment). However, the structure is likely to disrupt the downstream movement of coarser sediment such as gravels and cobbles, which are primarily transported as bed load. Stapleford weir may therefore reduce the supply of coarse sediment into the River Eye SSSI.

Figure 4.7: In-channel structures in the River Eye catchment



4.7.4 Sediment traps

As a result of the plentiful supply of fine sediments from the upper catchment into the River Eye SSSI, an online sediment trap was constructed in 2000, in the main river upstream of Ham Bridge. A second sediment trap was also installed on Burton Brook near Sawgate Road, a major tributary which drains the area to the south of the SSSI and drains into the main river downstream of Brentingby.

The traps consist of an area of widened channel and a small impounding structure which slows flows and encourages fine sedimentation. Fine sediment can then be removed from the traps once it has settled. Evidence from the local Environment Agency Asset Performance team (S. Pereira, *pers. comm.*) which maintain the sediment traps suggests that approximately 1500 tonnes of silt were extracted from the structure at Ham Bridge in 2011, after 10 years of operation. This was removed using excavators and spread on agricultural land. The material was reported to consist only of fine sediments. In addition, 200 tonnes of silt and 200 tonnes of vegetation were removed from the Burton Brook sediment trap in 2007; this tributary is considered to be a hot spot for sediment provision (Natural England, undated – River Eye Catchment Appraisal Refresh Proforma).

The changes in channel energy in response to the sediment traps would suggest that the structures are also likely to restrict the downstream transport of coarser sediments. However, the lack of gravels observed in the sediment traps suggests either that there has been very little coarse sediment supply from the catchment upstream of Ham Bridge since 2000 **(or earlier; cf. Section 4.7.3),** or that the majority of coarse sediment transportation occurs during flows that are sufficient to overtop the sediment trap, reducing its impact on flow velocities and shear stresses sufficiently to maintain coarse sediment transport. An area of coarse sediment erosion upstream of the sediment trap at Ham Bridge (D. Kay, *pers. comm.*) suggests that this is at least partly the case, since material eroded from this area was not recorded in the sediment trap.

4.7.5 Hard bank reinforcement

Hard bank reinforcement is present for approximately 200m of the SSSI area. This is mainly located in the vicinity of Brentingby Junction where it is associated with the Melton Mowbray FAS and railway bridge (SK774186). This represents approximately 2.5% of the total SSSI length and 0.5% of total water body length (below WFD thresholds for detailed assessment as defined in the NEAS guidance for assessing WFD compliance for new structures) and is therefore unlikely to represent a significant control over its geomorphology and ecology. Removal of hard bank reinforcement is not advanced as a potential option given the small extent and location of reinforcement, and the fact it forms part of the Melton Mowbray FAS).

4.7.6 Melton Mowbray Flood Alleviation Scheme

Historical flooding in the Melton Borough led to the construction of the Melton Mowbray FAS, comprising of a set of three automatic undershot flood gates operated automatically according to river flow data. The impoundment of the Brentingby Dam is limited to a few hundred metres. The scheme was completed in 2001, creating an on-line flood storage area with approximately 3.7 million m^3 of water storage capacity upstream of Brentingby Junction. To accommodate this storage, approximately $12{,}000m^3$ of clay were excavated from the floodplain surrounding the River Eye SSSI. The scheme can control flows of up to the 1 in 100 year flow, and reduces maximum flows downstream to the 1 in 5 year flow (Entec, 2008). In real terms, this reduces the flood peak at Melton Mowbray by 0.5m during the 1 in 100 year flow.

Under current operational conditions (K. Coleman, Environment Agency Asset Performance Team, *pers. comm.*), the three flood gates close enough to sufficiently restrict flow when the trigger level for overbank flows in Melton Mowbray (approximately $35m^3s^1$) is reached. The three flood gates operate to balance the flow based on the flow rate through at each respective site. The flood gates operate on a duty cycle of 4 – 6 weeks, independently of flood events. This means that it is possible for the same penstock to be open to drain residual flows during successive flood events, and as such it is possible for the same banks of the river to be exposed to erosive forces during floods.

During summer low flow conditions, flows through the flood gates are reported to be extremely low, and reverse flows during periods of strong wind have also been recorded (K. Coleman, *pers. comm.*). Non-flood flows are considerably larger during the winter, and are thought to average between 3 and $5m^3s^{-1}$.

The flood storage area drains very slowly, which results in bankfull conditions being maintained for three or four days after a flood event (K. Coleman, *pers. comm.*). Because the River Eye is a naturally flashy and hydrologically responsive, this means that the bankfull conditions upstream of the flood gates are maintained for an artificially long period. In addition, the release of stored water from the channel results in a sustained period of high velocity bankfull flows (K. Coleman, *pers. comm.*), which have the potential to cause morphological adjustments in the river channel downstream **(see Section 4.10).**

As a result, the FAS is likely to be an important driver in the current sediment dynamics within the River Eye, where high fine sediment input coupled with a reduction of coarse sediment transport due to a loss of high peak flows downstream of the scheme may result in a less diverse sediment load consisting of finer materials.

Alongside controls over sediment and hydrology, the FAS may affect the SSSI by altering in-stream biotic community composition. For example, the removal of very high flows will exert fewer disturbance events upon the benthic macroinvertebrate communities downstream, thus potentially reducing species diversity in line with the Intermediate Disturbance Hypothesis (Townsend *et al*., 1997). Furthermore, a change in sediment dynamics will impact substratum, where a loss of coarse substrate can remove areas of refugia and decrease food resources downstream of the structure, thus having a negative cascading effect upon the biotic communities.

4.8 Water resources

4.8.1 Water abstraction

The River Eye catchment includes three surface water abstractions within or adjacent to the SSSI catchment area. This includes a large abstraction of surface water from Scalford Brook (immediately downstream of the SSSI), from which $3,078,615m^3$ water can be abstracted per year (this accounts for $10,176m^3$ per day or $483m^3$ per hour), with water impounded from the River Eye and subsequently used for abstraction (Royal HaskoningDHV, 2012). However, the abstraction is not used to its full capacity, with an annual average abstraction of $900,000m^3$ recorded between 2008 and 2011 (less than a third of the maximum) (Royal HaskoningDHV, 2012).

In addition, there is one groundwater abstraction licence for $18,000m^3$ from the limestone to the north of the catchment area (part of the Blue Lias Formation), and there are several groundwater abstractions which have been de-regulated as they fall below the daily threshold volume of $20m^3$ per day.

The River Soar Abstraction Licensing Strategy (Environment Agency, 2013) has determined that the River Eye upstream of Melton Mowbray has “water available for further licensing”, subject to constraints for new licences.

Although the Abstraction Licensing Strategy indicates that there is water available in the catchment, it should be noted that if the Scalford Brook abstraction were to take the full licensed volume there would be a significant impact on water levels in the adjacent River Eye, with no water being available in the catchment in this scenario. Past Catchment Abstraction Management Strategy (CAMS) investigations have highlighted this as a significant issue. Future abstraction requirements should therefore be considered carefully when restoration measures (including modifications to the existing weir complex and abstraction equipment) are designed in detail for these reaches. Natural England and the Environment Agency will be reviewing the flow targets for the SSSI in late 2014.

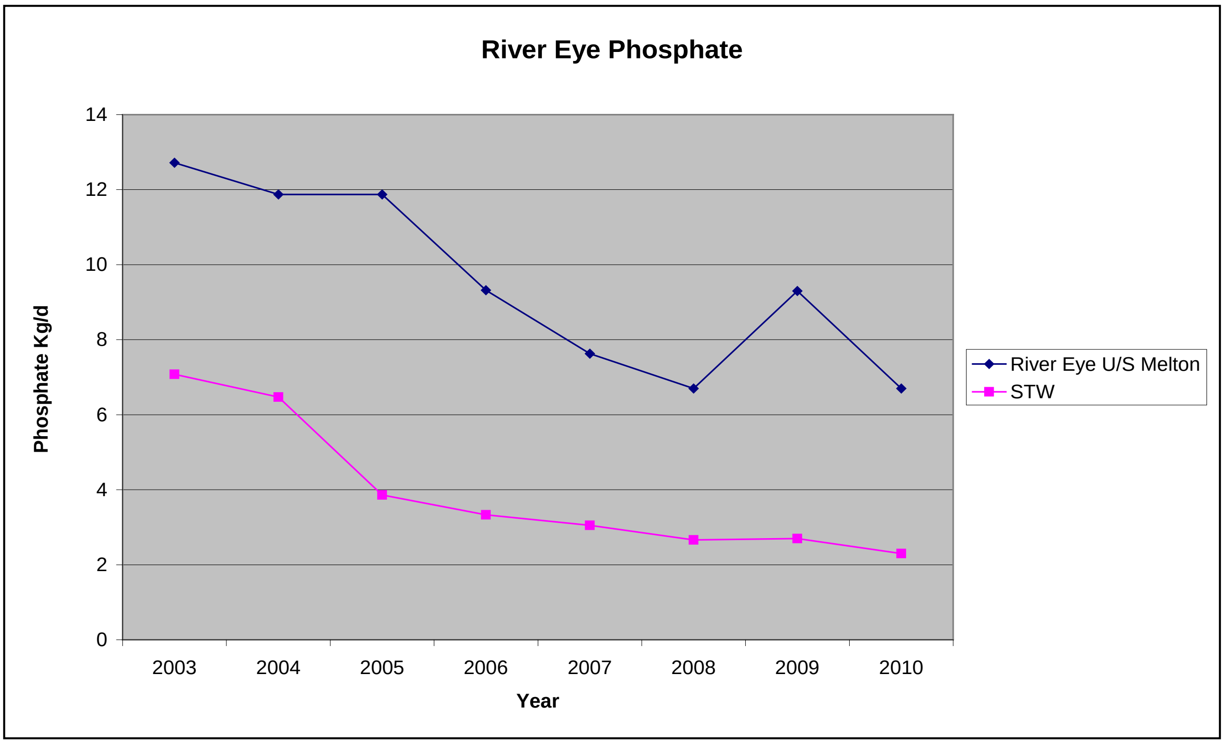
4.8.2 Water quality

Natural England has demonstrated that chemical quality values for data collected at the two EA monitoring sites in the vicinity of the SSSI (at Melton Mowbray within the downstream section of the SSSI and Stapleford within 500m of the upstream limit of the SSSI) have been consistently good across the last decade, achieving a General Quality Assessment (GQA) Chemistry module classification between A (very good) and B (good) (Natural England, 2010). Unionised ammonia and suspended sediment concentrations have been consistently recorded at values below (i.e. better than) recommended target values (0.025mg l^{-1} for ammonia and 25mg l^{-1} for suspended sediments) throughout the last decade.

The Common Standards Monitoring (CSM) assessment published in 2010 (Natural England, 2010) highlighted orthophosphate concentrations above the target values for SSSI favourable condition of 0.06 mg l^{-1} at sampling sites in Melton Mowbray and Stapleford. While thirteen Sewage Treatment Works (STW) discharge into the overall River Eye catchment, these have been demonstrated to contribute a small proportion (30%) of the phosphate found within the river, with the larger percentage (70%) presumed to originate from surface runoff (Natural England, undated – Catchment Appraisal Refresh Proforma). Natural England and the Environment Agency will be reviewing the water quality targets for the SSSI in late 2014.

Work undertaken as part of the Catchment Sensitive Farming programme and other initiatives in the catchment has resulted in a reduction of total phosphorus loadings in the catchment between 2003 and 2010 (Natural England, 2011) **(Figure 4.8).** Since the majority of phosphates in the catchment are associated with particulates, this may also suggest that sediment loadings from agricultural land in the catchment are also reducing. If phosphate loadings are analogous to sediment input, the largest sources of fine sediment in the catchment are likely to be Burton Brook, Wymondham Brook and Whissendine Brook (cf. Natural England, 2011). Burton Brook already has a sediment trap **(see Section 4.7.4),** while the others are relatively steep sub-catchments that enter the river upstream of Ham Bridge.

Figure 4.8: Phosphate loading in the River Eye catchment (Natural England, 2011)



4.8.3 Flood Risk Management and the Catchment Flood Management Plan

The River Eye SSSI is located in sub-area 8 (Rural Leicestershire) of the River Trent Catchment Flood Management Plan (CFMP). The CFMP describes the landscape of the sub-area as varied with a significant rural element. The area in the north-east is characterised by ridges used for arable farming, whilst the east supports pastoral farming on the steep sided valleys. The Trent Valley in the north supports washlands and a variety of farming. Run-off from land to the north-west of Leicestershire generates a fast response to rainfall that drains into both the River Soar and River Tame.

The plan states that no formal flood defences are found within the sub-area, although Melton Mowbray is protected from flooding from the River Wreake by the upstream flood storage area located on the River Eye near Brentingby **(Section 4.7.6).** Only 30 properties are considered at risk from flooding in the area during a 1% flood event, with no significant increase anticipated in the future. Flooding is considered to generally impact farmland and isolated properties, therefore disrupting people and agricultural activities. The River Eye SSSI is also considered liable to be affected by flooding.

The preferred policy for the sub-area is option 6, which means that action will be taken to store water or manage run-off in locations that provide overall flood risk reduction or environmental benefits. The long term vision for the area aims to reduce dependence on raised flood defences. Instead, the vision aims to set a framework to deliver a sustainable approach which considers the natural function of the river, including identifying opportunities to better utilise the floodplain to store floodwaters and to attenuate rainwater that will reduce flood risk within the sub-area and downstream.

4.9 Catchment ecology

4.9.1 WFD status

The status of fish and invertebrate populations in 2009 were assessed as “Good” for the River Eye / Wreake from Langham Brook to River Soar (Water body ID: GB 104028047550) (Environment Agency, 2009). Invertebrate populations have achieved “Good” scores in the quantitative assessments carried out in this water body. In addition, monitoring of macro-invertebrate diversity and abundance at the Stapleford site (immediately upstream of the SSSI limits) has recorded classifications of B (good) and A (very good) between 1998 and 2008. Classifications of “A” were obtained in 2007 and 2008, suggesting a potential improvement in macro-invertebrate quality in response to improved water quality.

Some tributaries of the River Eye are, however, failing to achieve good status for the quality of their biological elements (i.e. fish, macrophytes, invertebrates and diatoms). The Somerby Brook (Source to Langham Brook) and the Langham Brook (Source to Whissendine) have achieved “Moderate” scores for their macrophytes populations. In addition, the Whissendine Brook (Source to Langham Brook) and the Langham Brook (Wymondham Brook to River Eye) have been classified as “Poor” under their diatom assessment, the former also achieving a score of “Moderate” for fish populations.

4.9.2 River Eye SSSI Condition

Although the ecology of River Eye is overall considered to be good when assessed against the WFD metrics, it does not reach the standards required to meet favourable condition for the SSSI (which are closer to those for high ecological status) due to several tributaries upstream of the River Eye SSSI not meeting good standards. Comprehensive qualitative assessment of macrophyte abundance and diversity is not available on a catchment-wide scale but surveys conducted as part of the Common Standards Monitoring Condition Assessment of River Eye SSSI (Natural England, 2010b) suggest that the composition of the macrophyte populations may be negatively impacted by widespread poor channel and bank profiles associated with over-deepening and over-widening. In addition, “Poor” classifications for the phosphate quality element are widespread throughout the catchment and are considered to potentially affect the competitive interaction between higher plants and algae (Natural England, 2011).

4.9.3 Invertebrates

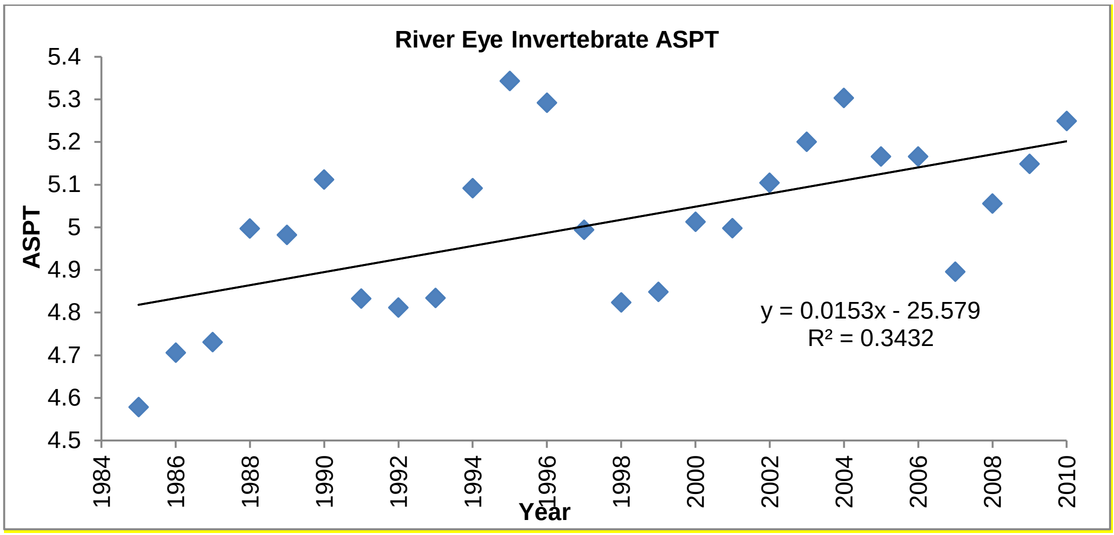
The use of macro-invertebrates within biological monitoring has become prevalent within stream ecology research and surveying. In terms of water quality assessment, species respond quickly to physiochemical changes and therefore the community present provides a reflection of the biological quality of the stream.

