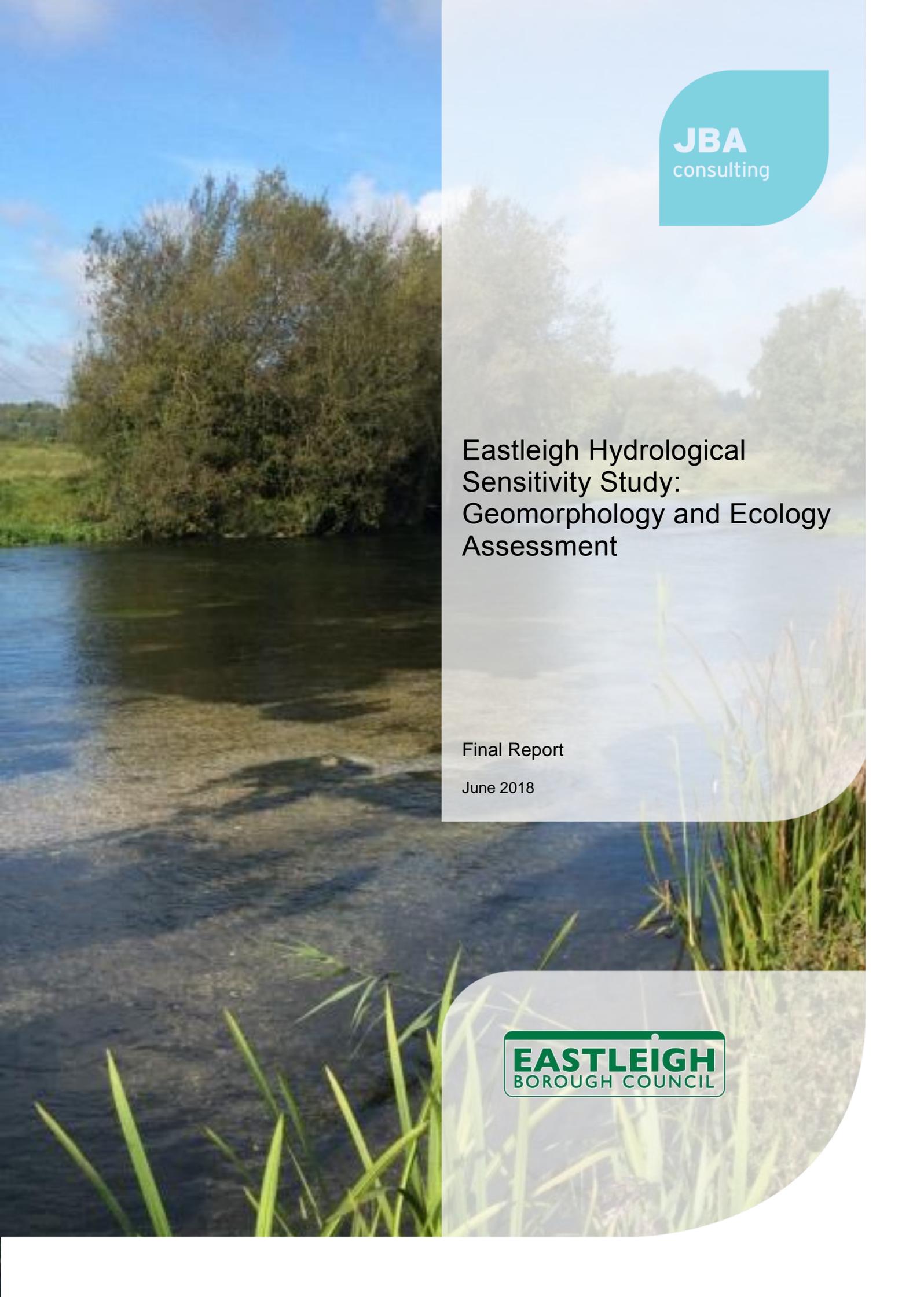


The logo for JBA consulting, featuring the text 'JBA' in a large, bold, white sans-serif font above the word 'consulting' in a smaller, white sans-serif font. The logo is set against a teal-colored rounded square background.

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The background of the cover is a photograph of a river. The river flows from the left towards the right, with a sandy and pebbly bank in the foreground. The water is dark and reflects the sky. In the background, there are dense green trees and a clear blue sky with some light clouds. The overall scene is a natural, outdoor setting.

Eastleigh Hydrological Sensitivity Study: Geomorphology and Ecology Assessment

Final Report

June 2018

The logo for Eastleigh Borough Council, featuring the text 'EASTLEIGH' in a large, bold, green sans-serif font above the text 'BOROUGH COUNCIL' in a smaller, green sans-serif font. The logo is enclosed in a green rectangular border with rounded corners.

EASTLEIGH
BOROUGH COUNCIL

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Revision History

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Contract

This report describes work commissioned by Eastleigh Borough Council. Eastleigh Borough Council's representative for the contract was Graham Tuck. Natasha Todd-Burley and Kimberley Jennings of JBA Consulting carried out this work.

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Purpose

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Abbreviations

EBC.....	Eastleigh Borough Council
HCC	Hampshire County Council
HRA	Habitats Regulations Assessment
INNS	Invasive non-native species
LNR.....	Local Nature Reserve
NBLR	North of Bishopstoke link road
NNR	National Nature Reserve
NVC	National Vegetation Classification
mAOD	metres Above Ordnance Datum
RBMP.....	River Basin Management Plan
SAC.....	Special Area of Conservation
SPA.....	Special Protection Area
SSSI.....	Site of Specific Scientific Interest
WFD.....	Water Framework Directive

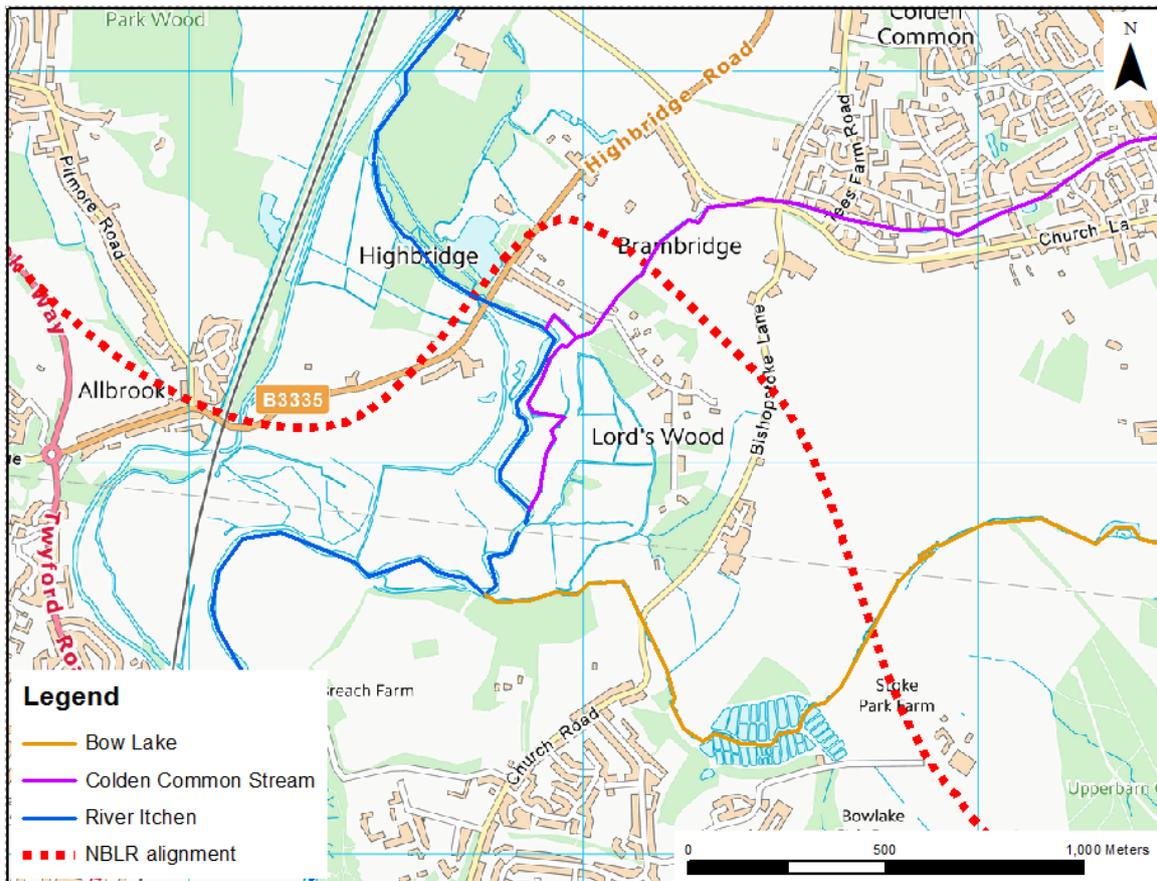
1 Introduction

1.1 Background

JBA Consulting were commissioned by Eastleigh Borough Council (EBC) to undertake a geomorphology and ecology assessment in relation to the proposed North of Bishopstoke link road (NBLR) alignment, developed by EBC as part of their Local Plan. The proposed NBLR crosses several of the watercourses, including the River Itchen Special Area of Conservation (SAC), which constitutes an ecological and hydrological constraint to development. This study advises on the alignment of the proposed NBLR alignment with regards to the geomorphological and ecological constraints.

The proposed NBLR alignment is shown in Figure 1-1.

Figure 1-1: Location of proposed NBLR alignment options



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1.2 Objectives

The purpose of this report is to provide a baseline geomorphological and ecological understanding of the watercourses in the vicinity of the proposed NBLR alignment, and to highlight any geomorphological and ecological constraints.

The proposed NBLR alignment crosses the River Itchen, Bow Lake and Colden Common streams between the villages of Colden Common Stream and Bishopstoke.

2 Study Approach

2.1 Geomorphology

2.1.1 Methodology

A fluvial geomorphological assessment has been carried out to determine river types and associated forms and processes within the study area. An understanding of the existing character and dynamics of the river has been developed during a site-based assessment of existing conditions, to evaluate how the system might respond to changes. The assessment has considered potential sediment and morphological impacts of the proposed road scheme, considering both the local and wider impacts. Whilst a Fluvial Audit methodology has been adopted for this study, a desk-based approach has been used to assess the wider catchment as the geomorphological walkover focussed on the locations that the proposed road routes cross watercourses within the study area.

2.1.2 Desk-based assessment

Initially a desk-based review of existing information was undertaken (e.g. historic maps, reports and aerial photography (Google Earth and Bing Maps), LiDAR 2m DTM (EA Open data)) to gain an overview of system functioning and understand the river within the context of historic modifications. This provides vital context on why the system is in its present state, identifies key historic and contemporary pressures and helps in predicting how the system is likely to respond to the proposed road scheme.

2.1.3 Site walkover

A site walkover was carried out on 18th September 2017 by JBA fluvial geomorphologist Natasha Todd-Burley and JBA ecologist Kimberley Jennings. The site walkover was carried out to determine the river types and associated forms and processes within the watercourses. Sediment processes were examined, identifying sediment sources and zones of erosion, transport and deposition. Constraints and barriers to hydromorphic processes were assessed, including modifications such as weirs, hard bank protection, bridges, culverts and other infrastructure within the channel and floodplain.

2.2 Ecology

2.2.1 Methodology

An initial site visit was undertaken on the 19th September 2017 by an JBA ecologist, Kimberley Jennings. The watercourse and surrounding habitat was surveyed between the westernmost extent from Allbrook, and southern extent of Dry Howe where access was possible (which was from one side of the watercourse).

For many species (e.g. bats, Otter and White-clawed Crayfish) the ecologist made an assessment of the suitability of the surrounding habitats to support these species. Habitats within and immediately adjacent to the works area were surveyed utilising the Phase 1 Habitat standard methodology (JNCC, 2010). During the walkover survey, any signs or sightings of other notable species were also recorded. In addition, any environmental features that might constrain the works were recorded.

Based upon this assessment, potential constraints to the project were identified and basic recommendations for avoidance/mitigation have been made.

2.2.2 Desk-based assessment

Prior to undertaking the field survey, searches of databases containing readily available information on ecological records and important sites for nature conservation were made. The following sources of information were included in these searches:

- MAGIC mapping service (www.magic.gov.uk)
- National Biodiversity Network NBN Atlas (www.nbn.org.uk)
- Environment Agency datasets (www.gov.uk)

2.2.3 Statutory designations

Sites with statutory designations receive varying degrees of legal protection under UK statute and European Directives. There are a number of statutory designations used for sites of high nature conservation value in the UK, which are applied depending upon the importance of the site in a local, regional, national or international context.

Statutory nature conservation sites within 2km of the works area were recorded. Statutory designations recorded include:

- Ramsar Sites (International designation)
- Special Area of Conservation (SAC) and Special Protection Area (SPA) (European designations)
- National Nature Reserves (NNR) and Sites of Special Scientific Interest (SSSI) (National designations)
- Local Nature Reserves (LNR) (Local designation)

2.2.4 Non-statutory designations

Non-statutory sites are afforded no statutory legal protection, but are normally recognised by local planning authorities and statutory agencies as being of local nature conservation value. The protection afforded to such sites is usually discretionary, through Local Plan policies. Non-statutory sites are designated by the local authority, usually in partnership with the County Wildlife Trust (or equivalent).