A study into the changes in invertebrate fauna communities in the River Eye over time (Seddon *et al*., 2011) indicated that broadly similar faunal communities occurred within riffle habitats of the river (circa 1962) as they do today. Two riffle beetle taxa (*Limnius volckmari* and *Riolus subviolaceus*) and two Trichoptera taxa (*Brachycentrus subnubilus* and *Athripsodes aterrimus*) present in the historic sample were not found in the 2011 sample. These taxa are typically associated with riffles, coarse-grained substrates and in-stream vegetation, suggesting that there may have been a migration of riffle habitat, an increase in the volume of fine sediment input and/or a reduction in the supply or movement of coarse sediment, and a corresponding reduction in aquatic macrophyte growth.

The Biological Monitoring Working Party (BMWP) Score was designed to give an indication of the biological condition of a broad range of UK Rivers; providing a sum of the present taxa tolerance scores. The Average Score Per Taxon (ASPT) is derived from the BMWP score, which is intended to eliminate seasonality and sample size problems that are present with the BMWP scoring system. Invertebrate survey results obtained from the Environment Agency from a site upstream of Melton Mowbray on the River Eye (National Grid Reference: SK 771 192) display the change in BMWP and ASPT from 1983 to 2010.

Figure 4.9 shows that ASPT has a cyclical pattern with a periodicity of approximately 6-8 years. These cyclical patterns in ASPT score could potentially derive from changes in macro invertebrate physiochemical stressors, potentially as a result of flood events or episodes of poor water quality. Within this pattern, there is an overall increase (R^2=0.34) in ASPT over time, indicating that there has been a general increase in more sensitive taxa within the River Eye invertebrate communities over time.

Figure 4.9: Invertebrate ASPT data for the River Eye



4.9.4 Fish

Data obtained from the Environment Agency National Fish Populations Database for the Brentingby site collected in September 2010 and March 2012 identifies differences between the fish communities over time within the River Eye. **Table 4.2** displays the differences between the numbers, weight and length of fish caught in 2010 compared to 2012.

Table 4.2: Fish survey results from 2010 and 2012 at Brentingby

Species	Numbers caught		Weight Caught (mean g)		Mean length (IF)	
	2010	2012	2010	2012	2010	2012
Three-spined stickleback [*Gasterosteus aculeatus*]	0	60	0	0.97	0	35
Stone loach [*Barbatula barbatula*]	0	20	0	3.63	0	74
Chub [*Leuciscus cephalus*]	27	6	93.52	27.43	174	131
Dace [*Leuciscus leuciscus*]	3	4	27.34	12.66	127	92
Roach [*Rutilus rutilus*]	21	1	56.4	48.25	139	149
Bullhead [*Cottus gobio*]	0	40	0	2.25	0	53
Minnow [*Phoxinus phoxinus*]	0	306	0	0.57	0	44
Gudgeon [*Gobio gobio*]	2	6	12.46	18.81	98	117
Pike [*Esox lucius*]	1	0	625.47	0	420	0
TOTAL	**54**	**443**	**815.18**	**114.56**	**958**	**695**

These data show a significant change in community composition over time. For example, in 2010, chub (*Leuciscus cephalus*) represented 50% of the total number of fish caught. In 2012 however, the number of chub caught declined to only 1.35%. Conversely, minnow (*Phoxinus phoxinus*), a species commonly predated by chub, dominated the 2012 community, representing 69.07% of the total catch. This trend suggests that the ecosystem may in part be controlled by cascading effects from top-level predation, where a decline in predator species (chub) potentially due to habitat or physico-chemical change, results in a release of pressure on prey species (minnow).

Another species present in the 2012 survey which was absent from the 2010 survey is the three-spined stickleback (*Gasterosteus aculeatus*). This species prefers shallow, slow-flowing or still water, sand or silt substrate, and dense submerged weed where it builds a nest in which the female lays her eggs (Environment Agency, undated). This result infers a potential change in habitat type within the River Eye which has allowed populations of fish such as stickleback to develop, therefore resulting in a more diverse community. However, geomorphological evidence does not suggest that there has been a significant increase in fine sediment supply between 2010 and 2012.

The mean weight of each species present in both survey rounds was shown to decline between 2010 and 2012, apart from the gudgeon (*Gobio gobio*). This may be a reflection of a lack of primary productivity in the river, or perhaps just a result of the differences in season between the two surveys.

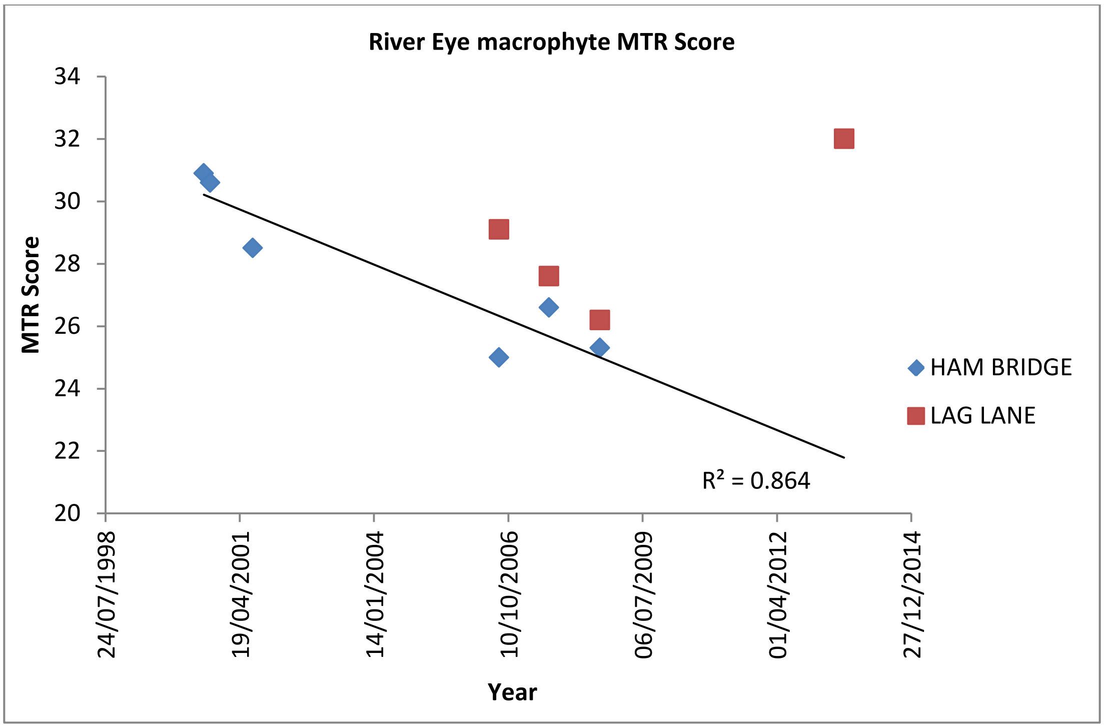
Ultimately, reliable conclusions about the fish communities present in the River Eye cannot be drawn from this dataset due to limited survey rounds and differences between the two rounds of survey such as season. The data does, however, offer an insight into the types of fish present within the ecosystem.

4.9.5 Macrophytes

Aquatic macrophytes are an important bio-indicator of river condition due to the complex relationship of the organisms with abiotic factors such as fine sediment in river channels; for example, they affect the conveyance of fine sediments and are, in turn, affected by the sediment loading (Jones *et al*., 2012).

Data obtained from the Environment Agency indicate a change in macrophyte community structure over time at both Ham Bridge (Station ID: 92913) and Lag Lane (Station ID: 144462) site on the River Eye. **Figure 4.10** shows how the Mean Trophic Rank (MTR) Score (a measure of the macrophyte community response to nutrient status) of macrophytes has changed over time at these sites. The trendline relates to the Ham Bridge sites.

Figure 4.10: Macrophyte MTR score in the River Eye



These data indicate that the River Eye was becoming increasingly eutrophic over the period 2000-2008; however a recent survey (2013) has shown an increase in MTR score, inferring a decrease in eutrophy. This result suggests a decrease in nutrient input into the river, which correlates with **Figure 4.8**, where phosphate loading into the River Eye has decreased as a result of Catchment Sensitive Farming practices (Natural England, 2011). The data also show that macrophyte diversity has not significantly changed over time, indicating a relatively stable community. The data indicate that farming practices are likely to be a prevalent factor in the observed changes in macrophyte community.

4.10 Summary: Catchment controls and conceptual model

- The River Eye catchment is underlain by predominantly fine grained bedrock, superficial deposits and soils, resulting in plentiful supply of silts and clays to the river system. However, the underlying lithology also contains some coarser sediment such as gravels, which means that there is also a natural supply of coarse material to the river. The soils have limited permeability, which results in a flashy hydrological regime with plentiful surface runoff.

- The upland parts of the catchment are dominated by moderate to steep slopes, which promote the mobilisation of soils and sediment-associated contaminants during rainfall events and contribute to high sediment loads through the catchment. Widespread silt mobilisation associated with runoff from agricultural land provides a plentiful supply of fine sediment into the lower catchment. The installation of artificial land drains has helped to increase channel-floodplain connectivity, increasing the speed of hydrological responses and ensuring that there is a direct pathway for eroded sediments to enter the main river system. Tributaries such as Burton Brook, Wymondham Brook and Whissendine Brook are likely to be significant sources of sediment to the river catchment. These relatively steep tributaries are also likely to erode coarser sediment from the superficial deposits that they flow over. The sediment loadings from these catchments may be reduced by the sediment traps on Burton Brook and at Ham Bridge (which intercepts material from Wymongdham and Whissendine Brooks).

- Channel capacity has increased due to a combination of natural erosive processes and historical channel modifications that were undertaken during the construction of the canal. This has resulted in uniform bank conditions and low energy flows which encourage the deposition of fine sediments on the channel bed, and an abrupt transition between the aquatic and terrestrial habitats.

- The natural functionality of the river is also affected by the presence of several in-channel structures. The weir located at Stapleford (just upstream of the SSSI) and the silt traps on the main river and Burton Brook are likely to reduce the downstream transport of both fine and coarse sediments. The Flood Alleviation Scheme at Brentingby limits the occurrence of geomorphologically effective flushing flows downstream, and therefore may reduce the supply of coarse sediment downstream. However, post-flood releases from the scheme artificially prolong high velocity flows and promote geomorphological instability downstream. The major weir complex immediately downstream of the SSSI limit causes considerable impoundment upstream and further encourages sedimentation.

- Elevated levels of phosphate associated with runoff from agricultural land (which has been exacerbated by an increase in river connectivity as a result of artificial land drainage) have been linked to interference with the competitive interaction between higher plants and algae. As a result, there has been deterioration, since notification in habitat quality for aquatic macrophytes and a decline in the abundance and diversity of plant species (Natural England, 2011).

- Populations of invertebrates which favour coarse sediments appear to have declined in the last fifty years, which may suggest that fine sedimentation has increased in this time (Seddon *et al*., 2011).

The chronology of developments in the River Eye catchment is currently unclear. However, we have developed a conceptual model of the likely development of the river system, which incorporates site-specific characteristics into the model of long-term river development in the English Midlands that has been produced by Brown (1997). This model is shown in **Figure 4.11.**

Figure 4.11: Conceptual model of the development of the River Eye catchment

8000 to 6000 years before present

- Shallow gravel bed river over alluvium, head and diamicton.
- Naturally high supply of fine sediments.
- Laterally active where substrate and valley conditions allow.
- Floodplain likely to be covered by birch and willow.
- Floodplain wetness increases over time.

6000 to 4500 years before present

- Floodplain dominated by alder woodland.
- Plentiful supply of woody debris to the channel promotes geomorphological diversity.

4500 to 2500 years before present

- Woodland cleared and replaced with arable agriculture.
- Fine sediment supply increases in response.
- Rate of fine sediment deposition on the floodplain increases.
- Lateral migration of the channel decreases.
- Plentiful supply of woody debris to the channel promotes geomorphological diversity.

2500 to 1000 years before present

- Thick accumulation of fine sediments creates high floodplain with steeper banks.
- River still retains the gravel bed inherited from earlier time periods.
- River adopts a passive meandering planform.
- Plentiful supply of woody debris to the channel promotes geomorphological diversity.

1000 to 200 years before present

- High banks subject to localised collapse and subsequent stabilisation.
- Growth of in-channel vegetation increases.
- River retains passive meandering planform.
- Plentiful supply of woody debris to the channel promotes geomorphological diversity.

Nineteenth and twentieth centuries

- Increased intensification of agricultural and pastoral land uses.
- Land use change exacerbates high natural fine sediment supply.
- Creation of network of land drains increases connectivity between river and surrounding catchment.
- In-channel structures alter hydrological and sediment regime.
- Channel enlargement due to modifications during the construction of the canal and natural scour.
- Woody debris removed from channel, removing a driver for localised geomorphological diversity.

Present

- Reduced channel maintenance promotes vegetation growth.
- Land use changes start to reduce sediment supply.
- Changes to flow regime downstream of the Melton Mowbray Flood Alleviation Scheme promote a degree of bank collapse and natural recovery.

Climate change implications for the River Eye

The latest climate projections from the UK Climate Projections 2009 (UKCP09 - http://ukclimateprojections.defra.gov.uk/), a climate analysis tool funded by Defra and produced by the UK Climate Impacts Programme (UKCIP), suggest that over the next 20-50 years, temperatures and precipitation levels in the River Eye catchment could be considerably different to current conditions. The main changes that are likely to occur are:

- Increased annual average daily temperatures: Temperatures are predicted to increase by up to 2°C by the 2020s, and 3°C by the 2050s.
- Decreased summer precipitation: Summer precipitation levels are predicted to decrease by up to 20% by the 2020s and up to 30% by the 2050s. This is likely to reduce river flows in the summer, and reduce the amount of water available to wetland habitats and grazing livestock.
- Increased winter precipitation: Winter precipitation levels are predicted to increase by up to 10% by the 2020s and up to 20% by the 2050s. This is likely to increase flows during the winter, leading to increased flood frequency and more sediment runoff.
- To summarise, over the next 50 years, summers are likely to become warmer and drier and winters are likely to become warmer and wetter.

There is therefore a need to consider climate change adaptation measures while working towards achieving favourable condition for the SSSI. This will ensure that the valuable habitats supported in the SSSI are able to adapt to a changing climate, and persist into the future.

5 GEOMORPHOLOGICAL AND ECOLOGICAL CONDITION

5.1 Purpose of this section

The purpose of this section is to provide a detailed description of the current geomorphology and ecology of the River Eye SSSI. The overall river habitat and characteristic ecology has a vital role in defining the condition of the SSSI. The physical shape and function of the river is therefore key in supporting the abiotic parameters for which the SSSI has been designated. The precise relationships between ecology and physical characteristics are still in many cases ill-defined, but it is possible to determine the requirements based on the characteristics of river reaches where habitat is in good quality. **Table 5.1** summarises the general physical characteristics supporting both good habitat and ecology of the river system based on the site-specific definition of condition of the River Eye SSSI (Natural England, 2012).

Natural England and the Environment Agency will be reviewing the water quality and flow targets in late 2014.

Table 5.1: Summary of Natural England site-specific targets for monitoring SSSI condition

Physical attribute	Target for supporting SSSI good condition
Substrate	**Siltation**: The target for this SSSI is to not display evidence of excessive siltation. The channel in the River Eye should contain levels of fine sediment characteristic of this river type (lowland clay river). While the target for this SSSI accounts for natural variations in siltation level dependent on reach character and associated hydromorphology as well as localised conditions, dominant siltation of channel substrate is considered a substantial barrier to the achievement of good condition in the River Eye SSSI.
Channel and banks	**Channel form**: Unfavourable condition is strongly associated with extensive bank reinforcement and widening or deepening of channels. The target for favourable SSSI condition includes a predominantly unmodified planform and profile. Channel form should support a range of substrate types, variations in flow, channel width and depth, in-channel and side-channel features and both in-channel and bankside vegetation cover. The target score for favourable SSSI condition includes a planform score of at least 3 out of a possible 5 (>5-10% of Evaluated Corridor Section (ECS) river artificial, re-aligned, or constrained) (*Note*: higher scores reflect less anthropogenic modification).
Water quality	**Suspended solids**: The target for favourable SSSI condition is for no unnaturally high loads. The highest recommended value under the EC Freshwater Fish Directive is of an annual mean concentration of 25 mg l^{-1}. However, an analysis of prevailing conditions of most SSSI rivers indicates a precautionary target of 10 mg l^{-1}.
Water flows	**Flow regimes** should include the maintenance of both flushing flows and seasonal base flows, including compliance with defined levels of abstraction and established ecological flow criteria. Maintenance of springs is also associated with achievement of favourable condition.
Habitat structure	**Bank and riparian zone vegetation**: The structure of bank and riparian vegetation should be near-natural, with mean scores of 4 or 5 points out of a possible 5 under the River Habitat Survey (RHS) methodology.
Negative indicators	**In-stream barriers**: There should be no artificial barriers in place that significantly impair characteristic migratory species from essential life-cycle movements. These barriers also potentially impact flow and sediment dynamics, subsequently affecting the freshwater biotic communities.