2.2.5 Limitations

Data from biological records centres, or on-line databases, is historical information and datasets might be incomplete, inaccurate or missing. It is important to note that, even where data is held, a lack of records for a defined geographical area does not necessarily mean that the species is absent; the area may simply be under-recorded.

The survey access was limited and the watercourses were only accessed where possible, usually from one side of the bank only, therefore survey information may not be comprehensive.

3 Desk-based assessment

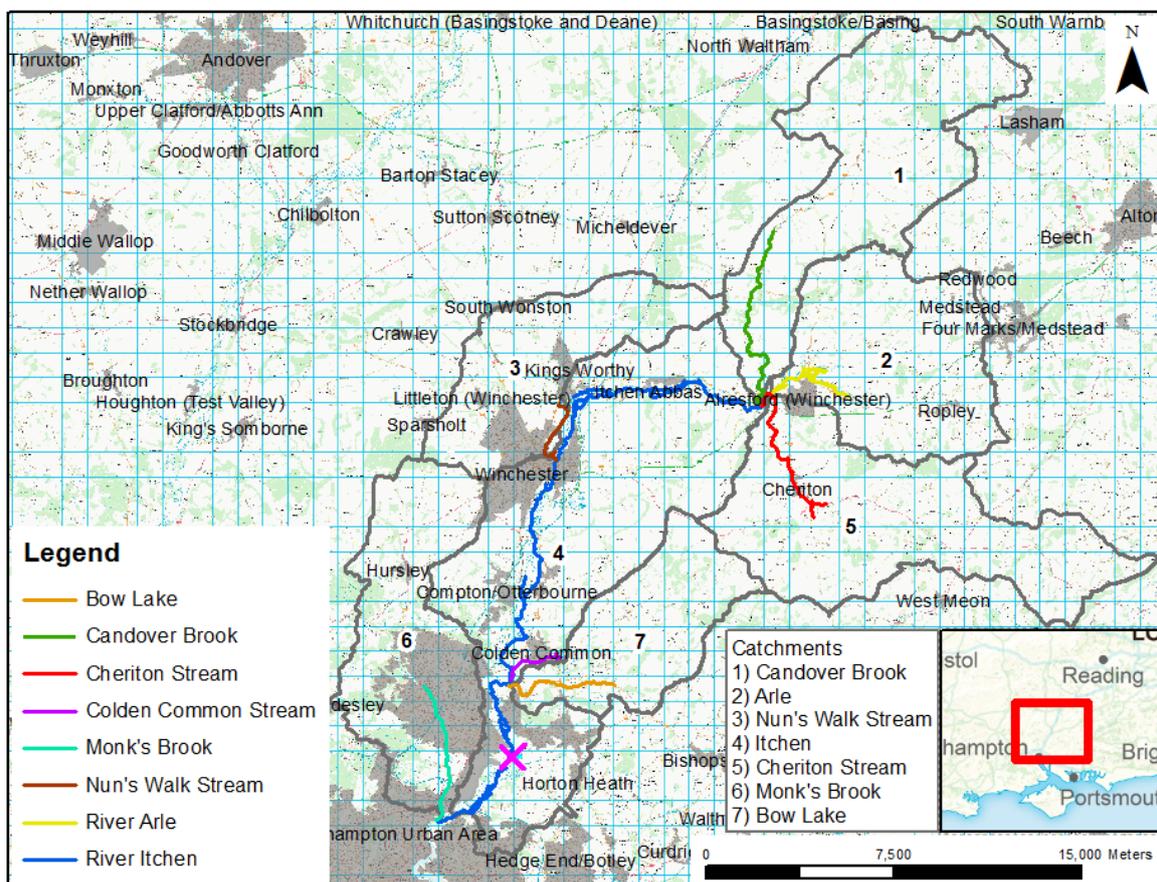
3.1 Geomorphology

3.1.1 Catchment overview

The River Itchen is fed by three major tributaries in its upper reaches; the Candover Stream, River Aire and the Cheriton Stream. The river flows through many Hampshire villages before entering the city of Winchester, from where it heads south, through a series of water meadows, before reaching the northern suburbs of Southampton at Mansbridge. The section between Winchester and Southampton also includes the Itchen Navigation - a disused 18th century canal system linking Winchester to the sea.

The Bow Lake is a tributary of the River Itchen, joining on the left bank between the villages of Colden Common and Bishopstoke. The Colden Common Stream is an unnamed tributary of the River Itchen also joining on the left bank, just downstream of Colden Common.

Figure 3-1: River Itchen and surrounding catchments



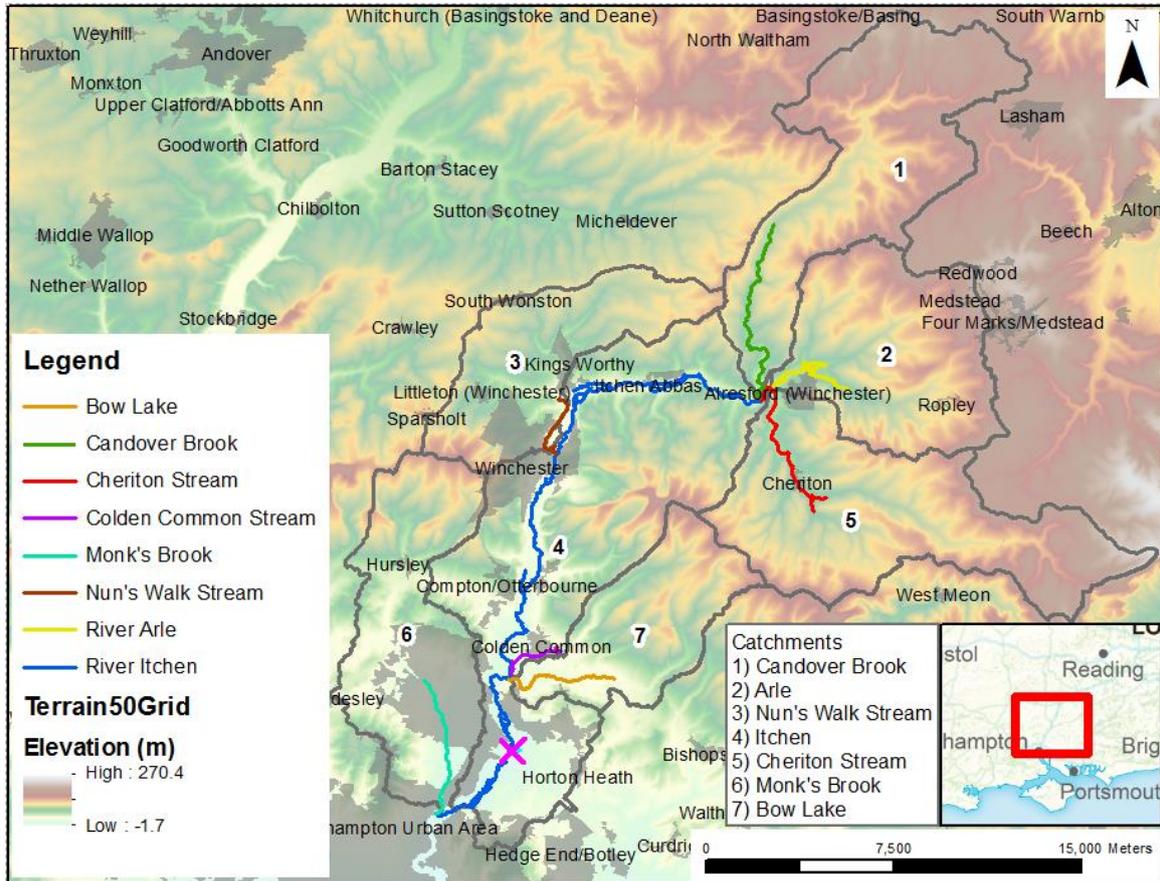
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The catchment is principally rural, with a predominance of arable/horticultural land use and small pockets of woodland. The urban extent is higher in the east of the catchment, with the settlements of Winchester and Eastleigh, as well as numerous small villages throughout the rest of the catchment. The catchment drains an area 463km².