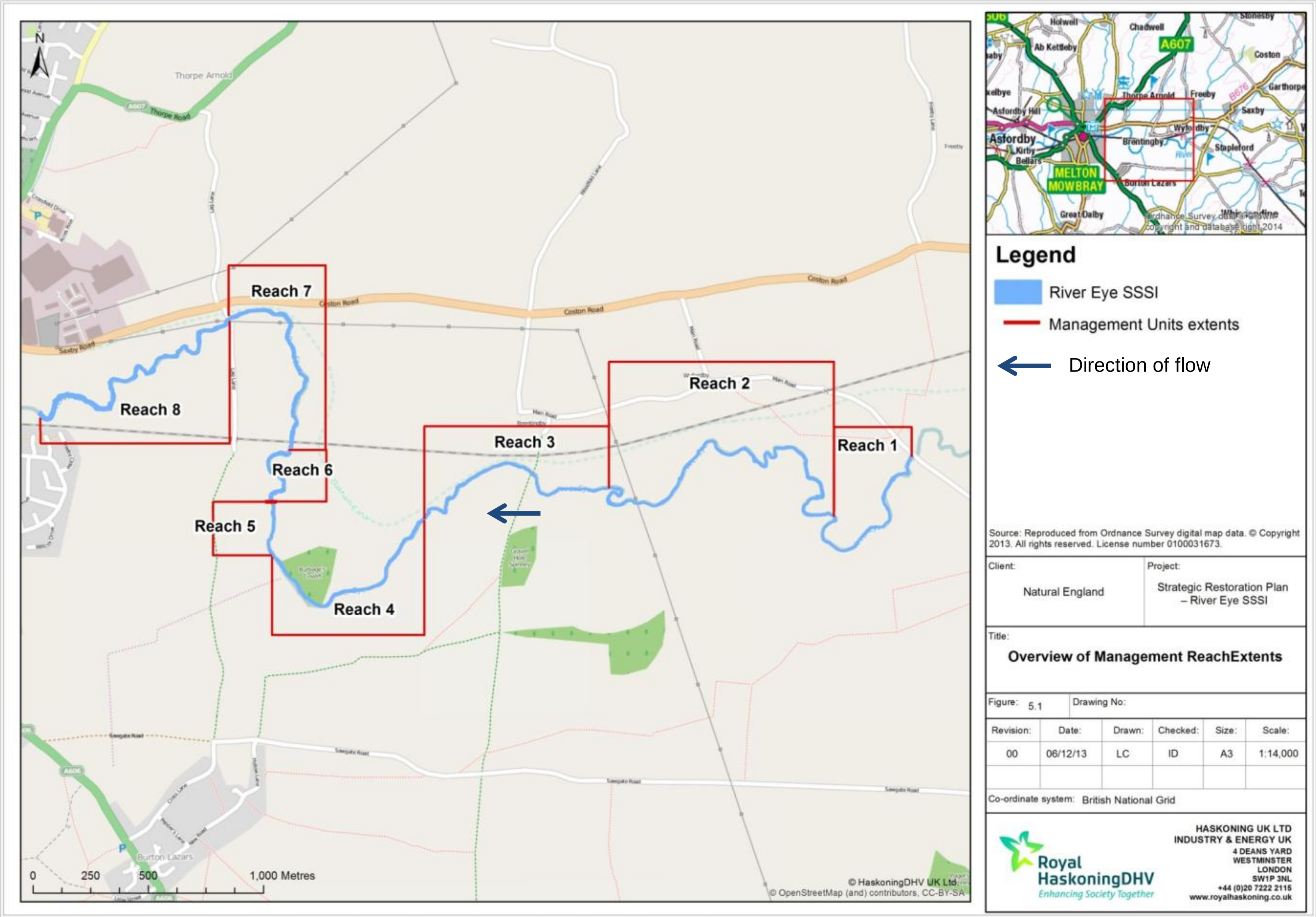
5.2 Summary of Management Reach-characteristics

Table 5.2 provides a brief overview of the geomorphology and ecology of each of the Management Reaches, and their locations are shown in **Figure 5.1.** More details are provided in the subsequent Management Reach Summary Sheets.

Table 5.2: Key characteristics of management reaches

Reach	Upstream limit	Downstream limit	Key characteristics
1	SK 80131 18615	SK 79786 18361	Low energy glides characterise flow conditions in this reach. Deposition of fine sedimentation on the river bed is dominant. Channel geometry is uniform displaying a lack of in-channel morphological diversity and disconnection to the floodplain.
2	SK 79786 18361	SK 78762 18484	Uniform slow flowing conditions and extensive colonisation of the channel by macrophytes result in widespread siltation of the river bed through vegetational trapping. Channel-floodplain connectivity is disrupted by steep, uniform banks and an over-deepened channel.
3	SK 78762 18484	SK 78032 18377	A varied range of in-channel habitat and flow conditions occur in this reach. Areas of clean gravel substrate are associated with an increase of in-channel morphological diversity. Floodplain connectivity is favoured by the presence of low, shallow banks.
4	SK 78032 18377	SK 77359 18193	Low energy glides and deposition of fine sediments on the river bed dominates this reach. Channel geometry is uniform displaying a lack of in-channel morphological diversity.
5	SK 77359 18193	SK 77357 18408	Riffle and run flows dominate this reach. Clean gravels and coarse sediment are present with sediment transport dominating the sediment regime throughout the reach. Channel-floodplain connectivity is disrupted by steep banks.
6	SK 77357 18408	SK 77435 18675	Glide and impoundment conditions dominate flows in this reach. Hard bank reinforcement associated with the FAS is present in the downstream sections of the reach. Channel-floodplain connectivity is generally limited by steep, uniform banks, hard bank reinforcement and over-deepening of the channel.
7	SK 77435 18675	SK 77169 19209	Uniform, slow flows dominate this reach with riffles present in isolated sections. Bank erosion contributes towards increased morphological diversity and the creation of vegetated berms throughout the reach.
8	SK 77169 19209	SK 76341 18814	Impoundment associated with in-channel structures downstream of the SSSI limit dominates this reach. Widespread deposition of fine sediments is associated with low flow velocities and extensive enlargement of the channel.

Figure 5.1: Location of Management Reaches



5.3 Management Reach Summary Tables

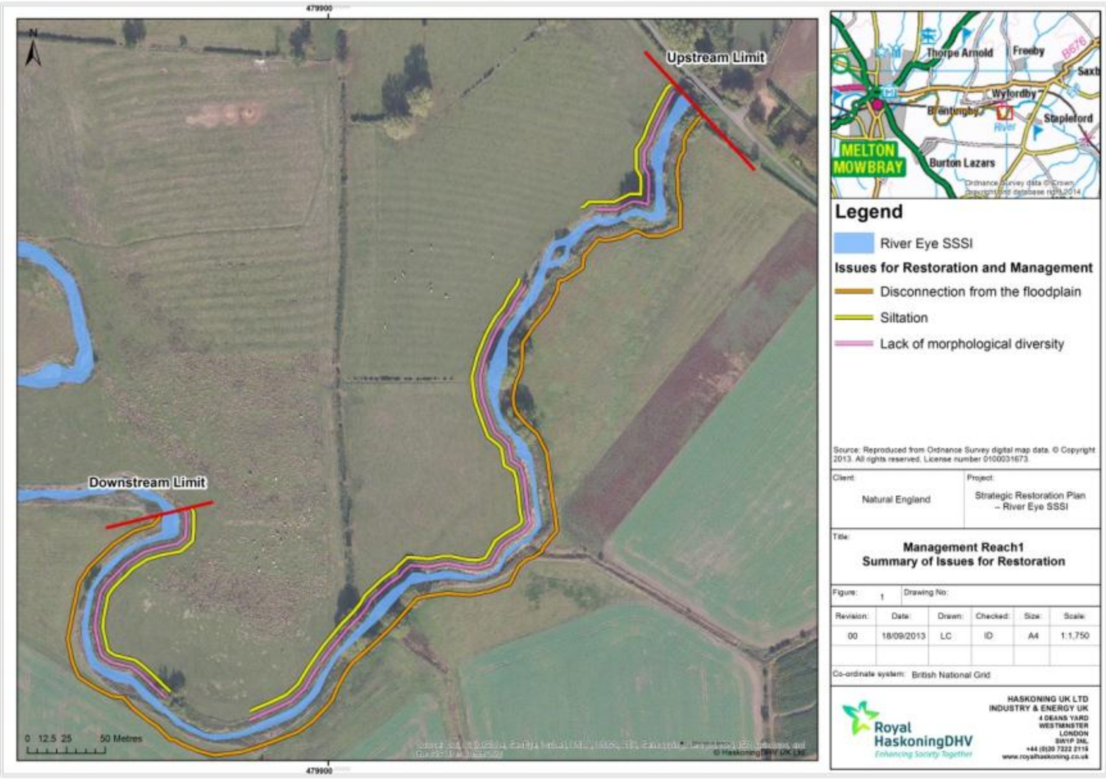
<table>
<tr><td colspan="3">MANAGEMENT REACH 1
SSSI UNIT: 1</td></tr>
<tr><td>Upstream survey limit:</td><td>Downstream survey limit</td><td>Length of river surveyed:</td></tr>
<tr><td>SK 80137 18632– Ham Bridge</td><td>SK 79786 18361 – Change in geomorphological character</td><td>840m</td></tr>
<tr><td colspan="3">Reach characterisation</td></tr>
<tr><td colspan="3">Hydromorphology: In this management reach, the River Eye flows through a wide, shallow valley, with a floodplain dominated by pastoral agriculture. The channel planform is characterised by irregular meandering, with no evidence of historic realignment. There is some evidence of historical channel enlargement (dredging), which has resulted in an over-deep and uniform channel with a shallow gradient. Widespread fine sedimentation dominates the substrate within this reach.

Ecology: Typical riparian vegetation i.e. emergent vegetation comprises rushes, sedges and reeds. There are occasional willow trees which provide shading thereby creating areas of open water. Some areas of open water occur independently of the willows, being dominated by rushes and reeds. Bank vegetation is dominated by nettles, bramble, willow herb, occasional mature willow trees and some planted willow on the north bank.</td></tr>
</table>

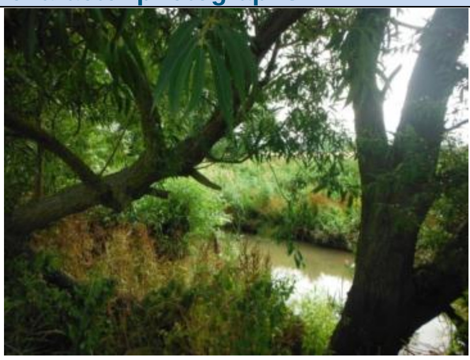
<table>
<tr><td colspan="3">Targets for SSSI favourable condition</td></tr>
<tr><td>Attribute</td><td>Survey assessment</td><td>Characteristics of Type II River</td></tr>
<tr><td>Flow dynamics and diversity</td><td>Flows are dominated by low energy glide conditions (Plates A and B) and areas of no perceptible flow. One riffle was observed in the downstream section of the reach (Plate C). General reach character is more uniform than the characteristic conditions for the River Eye SSSI. There are no obvious issues relating to water availability (e.g. abstraction and flow apportionment).</td><td>No</td></tr>
<tr><td>Substrate</td><td>The sediment regime of this reach is dominated by the in-channel deposition of fine sediments, although there are small, isolated sections of eroding bank at the downstream end of the reach. The substrate is dominated by fine sediments, with stable silt deposits along the channel margins which support patches of emergent macrophytes. As a result, there are no areas of clean gravels in this reach, with the exception of the coarse substrate observed at the riffle formation.</td><td>No</td></tr>
<tr><td>Channel and banks</td><td>The planform is slightly sinuous with a shallow gradient and no evidence of channel straightening. The channel appears to have been enlarged, potentially as a result of historic dredging (Plates B and D). The steep, high banks constrain bankside habitats and limit connectivity with floodplain. Tree cover is sparse with emergent reeds dominating bankside habitats.</td><td>No</td></tr>
<tr><td>Plant community species: Composition and abundance</td><td>Key species from the constancy table for River Eye SSSI Conservation Objectives were observed, including branched bur-reed (Spargantium erectum), yellow water lily (Nuphar letea), willow (Salix spp.), greater willow herb (Epilobium hirsutum), reed canary grass (Phalaris arundinacea), spiked water-milfoil (Myriophyllum spicatum), fennel pondweed (Potamogeton pectinatus), arrowhead (Sagittaria sagittifolia). This represents an insufficient diversity to meet the site-specific target.</td><td>No</td></tr>
<tr><td colspan="3">Negative indicators</td></tr>
<tr><td>Native species</td><td>Fennel pondweed / blanket weed identified within the reach of a coverage of >25%.</td><td>No</td></tr>
<tr><td>Alien/introduced species</td><td>No alien or introduced species were seen.</td><td>Yes</td></tr>
<tr><td>In-stream barriers</td><td>There are no in-channel structures in this management reach.</td><td>Yes</td></tr>
</table>

<table>
<tr><th>Issues for restoration and management</th><th>Potential restoration options</th></tr>
<tr><td>Disconnection from floodplain
Lack of morphological diversity
Siltation</td><td>In-channel enhancements to promote hydromorphological diversity
Targeted bank reprofiling
Narrowing of over widened channel
Reinstatement of coarse bed material</td></tr>
<tr><th colspan="2">Constraints</th></tr>
<tr><td colspan="2">Constraints related to current land use.
Presence of dense buffer strips and riparian fencing in parts of the reach.
It may not be possible to increase coarse sediment supply over the sediment trap if any modifications compromise its performance in reducing fine sediment loads downstream.</td></tr>
</table>

Overview of Management Reach 1



Reach character photographs



A: Dominant glide flows

B: Typical bankside vegetation

C: Wider pool

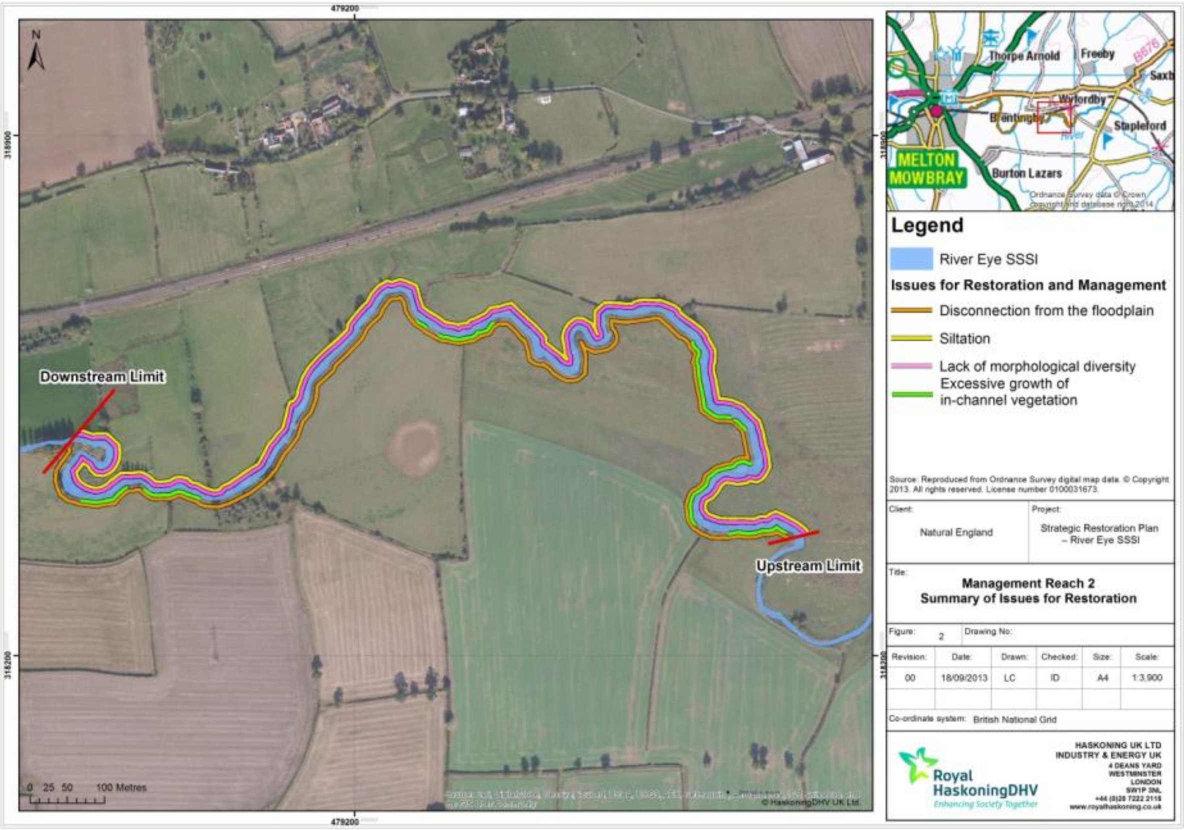
D: Emergent macrophytes

MANAGEMENT REACH 2 SSSI UNIT: 1, 2		
Upstream survey limit:	**Downstream survey limit**	**Length of river surveyed:**
SK 79786 18361	SK 78762 18484 – Change in geomorphological character	1890m
Reach characterisation		
Hydromorphology: The River Eye in Management Reach 2 is characterised by limited flow and geomorphological diversity. Floodplain land use and valley form remain similar to Reach 1. Extensive emergent macrophyte colonisation associated with sections of choked channel, distinguishing this unit from Reach 1. The sediment regime is dominated by depositional processes. Historic channel enlargement may be responsible for uniform channel geometry and limited floodplain connectivity throughout the reach. **Ecology:** Typical riparian vegetation i.e. emergent vegetation comprises rushes, sedges and reeds. There are occasional willow trees which provide shading thereby creating areas of open water. Some areas of open water occur independently of the willows, being dominated by rushes and reeds. Bank vegetation is dominated by nettles, bramble, willow herb, occasional mature willow trees and some planted willow on the north bank. At the downstream end of this reach there is a small plantation of mature poplar trees.		
Targets for SSSI favourable condition		
Attribute	**Survey assessment**	**Characteristics of Type II River**
Flow dynamics and diversity	Flows in this reach are markedly less varied than targets for favourable SSSI conditions for this type of river (JNCC, 2007). Flows are dominated by low energy glides throughout the reach **(Plate A),** with no areas of increased flow diversity (riffles, runs or sections of swifter flow) observed during the survey.	**No**
Substrate	Sediment deposition as a result of trapping by in-channel vegetation is the dominant process in the reach. Stable silt deposits are also present at the channel margins. As a result, there are no areas of clean gravels in the reach and substrate conditions fall below the required targets for favourable SSSI condition.	**No**
Channel and banks	The reach is characterised by moderately steep, generally uniform banks and a narrow channel which displays extensive macrophyte colonisation **(Plate B).** The high bank height, associated with historic channel enlargement, has caused a reduction in channel-floodplain connectivity **(Plates C and D).** Channel planform displays a degree of sinuosity, although this is limited in some sections. Bank reinforcement is not a significant pressure, although the lack of morphological diversity means that the reach falls below targets for favourable SSSI condition.	**No**
Plant community species: Composition and abundance	Key species from the constancy table for River Eye SSSI Conservation Objectives were observed, including branched bur-reed (*Spargantium erectum*), yellow water lily (*Nuphar letea*), willow (*Salix spp*.), greater willow herb (*Epilobium hirsutum*), reed canary grass (*Phalaris arundinacea*), spiked water-milfoil (*Myriophyllum spicatum*), fennel pondweed (*Potamogeton pectinatus*), arrowhead (*Sagittaria sagittifolia*). This represents an insufficient diversity to meet the site-specific target.	**No**
Negative indicators		
Native species	Fennel pondweed / blanket weed identified within the reach of a coverage of >25%.	**No**
Alien/introduced species	No alien or introduced species were seen.	**Yes**
In-stream barriers	There are no in-channel structures in this management reach.	**Yes**

Issues for restoration and management	Potential restoration options
• Excessive growth of in-channel vegetation • Disconnection from floodplain • Lack of morphological diversity • Siltation	• Bank regrading, creation of berms and other in-channel enhancements to promote hydromorphological diversity • Change in vegetation management regime • Reinstatement of coarse bed material

Constraints
• Constraints related to current land use. • Presence of dense buffer strips and riparian fencing in parts of the reach.

Overview of Management Reach 2



Reach character photographs

A: Dominant glide flows

B: Channel choked by dense vegetation growth

C: Overgrown channel with low sinuosity

D: Typical channel and bankside vegetation

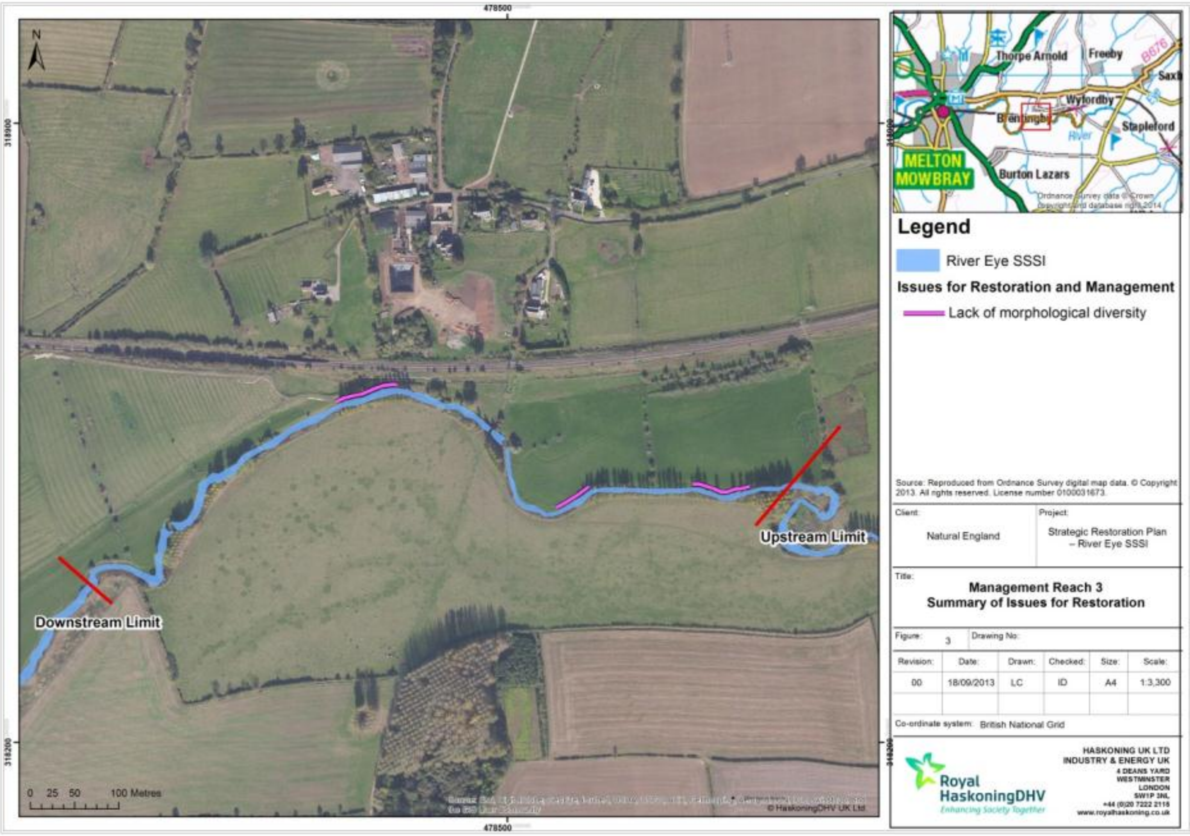
<table>
<tr><td colspan="3">MANAGEMENT REACH 3
SSSI UNIT: 2, 3</td></tr>
<tr><td>Upstream survey limit:</td><td>Downstream survey limit</td><td>Length of river surveyed:</td></tr>
<tr><td>SK 78762 18484</td><td>SK 78032 18377 – Change in geomorphological character</td><td>1040m</td></tr>
<tr><td colspan="3">Reach characterisation</td></tr>
<tr><td colspan="3">Hydromorphology: In Management Reach 3, the river displays a good degree of flow and morphological diversity. The channel planform is characterised by a meandering low flow channel with varied bank and bed profiles. Substrate composition is more varied than in upstream reaches, with a significant proportion of clean gravels and occasional cobbles. Floodplain land use and valley form remain similar to Reach 2.

Ecology: Typical riparian vegetation i.e. emergent vegetation comprise rushes, sedges and reeds, occasional willow trees form shading thereby creating areas of open water. Some areas of open water, occur independently of the willows, are edged with reeds and rushes with yellow water lily in the open water. Bank vegetation is dominated by nettles and bramble on the south bank. The north bank is primarily open grazed grass, sheep and cattle have access to the river. There are two sections of poplar trees lining the south bank in this reach. Occasional hawthorn occurs on both banks.</td></tr>
<tr><td colspan="3">Targets for SSSI favourable condition</td></tr>
<tr><td>Attribute</td><td>Survey assessment</td><td>Characteristics of Type II River</td></tr>
<tr><td>Flow dynamics and diversity</td><td>This reach is has greater diversity of flow than the upstream reaches, although there is less diversity at the upstream end of the reach. While glide flows are still dominant, the reach is characterised by the increased presence of run flows, which have resulted in more varied channel geomorphology and created conditions suitable for aquatic macrophytes (Plates A and B).</td><td>Yes</td></tr>
<tr><td>Substrate</td><td>The reach contains clean stable gravels alongside silts deposits at the channel margins. Unlike the previous reaches, there is no evidence of excessive siltation due to the increased flow diversity and associated zones of erosion in areas of swift flow and preferential deposition in low energy zones. This is compatible with targets for favourable SSSI condition.</td><td>Yes</td></tr>
<tr><td>Channel and banks</td><td>The bank profile displays considerable variation, including sections of shallow and slumping on the right bank (Plates C and D). Livestock grazing appears to control vegetation colonisation on the right bank and adjacent riparian zone. This has impacted on the establishment of marginal vegetation, preventing the channel from becoming choked. The development of vegetated berms and shallow banks has improved floodplain connectivity.</td><td>Yes</td></tr>
<tr><td>Plant community species: Composition and abundance</td><td>Key species from the constancy table for River Eye SSSI Conservation Objectives were observed, including branched bur-reed (Spargantium erectum), yellow water lily (Nuphar letea), willow (Salix spp.), greater willow herb (Epilobium hirsutum), reed canary grass (Phalaris arundinacea), spiked water-milfoil (Myriophyllum spicatum), fennel pondweed (Potamogeton pectinatus), arrowhead (Sagittaria sagittifolia). This represents an insufficient diversity to meet the site-specific target.</td><td>No</td></tr>
<tr><td colspan="3">Negative indicators</td></tr>
<tr><td>Native species</td><td>Fennel pondweed / blanket weed identified within the reach of a coverage of >25%.</td><td>No</td></tr>
<tr><td>Alien/introduced species</td><td>No alien or introduced species were seen.</td><td>Yes</td></tr>
<tr><td>In-stream barriers</td><td>There are no in-channel structures in this management reach.</td><td>Yes</td></tr>
</table>

Issues for restoration and management	Potential restoration options
• Lack of morphological diversity (for one isolated reach)	• In-channel enhancements to promote hydromorphological diversity in uniform part of reach

Constraints
• Constraints related to current land use. • Potential for woody debris to block the access bridge (although this is limited due to the size of the bridge).

Overview of Management Reach 3



Reach character photographs

A: Shallow banks

B: In-channel habitat mosaic

C: Evidence of natural channel adjustment

D: Historic bank slumping

<table>
<tr><th colspan="4">MANAGEMENT REACH 4
SSSI UNIT: 3, 4</th></tr>
<tr><td>Upstream survey limit:</td><td colspan="2">Downstream survey limit</td><td>Length of river surveyed:</td></tr>
<tr><td>SK 78032 18377</td><td colspan="2">SK 77359 18193 - Change in geomorphological character</td><td>975m</td></tr>
<tr><td colspan="4">Reach characterisation</td></tr>
<tr><td colspan="4">Hydromorphology: In this management reach, the River Eye displays less sinuosity than the preceding reach and has more limited geomorphological diversity. The floodplain is relatively narrow, particularly at the left bank, where the channel approaches the valley side. Flow patterns and bank profiles are generally less diverse than the preceding management reach but the presence of shallow banks in sections throughout the reach indicates that it also has relatively good floodplain connectivity. Land use in the floodplain is similar to the preceding reaches, with the exception of a wooded section at Burbage's Covert.

Ecology: Typical riparian vegetation i.e. emergent vegetation comprise rushes, sedges and reeds, occasional willow trees form shading thereby creating areas of open water. Some areas of open water, occur independently of the willows, are edged with reeds and rushes with yellow water lily in the open water. Bank vegetation is dominated by nettles, bramble, willow herb occasional willow and hawthorn. A small deciduous wood occupies the downstream area of this reach.</td></tr>
<tr><td colspan="4">Targets for SSSI favourable condition</td></tr>
<tr><td>Attribute</td><td colspan="2">Survey assessment</td><td>Characteristics of Type II River</td></tr>
<tr><td>Flow dynamics and diversity</td><td colspan="2">Flow in this reach is dominated by low energy glide conditions and areas of no perceptible flow (Plate A). Flow characteristics are more uniform than the target conditions for the River Eye SSSI.</td><td>No</td></tr>
<tr><td>Substrate</td><td colspan="2">The sediment regime of this reach is dominated by the in-channel deposition of fine sediments, with one small area of clean gravel within a sinuous sub-reach. Stable silt deposits at the margins of the channel were observed throughout the management reach.</td><td>No</td></tr>
<tr><td>Channel and banks</td><td colspan="2">The planform within this reach displays low small-scale sinuosity and little evidence of active bank erosion (Plates B and C), associated with low energy flows and a shallow channel gradient. There are no embankments along the length of the management reach, and the banks are generally shallow (Plates B and D). No evidence of recent channel realignment or hard bank reinforcement was observed during the walkover survey. A lack of morphological diversity and sections of enlarged channel indicate that this reach is currently not compliant with site-specific targets.</td><td>No</td></tr>
<tr><td>Plant community species: Composition and abundance</td><td colspan="2">Key species from the constancy table for River Eye SSSI Conservation Objectives were observed, including branched bur-reed (Spargantium erectum), yellow water lily (Nuphar letea), willow (Salix spp.), greater willow herb (Epilobium hirsutum), reed canary grass (Phalaris arundinacea), spiked water-milfoil (Myriophyllum spicatum), fennel pondweed (Potamogeton pectinatus), arrowhead (Sagittaria sagittifolia). This represents an insufficient diversity to meet the site-specific target.</td><td>No</td></tr>
<tr><td colspan="4">Negative indicators</td></tr>
<tr><td>Native species</td><td colspan="2">Fennel pondweed / blanket weed identified within the reach of a coverage of >25%.</td><td>No</td></tr>
<tr><td>Alien/introduced species</td><td colspan="2">No alien or introduced species were seen.</td><td>Yes</td></tr>
<tr><td>In-stream barriers</td><td colspan="2">There are no in-channel structures in this management reach.</td><td>Yes</td></tr>
<tr><td colspan="2">Issues for restoration and management</td><td colspan="2">Potential restoration options</td></tr>
<tr><td colspan="2">• Lack of morphological diversity
• Siltation</td><td colspan="2">• In-channel enhancements to promote hydromorphological diversity
• Reinstatement of coarse bed material</td></tr>
</table>

Constraints
• Constraints related to current land use. • It may not be possible to increase coarse sediment supply over the sediment trap if any modifications compromise its performance in reducing fine sediment loads downstream.

Overview of Management Reach 4

Reach character photographs

A: Low energy flows with shading from mature trees

B: Shallow bank in straight sub-reach

C: Marginal habitats in open reach

D: Well vegetated sub-reach

MANAGEMENT REACH 5
SSSI UNIT: 4

Upstream survey limit:	Downstream survey limit	Length of river surveyed:
SK 77359 18193	SK 77357 18408	260m

Reach characterisation

Hydromorphology: Management Reach 5 is dominated run conditions and swifter flows than the upstream management reaches. Sediment transport is the dominant process, with the substrate displaying significant sections of clean gravels and other coarse sediment. Land use is characterised by riparian shrub and unimproved grassland on the left bank where the river approaches the edge of the floodplain **(Plates A and B).**

Ecology: Typical riparian vegetation i.e. emergent vegetation comprise rushes, sedges and reeds, occasional willow trees form shading thereby creating areas of open water. Some areas of open water, occur independently of the willows, are edged with reeds and rushes with yellow water lily in the open water. Bank vegetation is dominated by willow and hawthorn.