The relief for the River Itchen and Bow Lake operational catchments is shown in Figure 3-2. The River Itchen has a moderate gradient in its upper, northern extent and wide, low-lying floodplain areas towards the southern end of the catchment. The topography of the River Itchen catchment broadly reflects the underlying geology (see section 3.1.3 for further details on geology). The outcropping Chalk of the northern area forms a landscape of rolling downland rising to a maximum elevation of c.290m on the northern Chalk boundary. As the Chalk dips below the Tertiary layers the landscape becomes more subdued with lower lying terrain.

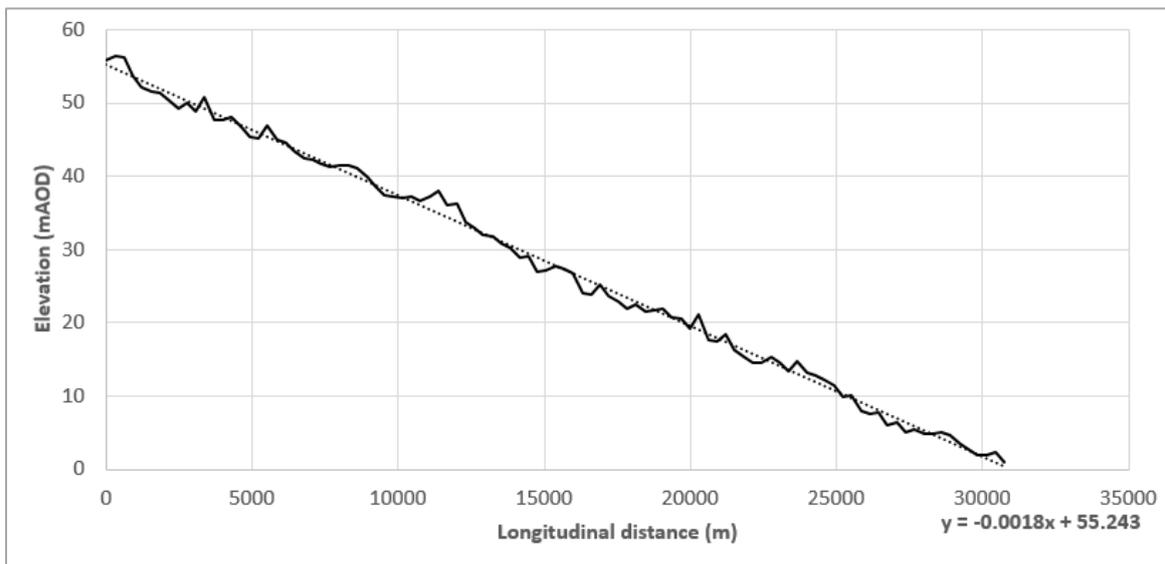
An approximate channel long profile has been extracted from the EA Terrain OpenData (50m grid resolution). This has been extracted from the upstream extent of the River Itchen operational catchment to the downstream extent at Southampton. The long profile is shown in Figure 3-3. The gradient is low throughout the catchment, with a value of 0.002.

Figure 3-2: Topography of the River Itchen catchment



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Figure 3-3: Gradient of the River Itchen

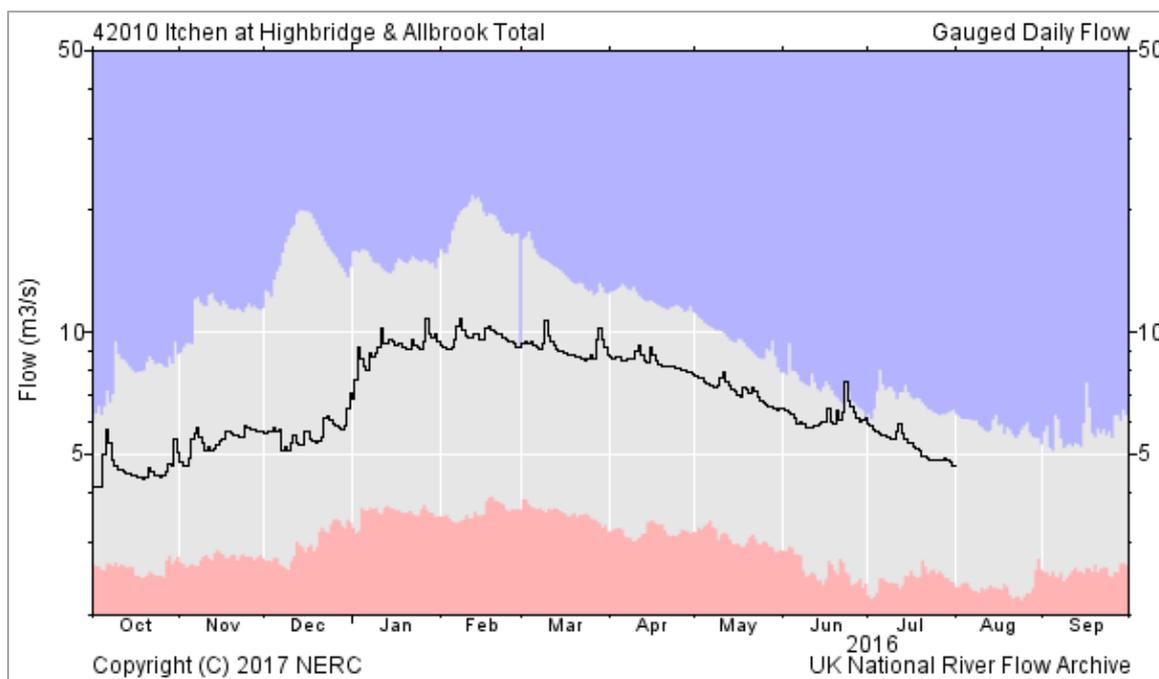


3.1.2 Flow regime

The River Itchen is a baseflow-dominated chalk stream, fed by three major tributaries in its upper reaches; the Candover Stream, River Alre and Cheriton Stream. The River Alre provides most water to the Upper Itchen due to its very large groundwater catchment, whilst flows in the Candover and Cheriton Stream are generally similar¹. The River Itchen gains flow from the Chalk aquifer between Alresford and Easton but between Easton and the Tertiary boundary at Allbrook & Highbridge, this gain in flow is markedly lower, partially because of the large surface and groundwater public water supply abstraction at Otterbourne. When the river flows over the clays and sands of the Tertiary deposits, abstraction is mainly from surface water and the dominant licence is the public water supply abstraction at Gaters Mill not far from the River Itchen's tidal limit.

The River Itchen is gauged at Highbridge, just upstream of the study site. Figure 3-4 shows the annual hydrograph from 2016 at Highbridge. The red and blue envelopes represent the lowest and highest flows on each day over the period of record. The annual hydrograph illustrates the relatively stable flow regime. Chalk rivers are characterised by a baseflow dominant flow regime: the slow release of water from the aquifer attenuates rainfall events, providing a steady flow regime with a characteristic cycle. A strong seasonal signal is evident with baseflows reducing significantly during the summer months. If the aquifer and land are saturated, some rainfall events can induce a more rapid response or where there are areas of impermeable deposits over the Chalk.

Figure 3-4: Gauged daily flow for the River Itchen at Highbridge & Allbrook



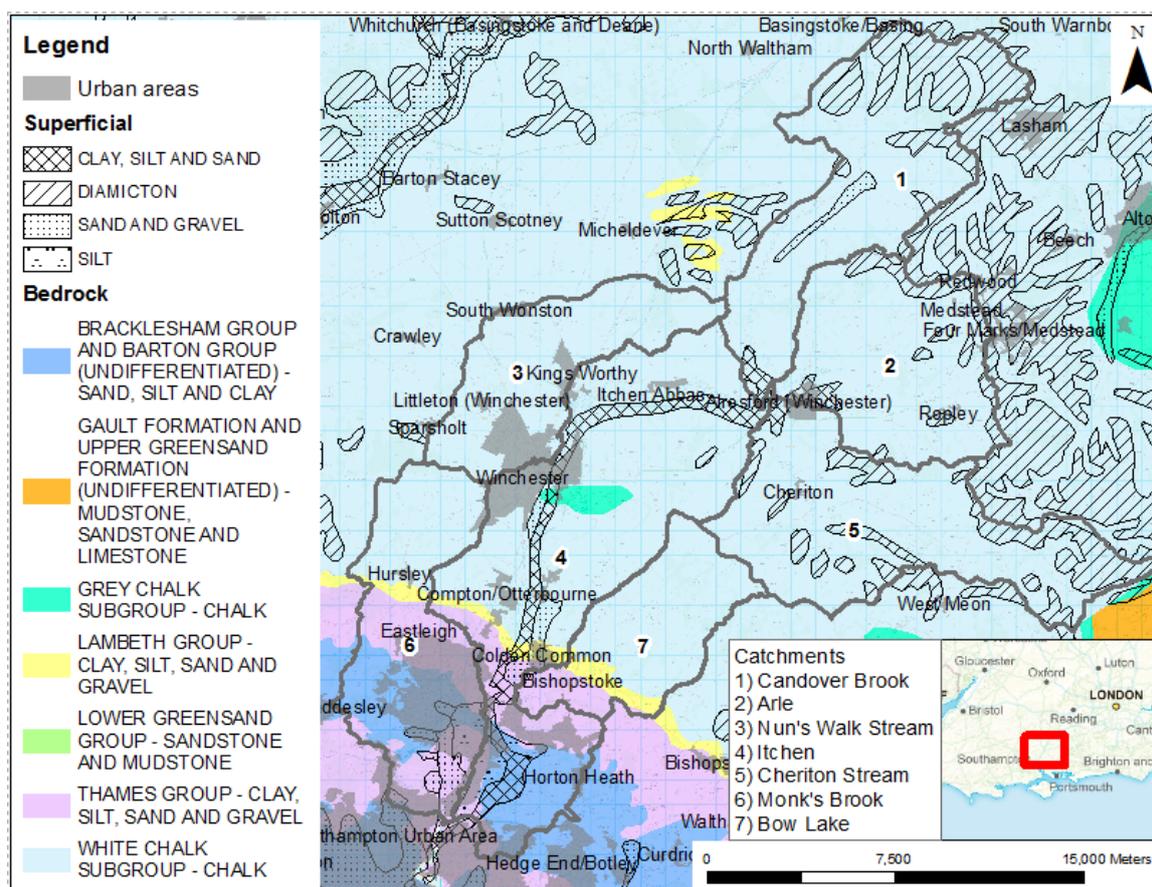
¹ Environment Agency (2013). Test and Itchen Abstraction Licencing Strategy.

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/289879/LIT_2494_0c58d2.pdf [Accessed 28/09/2017]

3.1.3 Geology

The River Itchen catchment is underlain by chalk in the north (Figure 3-5). In the lower areas to the south of the catchment, clays, sands and gravels of the Tertiary deposits overlie the chalk. The junction at which these Tertiary deposits begin, runs from Bishops Waltham in the east to Salisbury in the west. These units are relatively impermeable which causes rapid run off into the Itchen and their tributaries in these areas (Environment Agency, 2012)². Superficial deposits are concentrated in river valleys, where alluvial sediments have been deposited.

Figure 3-5: Bedrock and superficial geology within the catchment



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Contains British Geological Survey materials © NERC 2015

3.1.4 Historic Trend Analysis

The River Itchen catchment has undergone significant modification over centuries, which has had a lasting impact on the fluvial geomorphology of the river. Modifications include re-alignment and / or deepening for land drainage and the construction of a variety of sluices and artificial channels for navigation, milling and to feed water meadows. Historic mapping available online³ shows that the majority of the River Itchen modifications pre-date the earliest mapping available (OS Six Inch, 1888-1913 series).