Targets for SSSI favourable condition

Attribute	Survey assessment	Characteristics of Type II River
Flow dynamics and diversity	Flows within this management reach are characterised by run and riffle conditions. This includes turbulent flows within the fastest flowing sub-reach. While velocities appear to be higher than in most of the other management reaches, some areas of slower flows remain. This indicates that there is good flow diversity throughout the management reach.	**No**
Substrate	The sediment regime is dominated by transport processes, supporting clean gravels and other coarse sediments throughout the large majority of the management reach **(Plate D).** The presence of macrophytes such as *Ranunculus* spp. in fast flowing sections of the reach results in the in-channel accumulation of isolated patches of fine sediment.	**No**
Channel and banks	Channel planform and bank profiles are determined by the position of the channel at the left side of the valley floor. The planform within this reach is slightly sinuous and channel banks are generally steep. Isolated evidence of channel adjustment through erosion of the right bank was observed. However, floodplain connectivity appears to be limited due to bank height **(Plate C).**	**No**
Plant community species: Composition and abundance	Key species from the constancy table for River Eye SSSI Conservation Objectives were observed, including branched bur-reed (*Spargantium erectum*), yellow water lily (*Nuphar letea*), willow (*Salix spp*.), greater willow herb (*Epilobium hirsutum*), reed canary grass (*Phalaris arundinacea*), spiked water-milfoil (*Myriophyllum spicatum*), fennel pondweed (*Potamogeton pectinatus*), arrowhead (*Sagittaria sagittifolia*). This represents an insufficient diversity to meet the site-specific target.	**No**

Negative indicators

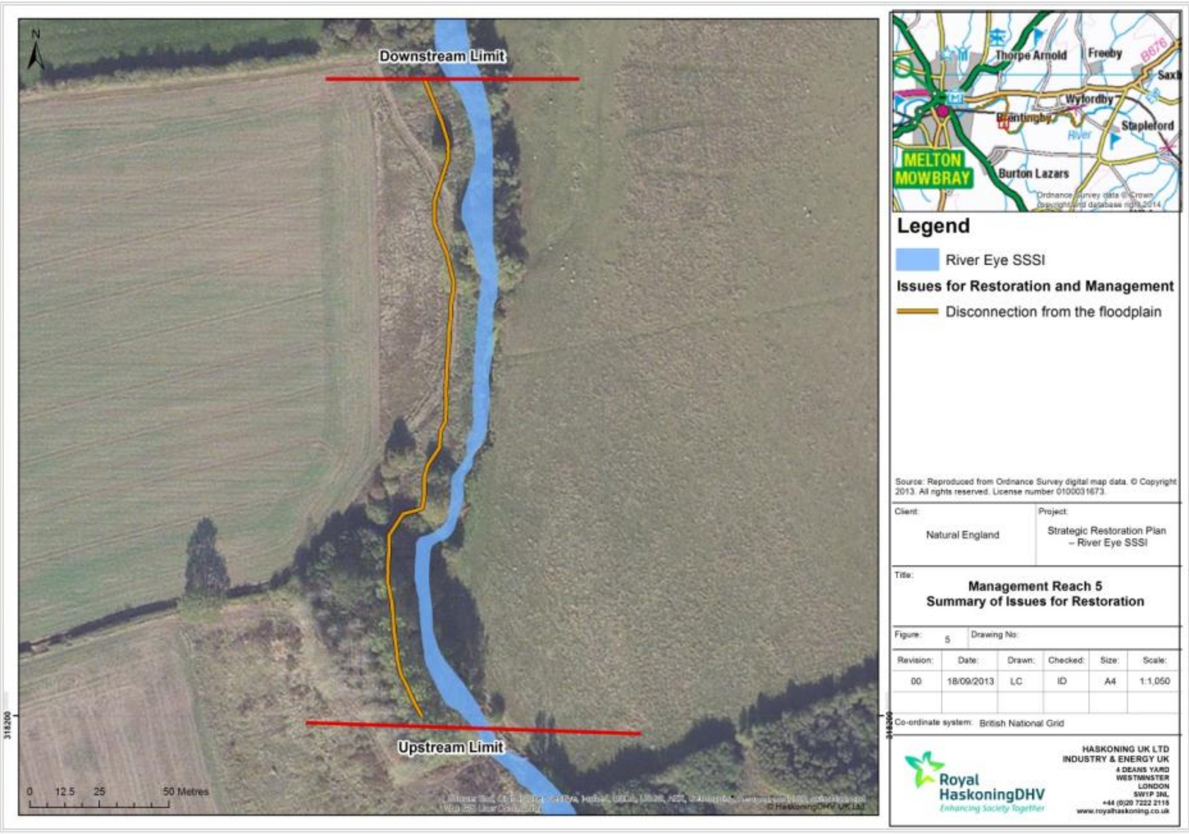
Native species	Fennel pondweed / blanket weed identified within the reach of a coverage of <25%.	**Yes**
Alien/introduced species	No alien or introduced species were seen.	**Yes**
In-stream barriers	There are no in-channel structures in this management reach.	**Yes**

Issues for restoration and management	Potential restoration options
• Disconnection from floodplain	• Limited regrading of right hand bank to improve channel-floodplain connectivity

Constraints

- Constraints related to current land use.

Overview of Management Reach 5



Reach character photographs

A: Typical floodplain profile

B: Run flow with channel adjustment on right bank

C: Riffle with exposed coarse bed material

D: Transitional section at downstream limit of reach

MANAGEMENT REACH 6 SSSI UNIT: 4		
Upstream survey limit:	**Downstream survey limit**	**Length of river surveyed:**
SK 77357 18408	SK 77435 18675 – FAS structures at Brentingby Junction	365m

Reach characterisation

Hydromorphology: In this management reach, the River Eye is dominated by glide conditions associated with a shallow channel gradient and impounding features at the downstream limit of the reach (undershot sluice gates). Valley form and land use on the floodplain are similar to Reach 5. Low flow velocities and impoundment result in the substrate character being dominated by fine sedimentation. Hard bank reinforcement is observed downstream and the channel is disconnected from its floodplain.

Ecology: Typical riparian vegetation i.e. emergent vegetation comprise rushes, sedges and reeds, occasional willow trees. Bank vegetation is open grazed grass with occasional mature willow trees and hawthorns. There are planted willows on the west bank.

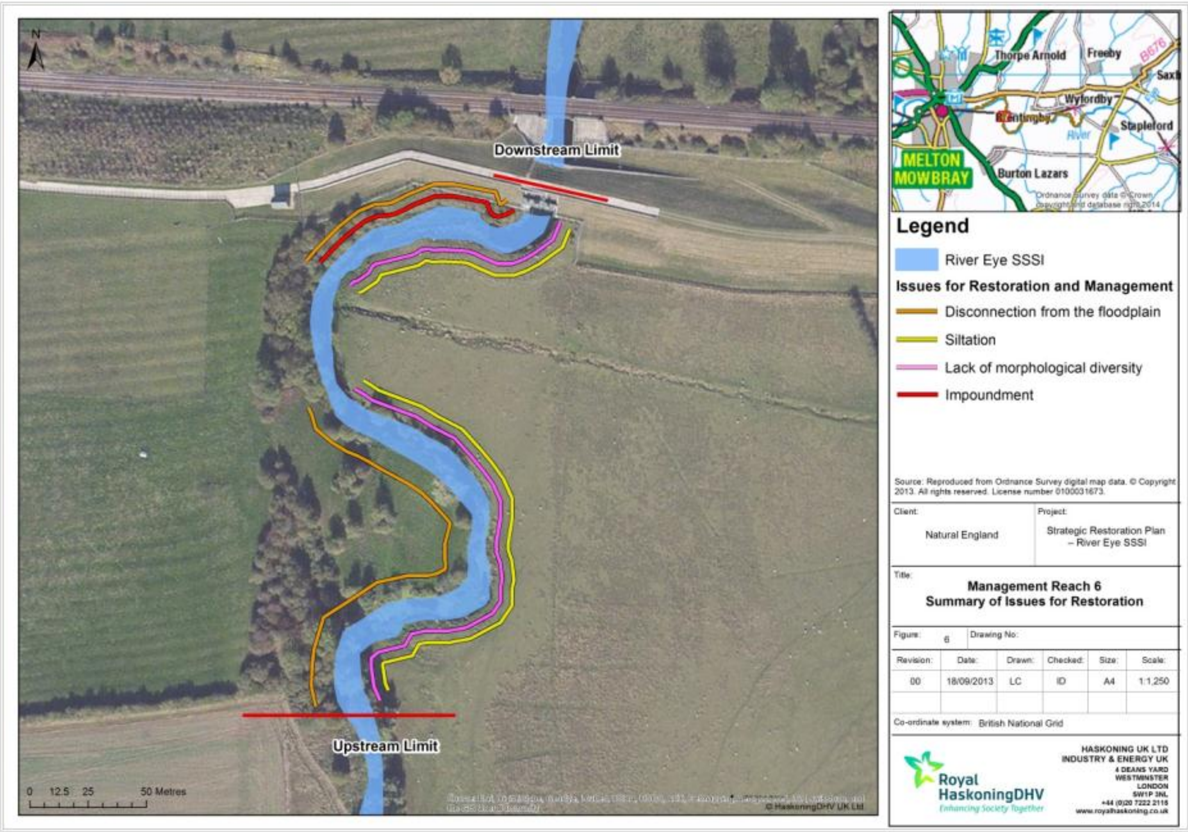
Targets for SSSI favourable condition

Attribute	Survey assessment	Characteristics of Type II River
Flow dynamics and diversity	Flow in this reach is dominated by impounded glide conditions and areas of no perceptible flow **(Plates A, B and C).** One riffle was observed **(Plate D);** however, this management reach is predominantly impounded by the structure at the downstream end.	**No**
Substrate	The sediment regime in this reach is dominated by the in-channel deposition of fine sediments with small, isolated sections of eroding bank toe observed along the riffle section of the reach where flow energies are higher. The coarse substrate is overlain with fine sediments, with stable silt deposits along the majority of the channel margins **(Plate A).** As a result, clean gravels only occur at the isolated riffle.	**No**
Channel and banks	The planform within this reach is slightly sinuous, with a shallow gradient and no evidence of channel straightening. The channel is over-deepened at the downstream section of the reach, in close proximity to the in-channel structure. There is also some hard bank reinforcement upstream of the structure **(Plate C).** The bank height indicates disconnection of the channel from its floodplain.	**No**
Plant community species: Composition and abundance	Key species from the constancy table for River Eye SSSI Conservation Objectives were observed, including branched bur-reed (*Spargantium erectum*), yellow water lily (*Nuphar letea*) and willow (*Salix spp*.). This represents an insufficient diversity to meet the site-specific target.	**No**
Negative indicators		
Native species	Pondweed / blanket weed identified within the reach of a coverage of <25%.	**Yes**
Alien/introduced species	No alien or introduced species were seen.	**Yes**
In-stream barriers	The downstream limit of this management reach is characterised by the presence of undershot sluices which control flows beneath the railway line.	**Yes**

Issues for restoration and management	Potential restoration options
• Impoundment • Siltation • Lack of morphological diversity • Disconnection from floodplain	• Bank regrading to promote floodplain connectivity • In-channel enhancements to promote hydromorphological diversity • Reinstatement of coarse bed material

Constraints
• Constraints related to current land use. • Operation of Flood Alleviation Scheme – flood risk cannot be increased. • Potential for woody debris to block the flood alleviation structures, requiring increased maintenance. • Any modifications must avoid changes to the railway embankment.

Overview of Management Reach 6

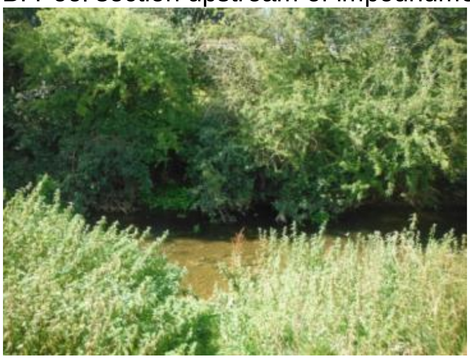


Reach character photographs

A: In-channel sediment deposition

B: Pool section upstream of impoundment

C: Impoundment due to sluices



D: Riffle and adjacent toe scour

MANAGEMENT REACH 7 SSSI UNIT: 5		
Upstream survey limit:	**Downstream survey limit**	**Length of river surveyed:**
SK 77435 18675 – FAS structures at Brentingby Junction	SK 77169 19209 - Lag Lane	885m

Reach characterisation

Hydromorphology: In this reach, the River Eye remains over deep and is dominated by low energy glide conditions and fine sedimentation. However, the steep, shallow banks are subject to considerable erosion and collapse, creating a degree of lateral channel variability in the reach. This process of natural recovery is helping to increase geomorphological diversity in parts of the reach, although others remain uniform. There are areas of floodplain wetland habitat, but these appear to be disconnected from the river channel **(Plate A).**

Targets for SSSI favourable condition

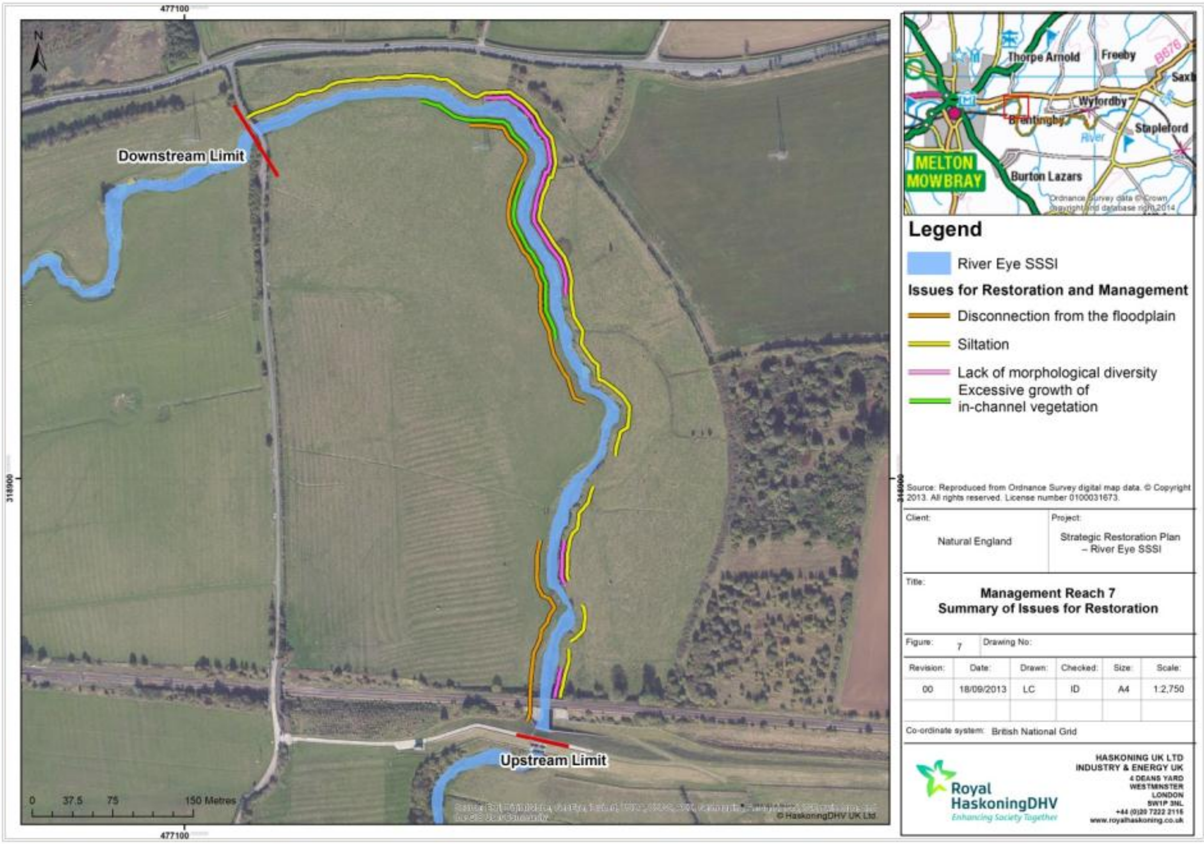
Attribute	Survey assessment	Characteristics of Type II River
Flow dynamics and diversity	Flows in this reach are dominated by low energy glides. There is very limited development of swifter flows in areas where in-channel vegetation has encroached sufficiently to narrow the river channel.	**No**
Substrate	The substrate in this reach is dominated by fine sedimentation, which is likely to be sourced from actively eroding parts of the bank in the reach as well as from wider catchment sources upstream. Areas of coarser substrate are largely absent, although swifter flows in localised reaches that have been narrowed by in-channel vegetation growth are less affected by siltation.	**No**
Channel and banks	The river banks are either steeply graded or consist of vertical cliffs which are subject to considerable lateral erosion and bank failure **(Plate B and C).** Deposition of this material along the channel margins and subsequent vegetation colonisation has helped to create low-level berms along much of the reach, which locally increases geomorphological diversity **(Plates C and D).** However, the channel remains enlarged and uniform in much of the reach, and therefore does not meet the standards required for the SSSI.	**No**
Plant community species: Composition and abundance	Key species from the constancy table for River Eye SSSI Conservation Objectives were observed, including branched bur-reed (*Spargantium erectum*), yellow water lily (*Nuphar letea*) and willow (S*alix spp*.). This represents an insufficient diversity to meet the site-specific target.	**No**
Negative indicators		
Native species	Algae identified within the reach of a coverage of <25%.	**Yes**
Alien/introduced species	No alien/introduced species were identified throughout this reach.	**Yes**
In-stream barriers	Lag Lane crosses the river at the downstream end of the reach, with a single bridge pier in the centre of the channel. However, this does not appear to adversely affect the hydromorphology of the river.	**Yes**

Issues for restoration and management	Potential restoration options
• Lack of morphological diversity • Siltation • Disconnection from floodplain • Excessive growth of in-channel vegetation	• In-channel enhancements to promote hydromorphological diversity • Encourage further natural recovery of bank structure and berm formation • Reinstatement of coarse bed material

Constraints

- Constraints related to current land use.
- Potential for woody debris to block the bridge at Lag Lane (although this is limited due to the size of the bridge).