The Itchen navigation, a disused canal system, was completed in 1710 to provide a means of moving goods, such as agricultural produce and coal, between Winchester and Southampton. However, the navigation ceased to operate in 1860 following the opening of the London and Southampton railway. The Itchen Navigation Trust was formed in 2005 as a joint venture between the Environment Agency and the Hampshire and Isle of Wight Wildlife Trust. A grant from the Heritage Lottery Fund has enabled the creation of the Itchen Navigation Heritage Trail Project, which has sought to preserve and interpret the remains of the Navigation.

² Environment Agency (2013). Test and Itchen Abstraction Licencing Strategy.

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/289879/LIT_2494_0c58d2.pdf [Accessed 28/09/2017]

³ National Library of Scotland. <http://maps.nls.uk/geo/explore/#zoom=16&lat=50.9885&lon=-1.3343&layers=6&b=1> [Accessed 30/09/2017]

3.1.5 Flood risk

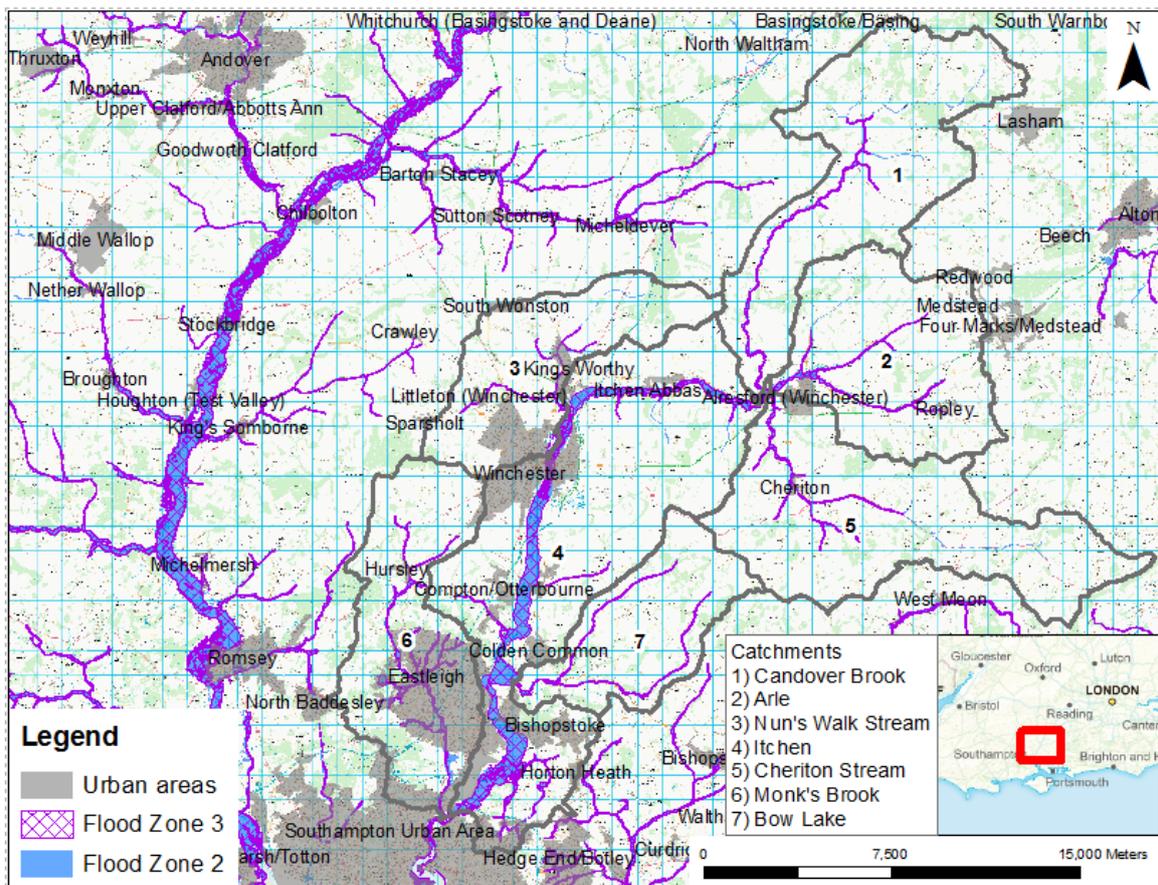
The Test and Itchen Catchment Flood Management Plan (CFMP) provides an overview of current flood risk within the Itchen catchment, and considers flooding from rivers, surface water and sewage flooding from the drainage system, as well as groundwater flooding. There are over 3,500 properties in the catchment that have a 1% chance of flooding in any one year.

There was extensive flooding in the winter of 2000/01 in the Test and Itchen catchment affecting up to 300 properties. Groundwater flooding of properties was experienced throughout the catchment during this time, while river flooding was located in places such as Winchester. The distribution of flood risk within Itchen and Bow Lake operational catchments is shown in Figure 3-6: Flood Zone 2 is the 0.1% annual probability flood outline and Flood Zone 3 is the 1% annual probability flood outline.

Historically flood risk management within the Test and Itchen CFMP area has been relatively limited, in large part to preserve the rich natural environment of the river corridors. Schemes completed have been largely related to the creation of culverted channels, and some limited raising of defences, that have often been closely integrated to ongoing urban development.