Overview of Management Reach 7



Reach character photographs

A: Artificial floodplain wetland (JBA, 2013)

B: Active reach with bank erosion (JBA, 2013)

C: Collapsing bank and naturalising riparian margin

D: Low level berm development

MANAGEMENT REACH 8 SSSI UNIT: 6		
Upstream survey limit:	**Downstream survey limit**	**Length of river surveyed:**
SK 77169 19209 - Lag Lane	SK 76341 18814 - SSSI Downstream limit	1320m

Reach characterisation

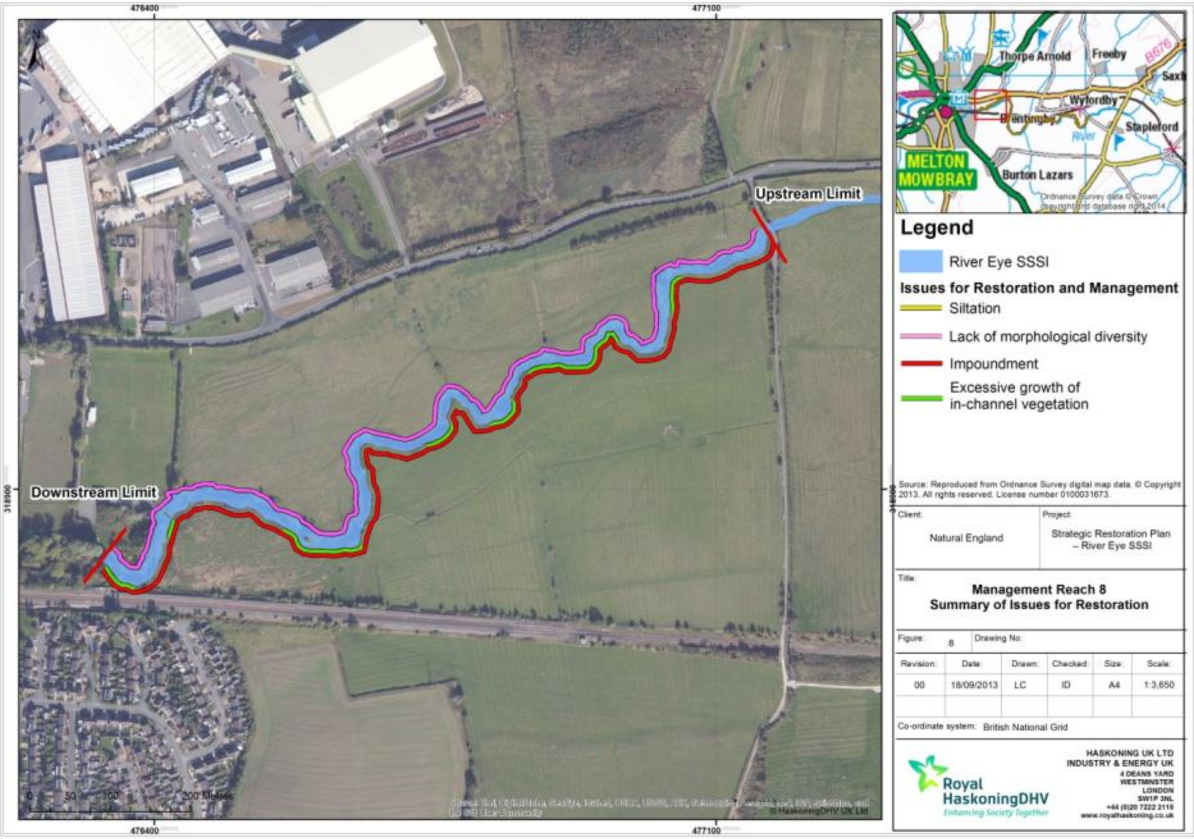
Hydromorphology: In this reach, the River Eye is heavily influenced by the weir complex downstream of the SSSI, which create uniform impounded flows, extensive fine sedimentation, and a general lack of flow and morphological diversity. Areas of bank have collapsed, potentially in response to pressures from grazing livestock, and low level berms have formed at the upstream end of the reach. This suggests that natural recovery may be occurring in parts of the reach that are less affected by impoundment pressures.

Targets for SSSI favourable condition

Attribute	Survey assessment	Characteristics of Type II River
Flow dynamics and diversity	Flows in this reach are uniformly impounded **(Plate A);** these conditions extend for more than 1km upstream of the weirs downstream of the SSSI. Although vegetation encroachment narrows the channel in places, this does not appear sufficient to introduce any flow diversity.	**No**
Substrate	The impounded conditions which dominate the reach have resulted in extensive siltation on the river bed upstream. The bed is very uniform and there do not appear to be any areas of clean gravel in the main river channel. Swift flows in the side channel downstream of the SSSI weir maintain clean gravel substrate, however.	**No**
Channel and banks	The channel has been extensively enlarged and locally realigned, most noticeably near the weirs at the downstream end of the reach **(Plate B).** Although the banks are relatively shallow, historical channel enlargement and the upstream flood storage area cause a degree of disconnection. Although the banks are largely stable and uniform, there are extensive areas of bank collapse (particularly at the upstream end of the reach) **(Plate C).** The wide, flat floodplain is used for pastoral agriculture, and grazing is allowed right up to the river's edge. This may have contributed towards bank collapse in some places. Low level berms have formed in places, and they are naturally narrowing the channel **(Plate D).**	**No**
Plant community species: Composition and abundance	Impounded conditions have resulted in the development of plant community that is associated with still water environments. Intense grazing activity limits the development of riparian vegetation throughout the reach. In-channel macrophyte growth is not widespread throughout the reach. Filamentous algae have been identified in association with areas of slow flows.	**No**
Negative indicators		
Native species	Algae identified within the reach of a coverage of <25%.	**Yes**
Alien/introduced species	No alien/introduced species were identified throughout this reach.	**Yes**
In-stream barriers	There are three major weirs at the downstream end of the reach (below the SSSI limit) which cause significant impoundment. These are locally known as the SSSI Weir, Thorpe Brook Weir, and Scafford Brook Weir.	**No**

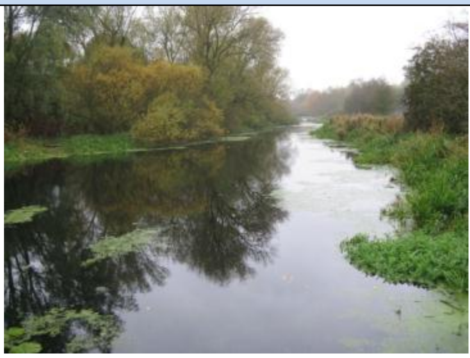
<table>
<tr><th>Issues for restoration and management</th><th>Potential restoration options</th></tr>
<tr><td>Impoundment
Siltation
Lack of morphological diversity</td><td>Reduce impoundment from weirs
In-channel enhancements to promote hydromorphological diversity
Encourage further natural recovery of bank structure and berm formation
Reinstatement of coarse bed material</td></tr>
<tr><th colspan="2">Constraints</th></tr>
<tr><td colspan="2">The in-channel structures just below the SSSI must be addressed first before any works are carried out within their zone of influence. See JBA 2013 for consideration of design options and preferred solution (JBA, 2013).
Constraints related to current land use.
Flood risk cannot be increased as a result of channel modifications.
Water levels in Scalford Brook need to be retained to avoid compromising the water abstraction point.</td></tr>
</table>

Overview of Management Reach 8



Reach character photographs

A: Uniform, impounded flows



B: Historically enlarged channel

C: Bank collapse

D: Low level berm development

5.4 Overview of catchment conditions

This section describes the comparison between the data gathered as part of the production of this report and the data presented in previous reports by APEM (2010), Royal HaskoningDHV (2012) and JBA (2013). The ideal conditions under relatively natural conditions for this type of river and specific SSSI are defined in Natural England's 2007 and 2010 condition assessment reports. Headings within this section follow the criteria laid out in the site specific standards for the SSSI (Natural England, 2010).

5.4.1 Substrate

Required characteristics

The substrate in lowland, clay-dominated Type II rivers should comprise of silts and sands in sections characterised by slow flows, and coarse gravels in swifter flowing riffles. The site-specific targets for the River Eye SSSI highlight the importance of most sites displaying a variety of channel substrates. Widespread siltation on the channel bed has, therefore, been identified as a barrier to achieving favourable SSSI condition **(see Section 3).**

Observed substrate conditions

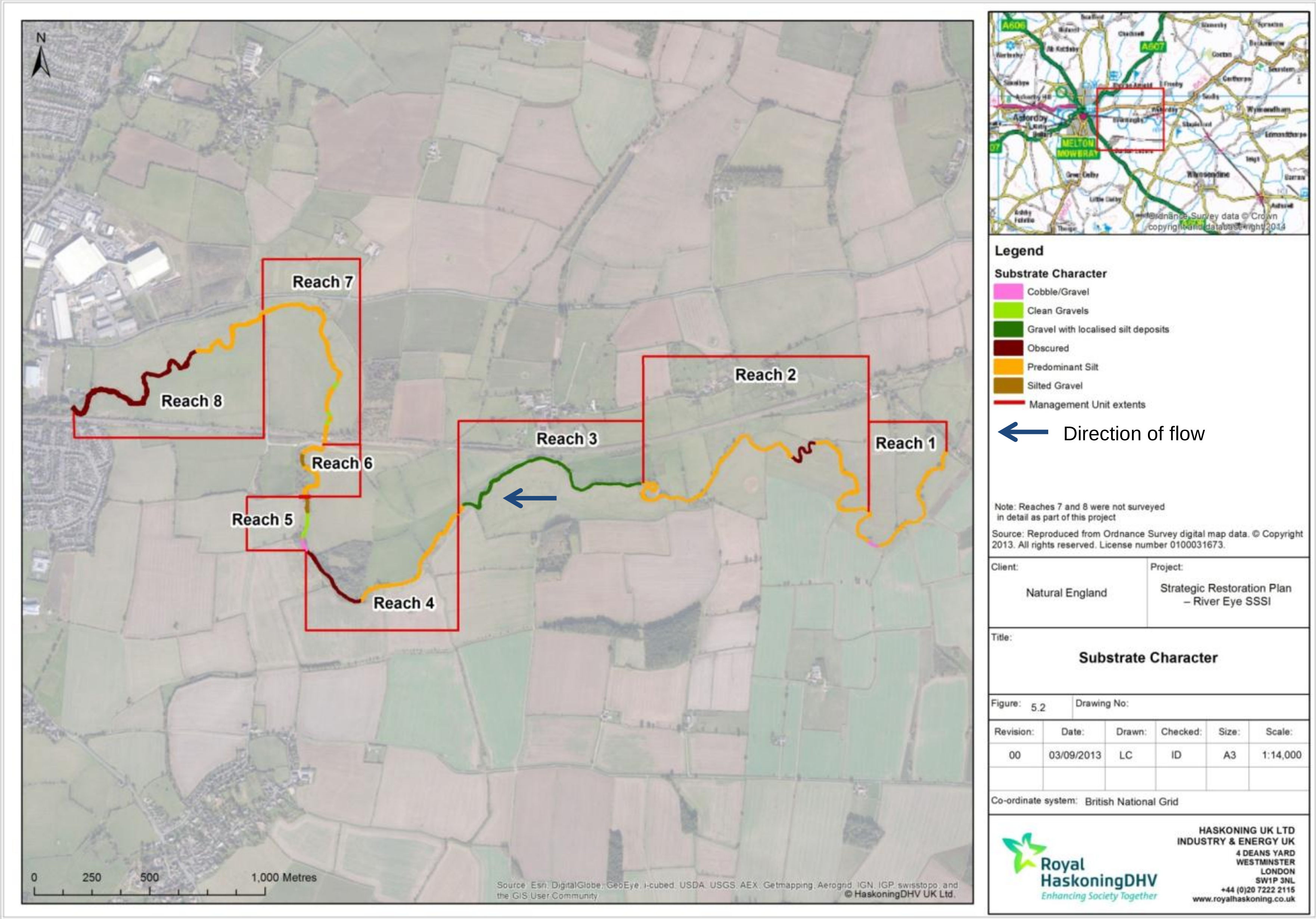
The fluvial audit has demonstrated that the sediment regime in the River Eye SSSI is dominated by depositional processes, with substantial evidence of fine siltation. The substrate composition of the River Eye SSSI is closely linked to low flow velocities which dominate the majority of the designated area. The substrate in the upper reaches of the SSSI (Management Reaches 1 and 2), as well as the majority of the downstream sections of the study area (Management Reaches 4, 6, 7 and 8), are dominated by fine sediments, with apparently uniform bed conditions. The proportion of gravel substrate increases significantly in the middle section of the study area (Management Reach 3) and within a small downstream sub-section (Management Reach 5). The increase in the proportion of coarse sediment at these sites does not appear to be connected to an increased supply of coarse sediments, since no areas of direct bank erosion were observed upstream. It is therefore likely that the increase in clean gravels results from localised increases in geomorphological diversity associated with channel narrowing due to the development of vegetated berms, increased channel gradient (Management Reach 5 only) and increased flow velocities **(Figure 5.2).** Although the gravel supply is limited by upstream obstructions (potentially including Stapleford Weir, the Flood Alleviation Scheme and the Sediment Traps at Ham Bridge and Sawgate Road, it appears that there is sufficient material in the system (including in-situ material and sediment that is transported over these obstructions and/or derived from tributary sources during high flows) to support coarse substrate when flows have sufficient velocity to prevent fine sedimentation. This means that it may be possible to encourage further substrate recovery in suitable reaches through physical modifications to bed and bank form which increase flow energy.

Agricultural run-off, sewage and industrial discharges have been identified as significant fine sediment sources within the River Eye SSSI (Natural England, 2011). The data collected during the fluvial audit suggests that sediment transport and run-off from surrounding agricultural land as the principal sources for observed sediment deposits, with active bank erosion and bed scour scarcely present apart from very isolated areas in Management Reaches 3 and 5. No significant sediment input from tributaries was observed at the time of survey, given the lack of significant rainfall events in the preceding weeks. Tributary sources, are, however, likely to be a significant source of fine sediment, and steeper tributaries such as Whissendine and Whymondham Brooks are also likely to supply coarse sediment. Concurrently, potential historical dredging activities (or natural channel incision) throughout the SSSI is likely to be responsible for observed increases in channel capacity throughout the SSSI. It is likely that these channel modifications have, in conjunction with the shallow channel gradient characteristic of this river type, exacerbated the observed sedimentation issues, since low energy flows in the enlarged channel sections are less able to transport sediments than swifter flows in more natural channels.

As a result, the range of aquatic habitats supporting species associated with high quality interstitial waters and coarse sediment is limited. Suitable habitat for fish spawning and aquatic vegetation such as water crowfoot and water milfoil is generally limited, with the exception of Management Reaches 3 and 5. Where flows are sufficiently fast to prevent siltation (e.g. in reaches that have not been artificially enlarged, or where inset berms have developed at the bank toe), the river bed displays a mosaic of substrate materials characteristic of this river type.

Contrary to conclusions from the “Common Standards Monitoring Condition Assessment of River Eye SSSI” report (Natural England, 2010b), bed siltation was assessed as a widespread barrier to favourable SSSI condition throughout the study area. Notable exceptions were Management Reaches 3 and 5 (accounting for approximately 24% of the length of the study area). This disparity in assessment appears to be associated with methodological differences between the reports. While siltation was tallied continuously throughout the study area as part of this study, the earlier report made use of two sampling sites for assessment of siltation. One of the sampling locations chosen in the earlier report is located within Management Reach 3, which appears to have favourable substrate conditions. It this therefore likely that the previous assessment is not representative of the overall substrate condition of SSSI Units 1 – 4 and that previous assessments of widespread siltation based on local knowledge are correct.

Figure 5.2: Substrate character overview



5.4.2 Channel and banks

Required characteristics

The River Eye SSSI should be characterised by a sinuous meandering and largely natural planform. Bank structure should be characterised by sequences of alternating steep and shallow bank profiles, potentially leading to vertical cliffs and point bars. Hard bank reinforcement and channel realignment should be restricted to no more than small areas of the channel. No substantial widening or deepening of the channel should be present under favourable conditions (Natural England. 2010b).

Observed planform and profile characteristics

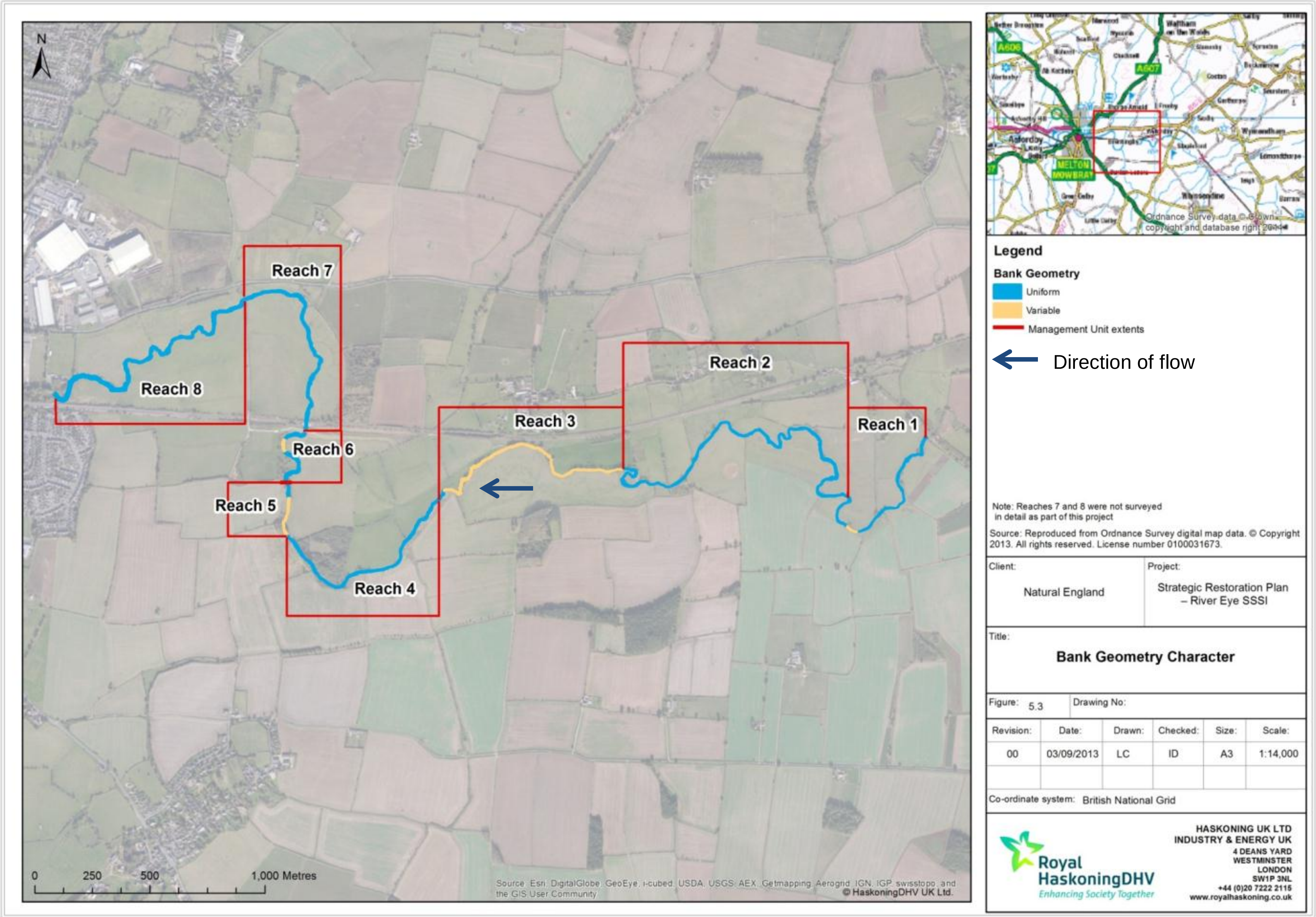
On a study-area scale, the River Eye SSSI is characterised as a sinuous lowland river system. Management Reaches 1, 2, and 6 displays the most sinuous planform within the study area, with no management reach showing signs of recent channel straightening. Analysis of historical mapping supports the hypothesis that no anthropogenic channel straightening has affected the River Eye SSSI planform over the last century.

However, the capacity of the channel is likely to have been enlarged historically. The mechanism for this enlargement is unclear, although it could be a result of historical dredging activities, natural incision as a response to increased connectivity with the drainage network, or a combination of the two. The increase in channel capacity and cross section means that the banks of the River Eye SSSI are generally high and moderately steep. Areas affected by localised geotechnical failure and livestock trampling are restricted to Management Reach 3 (where the apparent absence of dredging has contributed to lower, more natural banks and collapsed agricultural fencing allows grazing in proximity to the river channel) and parts of Management Reaches 7 and 8 (where the banks are actively collapsing). Management Reach 3 approaches the ideal conditions for this type of river under the low anthropogenic impact scenario, with a sequence of shallow and steep banks and good floodplain connectivity. With the exception of this management reach and isolated sections associated with riffle features, the majority of the study area displays a bank geometry characterised by a uniform, trapezoidal cross section with high banks and limited floodplain connectivity **(Figure 5.3).**

The presence of natural bank adjustment and the formation of low level inset berms in the channel margins in parts of Management Reaches 7 and 8 (which are likely to have formed as a result of prolonged high in-channel flows when flood waters are released from the flood alleviation scheme at Brentingby) suggest that the river is beginning to recover naturally to the physical modifications that affect it. However, this recovery is limited by the influence of impoundment from the weir complex at the downstream end of the SSSI.

No hard bank reinforcement was observed in the study area, with the exception of the downstream limit of the study area, within 50m of the structures associated with the Melton Mowbray FAS at Brentingby Junction.

Figure 5.3: Bank geometry character overview



The trapezoidal cross-sectional profile with an over-wide and over-deep channel which dominates the majority of the SSSI is strongly associated with the small, abrupt zone of hydrological transition observed during the fluvial audit. The lack of a more natural, gradual transitional zone limits the range of habitat niches that are supported in the margins of the channel. This limits the potential for colonisation of emergent species such as branched bur-reed and reed canary grass, wetland species such as brook-lime, water forget-me-not, water-mint and water-cress, and invertebrates which depend upon them.

5.4.3 Flow dynamics and diversity

Required characteristics

Flow characteristics for this river type are likely to be dominated by glide flows, while retaining some flow diversity characterised by occasional riffle features or impounded sections associated with large woody debris.

Observed flow characteristics

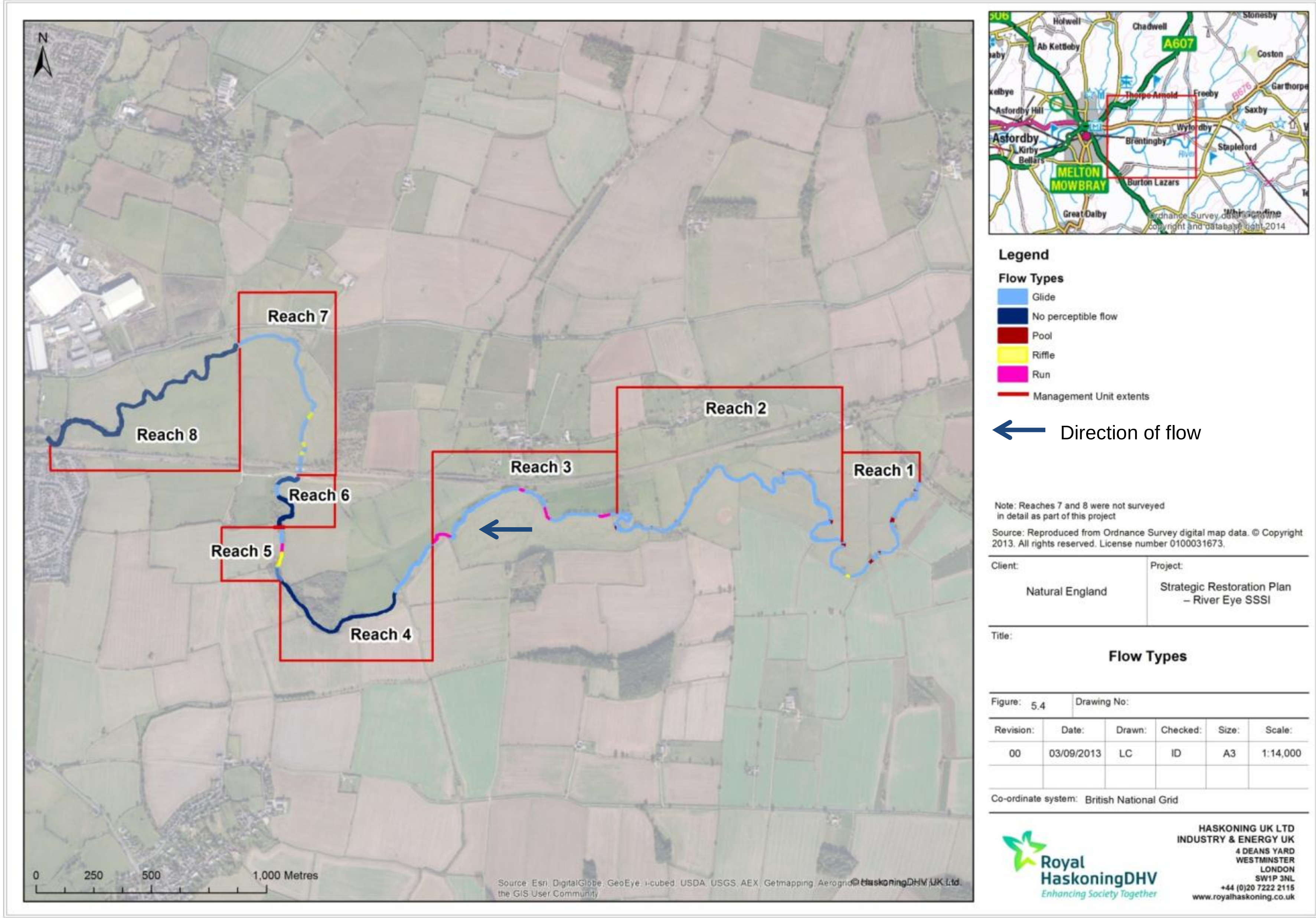
The flow regime along a large proportion of the River Eye SSSI is characterised by glide flows, broadly complying with the requirements for Type II lowland, clay dominated rivers **(Figure 5.4).** However, widespread channel enlargement has resulted in a reduction in the occurrence of faster flow velocities, as well as riffle features. These are of crucial importance to the maintenance of the mosaic of in-channel habitats that support the characteristic flora and fauna of this river type.

Zones of no perceptible flow are frequent through Management Reaches 1, 2, 4, 6, 7 and 8. While the presence of slow flowing sections is not in disagreement with targets for favourable SSSI condition, their prevalence over faster flowing sections and riffle features is concurrent with widespread presence of enlarged sections throughout the study area. This displays a lack of compliance to the targets for this type of river and the River Eye SSSI.

Impoundment by in-channel structures is a major issue in Management Reach 8 at the downstream end of the SSSI **(see Section 5.3.4 for further details).** However, natural impounding features are scarce throughout the study area, with infrequent large woody debris associated with riparian tree cover. Although infrequent, this feature is distributed throughout the study area, in compliance with defined SSSI targets.

Notable exceptions to the uniform flows occur in Management Reaches 3 and 5. Management Reach 3 includes a good range of in-channel geomorphological features including low berms and small point bars associated with light grazing and localised bank collapse, resulting in variable flow types with faster flows coexisting with areas of refugia. This reach is therefore a good example of ideal flow characteristics for this type of a shallow gradient river. Reach 5 is, in turn, dominated by fast flow velocities. The fast flows observed in this reach are directly associated with an atypical steeper channel gradient and are not easily replicable throughout the rest of the study area, making this management reach less suitable as a reference for the restoration of the River Eye SSSI. The geomorphological features within these reaches represent a significant contribution to the achievement of the flow diversity targets associated with favourable condition in the River Eye SSSI.

Figure 5.4: Flow type overview



5.4.4 In-channel structures

In-channel structures alter the natural processes which operate within the river channel, creating slow flowing impounded conditions upstream and preventing the free movement of fish and other aquatic organisms (**Figure 4.7** shows the in-channel structures in the River Eye catchment). This change in conditions can encourage fine sedimentation, reduce the movement of coarse sediments, and create uniform bed habitats. In addition, impounded conditions can also result in increased water temperature and a change from biological communities from those that prefer active flows to those that prefer still water.

Stapleford Weir, located upstream of the SSSI, is likely to impact upon the downstream channel by reducing the supply of coarse sediment from the headwater tributaries of the River Eye. However, the scale and significance of any impact is currently unclear, since there appears to be sufficient coarse material in situ in several reaches **(cf. Section 5.4.1).**

The undershot flood gates at the downstream limit of Management Reach 6 (part of the Melton Mowbray FAS at Brentingby Junction) are the only in-channel structures within the SSSI. Downstream impoundment associated at Brentingby Junction was not significant at a study-area scale at the time of the fluvial audit, impacting no more than 50m upstream of the downstream limit of Management Reach 6. In addition, the structure did not appear to cause any significant increase in upstream sedimentation (fine or coarse), which suggests that the current operational regime does not have a significant impact on sediment conveyance. However, the structures artificially maintain bankfull flow conditions upstream, and reduce the frequency of larger out of bank flows downstream. This means that they are likely to reduce geomorphologically effective flows and have an impact on downstream channel geomorphology. Conversely, evidence from landowners at the site suggests that the release of stored floodwater from the floodplain upstream of the structure creates prolonged periods of high velocity flows in the river downstream. These flows are likely to be responsible for the geomorphological changes that have been observed downstream of the FAS structures.

The sediment traps on the River Eye at Ham Bridge and Burton Brook at Sawgate Road are also likely to have some impact on the SSSI. Their main function of reducing fine sediment supply is likely to be beneficial for SSSI communities, however, and it is unclear whether they disrupt the supply of coarse sediments.

Further downstream, it is clear that the major weir complex that is located immediately downstream of the SSSI has a significant impact on Management Reach 8, creating uniform impounded conditions for at least 1km upstream. This is likely to promote fine sedimentation, limit geomorphological diversity, and reduce the effectiveness of the natural recovery that has been identified in parts of Management Reaches 7 and 8.

5.4.5 Habitat structure and species abundance

The 2013 ecological survey noted that the typical emergent vegetation along the entire length of the River Eye SSSI comprised rushes, sedges and reeds. There are occasional semi-mature and mature willow trees which provide shading thereby creating areas of open water. Some areas of open water occur independently of the willows, being dominated by rushes and reeds.

Key species of marginal vegetation during the 2013 survey include Bulrush (*Scirpus lacustris*), branched bur-reed (*Spargantium erectum*), flowering rush (*Butomus umbellatus*), greater pond-sedge (*Carex riparia*), slender tufted-sedge (*Carex acuta*), reed canary grass (*Phalaris arundinacea*) and arrowhead (*Sagittaria sagittifolia*). Within the river, yellow water lily (*Carex acuta*), floating pondweed (*Potamogeton natans*), spiked water-milfoil (*Myriophyllum spicatum*), fennel pondweed (*Potamogeton pectinatus*), and some blanket weed were recorded. Vegetation along the River Eye banks was noted to include stinging nettles (*Urtica dioca*), marsh woundwort (*Stachys palustris*), thistle spp, greater bindweed (*Calystegia sepium*), dock species, greater willow herb (*Epilobium hirsutum*) and willow species.

Within Management Reach 3, an otter spraint and feeding remains (the remains of a white clawed crayfish) were noted, therefore indicating the presence of otters and white clawed crayfish along the River Eye. No evidence of other legally protected species, e.g. water voles and badgers, was noted during the 2013 ecological survey. However the absence of these species is not conclusive that they are not present, given that the River Eye has the potential to support such species due to the presence of suitable habitats (e.g. shelter and food sources for water voles).

5.4.6 Invasive non-native species

No invasive non-native species were observed during the walkover survey, which suggests that this is not an issue in the River Eye SSSI. The walkover surveys were unable to determine the presence of signal crayfish (*Pacificastacus leniusculus*) in the catchment; however, Himalayan balsam (*Impatiens glandulifera*) is present in Management Reach 8.