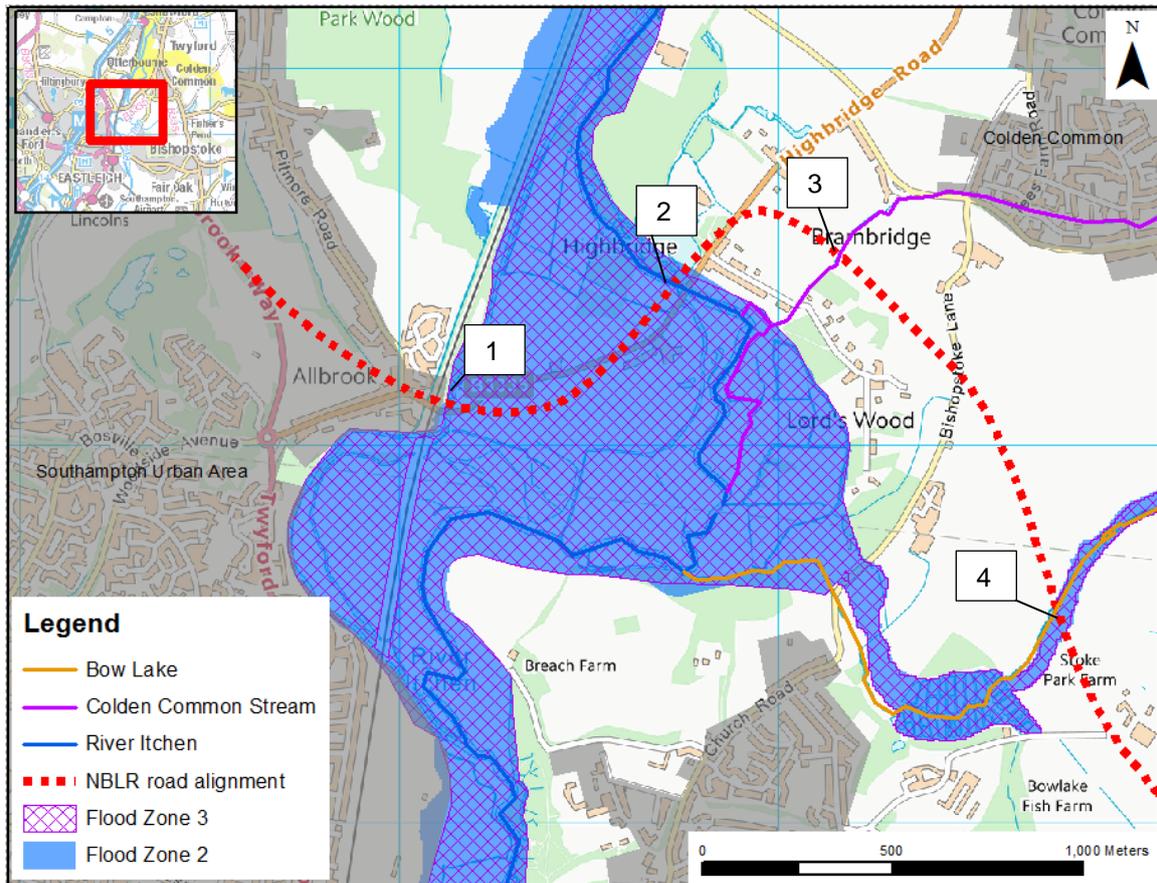
Approaches to managing current and future flood risk varies across the Itchen catchment. Our study site, located in the lower Itchen catchment is located in an area in which flood risk is considered to be managed effectively but where there may need to be further actions take in the future to keep pace with climate change. The SFRA states that whilst there is little in the historic record that refers to this specific area, the hydraulic modelling suggests that there is significant flood risk to Bishopstoke and Eastleigh. Proposed development in Eastleigh and more intense storms all have the potential to increase flood risk. Furthermore, the SFRA identifies that it is necessary to better understand the flood risk in the Lower Itchen area in order to put in place measures to mitigate for the increased risk from climate change.

Figure 3-6: Flood risk within the River Itchen catchment



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Figure 3-7: Flood risk within the study area. Numbered points relate to locations of maximum water levels at key locations outlined below.



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JBA are currently preparing new flood risk modelling and mapping for fluvial flood risk across the full River Itchen catchment for the Environment Agency. The draft version of the models for the River Itchen, Colden Common Stream and Bow Lake watercourse has been supplied for use in this study in order to provide 1-in-100 year plus 105% Climate Change maximum water levels at key locations. **It is important to note that these draft results have not yet been calibrated, finalised or approved by the Environment Agency and have only been provided at this stage due to timescale constraints associated with this study. They are therefore considered to be indicative only and will likely be subject to change following formal Environment Agency review.** The maximum 1-in-100 year plus 105% Climate Change water levels are:

1. Allbrook crossing - 15.6mAOD - this level is being controlled by 2D flooding bypassing the existing bridge to the east.
2. Highbridge crossing - 16.5mAOD - this level is being controlled by 2D flooding bypassing the existing bridge to the south west.
3. Colden Common crossing - 20.2mAOD
4. Bow Lake crossing - 20.7mAOD

3.1.6 Water Framework Directive

The River Itchen is included in the South East River Basin Management Plan (RBMP); first published in 2009 and updated in 2015. A management plan is required for each River Basin District (RBD) under the EU Water Framework Directive (WFD), and aims to protect and improve the water environment. The RBMP includes information on the current classification of waterbodies in the RBD, which serve as a baseline status. It also provides future targets to improve the current status of its waterbodies. The South East River Basin has been divided into nine management catchments. The study site includes the River Itchen and Colden Common Stream, which are

located within the River Itchen management catchment, and the Bow Lake, which is located within the Bow Lake management catchment.

The current overall status of the River Itchen is Good in the 2016 Cycle 2 Assessment, with an objective of reaching Good by 2015. The River Itchen is therefore currently meeting its WFD Status objectives.

The Bow Lake watercourse is also listed in the South East RBMP. In contrast, the current overall status of the Bow Lake watercourse is Bad in the 2016 Cycle 2 assessment, with an objective of reaching Good Ecological Status by 2027. The reasons for not achieving good are listed as:

- Physical modification in the form of barriers which are causing ecological discontinuity and the Fish classification elements;
- Physical modification in the form of commercial fin fisheries that are impacting upon the Invertebrates classification elements;
- Impacts on the Hydrological Regime.

The Bow Lake watercourse has an objective of reaching Good Ecological Status by 2021. The less stringent objective of reaching Good Ecological Status by 2027 (instead of by 2021) has been set because reaching Good Status is considered to be disproportionately expensive.

3.2 Ecology

3.2.1 River Itchen SAC

The proposed road route passes through areas within the River Itchen SAC. Figure 3-8 shows how the proposed road interacts with the SAC.

The citation lists the following habitats and species: Water courses of plain to montane levels with the *Ranuncion fluitantis* and *Callitricho-Batrachion* vegetation for which this is considered to be one of the best areas in the United Kingdom; Brook Lamprey *Lampetra planeri*, for which the area is considered to support a significant presence; Atlantic Salmon *Salmo salar* for which the area is considered to support a significant presence; European Bullhead *Cottus gobio* for which this is considered to be one of the best areas in the United Kingdom; Otter *Lutra lutra* for which the area is considered to support a significant presence; Southern Damselfly *Coenagrion mercuriale* for which this is considered to be one of the best areas in the United Kingdom; White-clawed Crayfish *Austropotamobius pallipes* for which the area is considered to support a significant presence.

3.2.2 River Itchen SSSI

The River Itchen SSSI covers a similar extent to the SAC and many of the qualifying features of its designation are also the same. The River Itchen SSSI is classified as neutral grassland – lowland, described as in unfavourable condition, either recovering or not changing.