5.5 Key issues affecting the condition of the SSSI

The previous sections demonstrate that the condition of the River Eye SSSI is adversely affected by physical modifications, which impact upon the habitats that can be supported. The desk-based assessment and field survey demonstrate that there are four primary issues which are likely to be responsible for the adverse condition of the SSSI:

- **Fine sediment supply and deposition:** Fine sedimentation is a persistent issue throughout the River Eye SSSI, and is largely attributable to the input of fine sediment from erodible agricultural soils into the drainage network and main river channel. An increase in channel capacity as a result of historical modifications and natural processes, and a change in river flow regime due to the influence of the weir complex downstream of the SSSI combine with the increased sediment supply to promote in-channel sedimentation. Excessive fine sedimentation has a detrimental effect on river habitat by reducing the diversity of the channel bed and creating uniform, silted conditions. Where coarser sediments are present, sedimentation will also inhibit flora and fauna that rely on these sediments.
- **Channelisation and disconnection from the floodplain:** A large proportion of the river channel has been historically modified as a result of anthropogenic changes and natural processes. This results in an enlarged channel with relatively high banks and uniform geomorphology. As a result, the floodplain is largely disconnected from the river channel during lower flows. This limits the frequency by which fine sediment can be transferred from the river and stored on the floodplain, and creates an abrupt transition between the aquatic and terrestrial environments that constrain habitat diversity and the development of floodplain wetland habitats. The geomorphological uniformity of the channel and lack of in-channel features which act as niche habitats also limits the range of habitats that can be supported. In particular, the important habitats which are representative of a gradual transition between aquatic and terrestrial conditions are largely absent from a large proportion of the river channel. Furthermore, the enlargement of channel capacity creates low energy flow conditions, which exacerbates the fine sedimentation issues caused by sediment over-supply and impoundment.
- **In-channel structures:** The River Eye is affected by several In-channel structures, including Stapleford Weir upstream of the SSSI limit, the flood control gates at Brentingby, and the weir complex at the downstream limit of the SSSI. These structures alter the natural functionality of the geomorphological and hydrological processes that operate within the river channel, creating slow flowing impounded conditions upstream and potentially limiting coarse sediment supply downstream. These low energy conditions combine with high fine sediment supply to encourage sedimentation in the channel. Structures also act as significant barriers to the free movement of fish and other aquatic organisms in the SSSI, and may also increase temperature and promote still water species.
- **Lack of suitable riparian habitats:** Marginal and riparian vegetation provides shelter for both terrestrial species and aquatic species in the channel. The channelisation issues described above have limited the occurrence of good quality emergent and marginal habitats which are supported by gentle bank profiles and a gradual transition between the aquatic and terrestrial environments. In addition, lack of tree cover in some reaches limits the frequency of tree roots and woody debris in the channel and allows water temperatures to increase when the sun is directly on the water, constraining the quality of habitats that the channel supports. However, it is important that over-shading, which limits the amount of light that penetrates the water column and restricts plant growth, does not occur as this also limits habitat development.

The ways in which the key issues adversely affect the SSSI are summarised in **Table 5.3.**

Table 5.3: Key issues identified within the River Eye SSSI

Key issue	Example photograph	Characteristic impacting on the ecology of the SSSI	Management Reach							
			1	2	3	4	5	6	7	8
			Corresponding SSSI Units							
			1	*1,2*	*2,3*	*3,4*	*4*	*4*	*5*	*6*
Fine sediment supply and deposition	 A uniform part of MU8 where slow flows have encouraged fine sedimentation on the river bed.	• High turbidity in the water column limiting light penetration for macrophytes • Fine sedimentation on the channel bed limiting habitats for macrophyte communities, invertebrates and fish	✓	✓	-	✓	-	✓	✓	✓
Channelisation and disconnection from the floodplain	 Steep sided bank in MU1 which has resulted in reduced floodplain connectivity and low energy flows.	• Floodplain disconnection, limiting the development of riparian and wetland habitats for bird populations • Exacerbation of fine sedimentation issues • Lack of marginal habitats for colonisation by aquatic vegetation • Lack of morphological and flow diversity, limiting the range of habitats for fish and invertebrate communities • Higher energy flows contained within channel, increasing risk of erosion and bank failure	✓	-	✓	✓	✓	✓	✓	✓

Key issue	Example photograph	Characteristic impacting on the ecology of the SSSI	Management Reach							
			1	2	3	4	5	6	7	8
			Corresponding SSSI Units							
			1	*1,2*	*2,3*	*3,4*	*4*	*4*	*5*	*6*
In-channel structures	 An example of a weir that forms part of the weir complex at the downstream extent of the River Eye SSSI.	• Creation of impounded conditions • Exacerbation of fine sedimentation issues • Potential disruption of coarse sediment transport • Physical barrier to free movement of fish and other aquatic organisms • Lack of flow diversity, and reduced ability to tolerate flow variations	-	-	-	-	-	✓	-	✓
Lack of suitable riparian habitats	 An example of a reach with a lack of suitable riparian and marginal habitats in M.	• Limited in-channel shelter for fish populations and invertebrates • Limited riparian shelter for bird communities and mammals	✓	✓	-	-	-	-	✓	✓

6 CONCLUSIONS AND FURTHER ACTION

6.1 Purpose of this section

This section provides a brief summary of the key geomorphological issues which adversely affect the condition of the River Eye SSSI, justifies the need for further action and outlines the approach that will be used in the development of a strategic plan to address these issues and restore the river to its favourable SSSI condition.

6.2 Summary of key issues

The previous sections have demonstrated that the geomorphology of the River Eye SSSI is controlled by the interaction of a complex range of physical and hydrological parameters. Four main factors have been identified as key issues which adversely affect the condition of the SSSI:

- Fine sediment supply and deposition.
- Channelisation and disconnection from the floodplain.
- In-channel structures.
- Lack of bankside shelter and shading.

It is therefore important that these issues are addressed effectively in any future restoration actions undertaken within the SSSI.

6.3 Restoring the River Eye SSSI

6.3.1 Development of a restoration strategy

The previous sections have demonstrated that there are a number of key geomorphological issues within the River Eye SSSI that are adversely affecting the lowland river habitat. These habitats are to some extent dependent on the physical habitat conditions which support them, which are themselves controlled by the interaction of geomorphological and hydrological parameters. There is therefore a clear need to develop a restoration strategy to ensure that the SSSI reaches favourable condition.

6.3.2 Principles of restoration

The national guidelines for physical restoration of SSSI rivers (Natural England, 2010) outline a process for generating a strategic restoration plan consistent with the favourable condition of the whole river, whilst taking into account constraints.

The guidelines attempt to move physical restoration efforts away from *ad hoc*, opportunistic, reach-based activities to whole-river strategic plans based around the concept of assisted natural recovery, with sequenced practical measures, clear roles for all interested parties, and identified resourcing mechanisms. These plans need to define restoration requirements throughout the designated length of river, ensuring that habitat degradation problems are resolved at source as far as possible. This often means resolving local habitat problems through measures on upstream or downstream reaches. With such a plan in place, quick-wins can be recognised and acted upon but as part of a strategic process recognising all habitat degradation problems and solutions to larger scale geomorphological impacts.

Potential solutions will follow three levels of intervention:

- **Conserve and enhance:** The lowest level of intervention, where areas of high quality habitat are protected and minor improvements are undertaken.
- **Rehabilitate (assisted natural recovery):** The next level of intervention, which is based on working with natural processes to encourage geomorphological and ecological development.
- **Restore:** The highest level of intervention, which involves more intensive intervention and creation of new habitats.

6.3.3 Restoration vision

The overall vision for the River Eye SSSI is based on the analysis presented in the previous sections of the report, and builds upon work previously undertaken in the catchment (e.g. APEM, 2010). This vision is to have a river system that exhibits an increased amount of connectivity with its floodplain and associated wetlands. This can be achieved through sustainable practices in agriculture and development and a certain degree of river restoration techniques where appropriate.

The vision has several key objectives that need to be delivered to improve the condition of the River Eye SSSI:

- Creation of a wider riparian corridor, for example by setting back agriculture and allowing natural marginal and riparian habitats to develop.
- Establishment of a wider variety of substrate conditions, flow types and depths, for example by introducing large woody debris, narrowing the channel and, if there is a lack of coarse sediment supply, targeted seeding of coarse substrates.
- Increase hydrological connectivity between the river and riparian zone, for example by regrading the banks and allowing natural marginal and riparian habitats to develop.
- Reduce the impact of impoundments, for example by removing structures, bypassing them, or changing the way in which they are operated.
- Reduce the impacts of grazing, for example by managing grazing pressures effectively and allowing marginal and riparian habitats to develop.

Any flood defence works to be carried out in the future should be more focused on sustainable floodplain management, which will be carried out in an environmentally sympathetic way and where possible enhance the rivers. The resulting environment will support a diverse range of keystone species including otters, water voles, white-clawed crayfish, bullhead and spined loach.

Additional details of the restoration vision are provided in the **River Eye SSSI Strategic Restoration Action Plan.** The vision and restoration plan should be implemented in conjunction with actions required at structures immediately downstream of the SSSI (see JBA 2013).

6.3.4 Actions under the River Eye SSSI Strategic Restoration Action Plan

The **River Eye SSSI Strategic Restoration Plan** will closely consider the policies and long term vision of the Catchment Flood Management Plan when assessing the best restoration measures for the Eye. The plan will also consider the environmental opportunities that restoration to the River Eye can contribute to as outlined in the National Character Area Profile. Specific examples include enhancing biodiversity by restoring the mosaic of characteristic habitats naturally found in lowland clay rivers with respect to targeted fauna and flora that owe to the SSSI designation. A suite of potential solutions to address the issues identified in the River Eye SSSI have been identified at a reach scale. Further details of the potential solutions and how key issues will be addressed are provided in the accompanying **River Eye SSSI Strategic Restoration Plan.** A brief summary of the types of restoration solution is provided below:

- **Conserve and enhance:** The lowest level of intervention, where areas of high quality habitat are protected and minor improvements are undertaken. Solutions under this category include:
  - Preserve and enhance channel bank and floodplain wetland habitats through sensitive management and targeted habitat creation.

- **Rehabilitate:** The next level of intervention, which is based on working with natural processes to encourage geomorphological and ecological development. Where natural recovery is already occurring, solutions should aim to encourage this process further. Where natural recovery is not occurring, solutions should aim to kick-start the process. Solutions under this category include:
  - Reduced or modified riparian zone management operations, which promote natural recovery of river form and function. This can include modified livestock management and tree planting, and the retention of large woody debris in the channel.

- Introduce large woody debris to increase flow and geomorphological diversity. This could be undertaken in conjunction with other enhancement works, such as bank reprofiling and reinstatement of coarse bed material.

- **Restore:** The highest level of intervention, which involves more intensive intervention and creation of new habitats. Solutions under this category include:

  - Bank enhancements to improve the transitional zone in the channel margins and promote the establishment of more diverse marginal vegetation communities.
  - Reinstate coarse bed material to improve floodplain connectivity and create habitats for fish, invertebrates and plants that require coarse substrates.
  - Increase channel sinuosity through re-meandering or meander reconnection to restore habitat length, improve flow and substrate conditions, and produce better habitats.
  - Removal or modification of in-channel control structures to restore natural river flows and sediment movement, promote the development of riffle habitats, and allow fish and other aquatic organisms to move freely.

- Strategic review: Additional investigations to inform future management. Solutions under this category include:

  - Review operation of structures to reduce the impact they have on SSSI habitats.

6.3.5 Developing solutions and identifying constraints

The solutions included in the action plan are those identified as being necessary to meet the favourable condition targets for each SSSI Management Unit. The solutions have only been identified in outline, and there is therefore a need for them to be developed further in the future through further detailed consultation with key stakeholders (including landowners, land managers, riparian users, conservation bodies and recreational groups). The action plan will need to be updated and revised to take account of this consultation process.

The solutions outlined in the previous section and explained in more detail in the restoration plan have been developed from an ecological perspective, with the aim of delivering favourable condition for the SSSI. Initial constraints have been identified in the plan, and the aim of the consultation process was to minimise these issues, build a consensus between Natural England, the Environment Agency and other stakeholders, and produce restoration actions that are supported by all parties.

6.3.6 Sequencing of actions

Natural England guidance suggests that the following principles should be used to help develop short, medium and long term plans:

- Prioritise adaptive management actions in the short term.
- Sequence working from upstream to downstream where possible.
- Develop solutions to deliver restoration actions over different timescales (e.g. feasibililty, construction).

These principles have been used to sequence restoration actions for each management reach in three categories:

- Short term (up to 2015).
- Medium term (up to 2021).
- Long term (up to 2027).

The sequenced list of restoration options is provided in **Table 6.1.** Further details are provided in the accompanying **River Eye SSSI Strategic Restoration Plan.**

Table 6.1: Breakdown of Phase activities

Phase	*Corresponding SSSI Units*							
	1	*1, 2*	*2, 3*	*3, 4*	*4*	*4*	*5*	*6*
	Management Reach							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1 to be commenced by **2015**	Identify need for bank enhancements	Identify need for bank enhancements	Retain large woody debris	Identify need to increase channel sinuosity	Identify need for bank enhancements	Identify need for bank enhancements	Identify need for bank enhancements	Agree preferred option for structure removal or modification
	Identify need for gravel augmentation	Identify need for gravel augmentation	Riparian zone management: willow trees	Identify need for gravel augmentation	Identify need to increase channel sinuosity	Identify need for gravel augmentation	Identify need for gravel augmentation	Riparian zone management: planting of trees, marginal and aquatic vegetation, and establish buffer strips
	Retain large woody debris	Riparian zone management: change management regime, tree planting and willow tree management	Continued management	Retain large woody debris	Riparian zone management: tree planting	Riparian zone management: grassland planting	Riparian zone management: planting of trees, marginal and aquatic vegetation, and establish buffer strips	
	Riparian zone management: willow trees			Review operation of sediment trap		Retain large woody debris	Investigate potential to create floodplain wetlands	
	Review operation of sediment trap					Review operation of flood alleviation structures at Brentingby Junction		
	Review impacts of Stapleford Weir							

2 to be delivered from **2015-2021**	Bank enhancements	Bank enhancements		Increase channel sinuosity	Bank enhancements	Bank enhancements	Bank enhancements	Structure removal or modification
	Gravel augmentation	Gravel augmentation		Gravel augmentation	Increase channel sinuosity	Gravel augmentation	Gravel augmentation	Identify need to increase channel sinuosity
	If necessary, alter operation of sediment trap	Install large woody debris		If necessary, alter operation of sediment trap	Install large woody debris	If necessary, alter operation of flood alleviation structures at Brentingby Junction	Install large woody debris	Identify need for gravel augmentation
	If necessary, alter impacts of Stapleford Weir						Create floodplain wetlands	Identify need to install large woody debris
								Identify potential to create floodplain wetlands
3 to be delivered from **2021-2027**								Increase channel sinuosity
								Gravel augmentation
								Install large woody debris
								Create floodplain wetlands

Key	**Conserve and enhance**	**Rehabilitate**	**Restore**	**Strategic review**

6.4 Delivery mechanisms

Whole river restoration plans are based on multi-partner working, time horizons suited to the nature and scale of each site's problems and solutions (typically 20-50 year time horizons), and an open-minded approach to implementation. Funds need to be secured and include rolling bids to obvious budgets such as Environment Agency Flood and Coastal Erosion Risk Management (FCRM) capital works, the Catchment Restoration Fund, and Environmental Stewardship, but also opportunistic bids to a range of other funding sources including European programmes. Work in-kind from third parties; including 'third sector' partners such as the Rivers Trusts and private developers (including section-106 agreements) are also important sources for opportunistic funding.

Further details of potential delivery mechanisms are provided in the accompanying **River Eye SSSI Strategic Restoration Plan.**

6.5 The next steps: The need for consultation

Natural England and the Environment Agency recognise that it is vitally important for them to work closely with landowners and other local stakeholders in order to achieve their restoration aims for the River Eye SSSI.

The Strategic Restoration Plan is intended as the first step towards engaging with landowners, and other stakeholders in the catchment by giving them an opportunity to comment on the outline restoration actions that have been proposed for each Management Reach. The plan will be presented to stakeholders, and they will be given the opportunity to comment on the proposals. Natural England will meet with stakeholders to discuss the measures presented in the plan in more detail, to help them understand the nature of the proposals in more detail, give them an opportunity to discuss potential constraints, and if necessary identify changes to the proposed actions that will allow the needs of all parties to be accommodated. The key aim of the consultation process is to ensure that the needs of local stakeholders are balanced with requirements to achieve favourable condition for the SSSI.

The Strategic Restoration Plan contains outline descriptions of the proposed restoration actions and an initial estimate of their likely implementation cost. This reflects the strategic nature of the report and the fact that the final details of each action will need to be developed in close consultation with relevant stakeholders. Once agreement on the preferred course of action has been achieved, further investigations will be required to fully explore the feasibility of the proposed actions, develop designs that are supported by all stakeholders, and identify fully detailed implementation costs.

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