This SSSI is notified for classic chalk stream and river, fen meadow, flood pasture and swamp habitats, particularly formations of in-channel vegetation dominated by Water Crowfoot *Ranunculus spp*, riparian vegetation communities (including wet woodlands) and side channels, runnels and ditches associated with the main river and former water meadows. The site is also notified for significant populations of the nationally-rare Southern Damselfly *Coenagrion mercuriale* and assemblages of nationally-rare and scarce freshwater and riparian invertebrates, including the White-clawed Crayfish *Austropotamobius pallipes*. This site is also notified for Otter *Lutra lutra*, Water Vole *Arvicola terrestris*, freshwater fishes including Bullhead *Cottius gobbo*, Brook Lamprey *Lampetra planeri* and Atlantic Salmon *Salmo salar*. The assemblage of breeding birds including Tufted Duck *Aythya fuligula*, Pochard *A. ferina* and Shoveler *Anas clypeata*, the waders Lapwing *Vanellus vanellus*, Redshank *Tringa totanus* and Snipe *Gallinago gallinago*, and wetland passerines including Sedge Warbler *Acrocephalus schoenobaenus*, Reed Warbler *A. scirpaceus* and Cetti's Warbler *Cettia cettia*.

3.2.3 Other sites

The South Downs National Park is located approximately 400m north of the proposed road routes. No other statutory protected sites within 2km or that were considered likely to be impacted by the scheme were identified.

3.2.4 Protected species records

The following records for notable species, such as those with legal protection or classed as nationally rare, were returned from a 2km search area around the centre of the site (grid ref. SU 47431 20942), from the National Biodiversity Network (NBN) Atlas⁴. Only records from the year 2000 or later have been included.

3.2.4.1 Birds

NBN returned numerous bird records from the search area. A number of the results for birds were either red listed under the British Trust for Ornithology's (BTO) Birds of Conservation Concern, or are afforded additional legal protection under Schedule 1 of the Wildlife and Countryside Act 1981.

3.2.4.2 Mammals (excluding bats)

A diverse array of mammal records were returned from within the search area, many of which are which are protected under The Wildlife and Countryside Act, 1981 (as amended), or under the Protection of Badgers Act 1992. There was only a single record of each of these three species within the search area. Due to their sensitive status as protected species, public records of Otter and Badger are not available at a high resolution from NBN and their exact location in relation to the proposed road is only available to within the nearest kilometre.

3.2.4.3 Bats

All UK bat species are afforded legal protection under The Wildlife and Countryside Act 1981 and The Conservation of Habitats and Species Regulations 2017. A number of bat species were returned from publicly available sources within the search area, including Daubenton's Bat *Myotis daubentonii*.

3.2.4.4 Other records

No reptile records were returned within the search area. There were a small number of records for amphibians, however none for Great Crested Newt *Triturus cristatus*. A single record for White-clawed Crayfish was returned. The lack of these records does not necessarily indicate that these species are not present however, simply that there may be a lack of data for this area.

3.2.4.5 Environment Agency protected species records

The Environment Agency holds public access data on protected and notable species records⁵. These data are primarily for fish and aquatic species. Within the immediate vicinity of the proposed road scheme, the following records were returned:

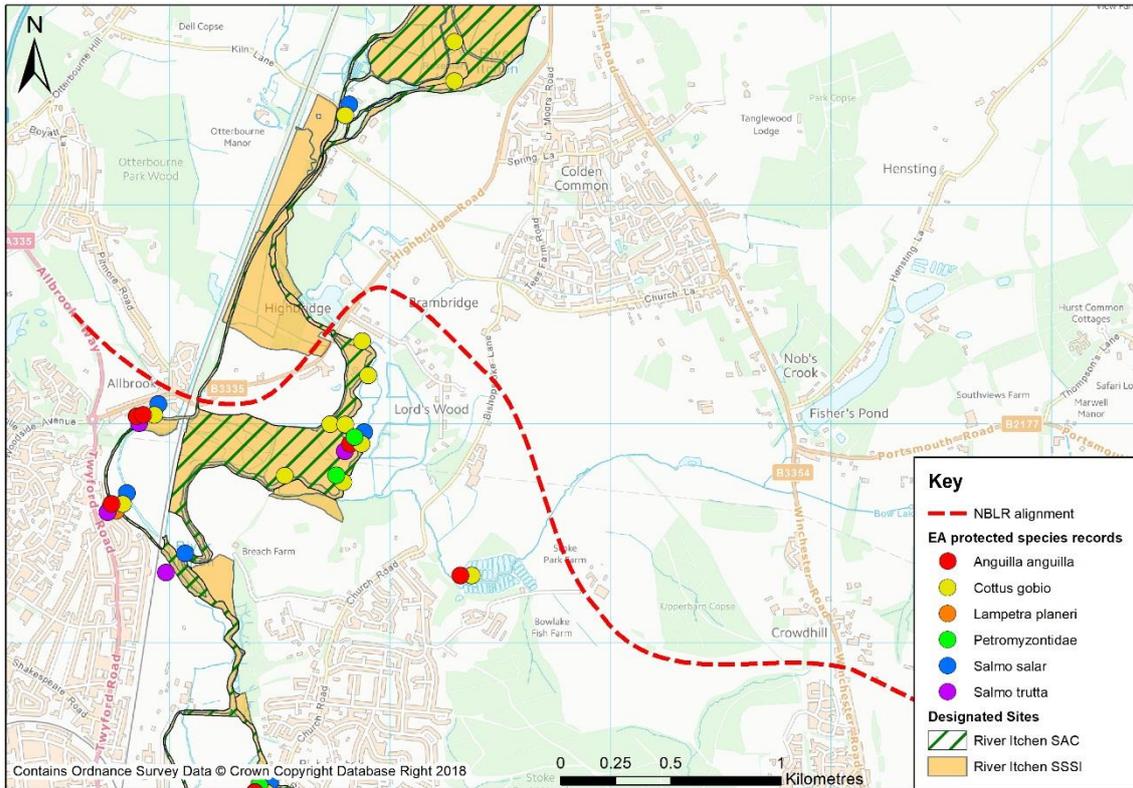
- European Eel *Anguilla Anguilla*
- European Bullhead *Cottus gobio*
- Brook Lamprey *Lampetra planeri*
- Unknown Lamprey species. *Petromyzontidae spp.*
- Atlantic Salmon *Salmo salar*
- Brown Trout *Salmo trutta*

The locations of these records have been mapped in Figure 3-8 below.

⁴ NBN Atlas occurrence download at <https://nbnatlas.org> accessed on Mon Mar 19 12:00:27 UTC 2018.

⁵ <https://data.gov.uk/dataset/species-surveys-rare-and-protected-species>

Figure 3-8: Protected species records, designated sites and the proposed road route



4 Current geomorphological condition and processes

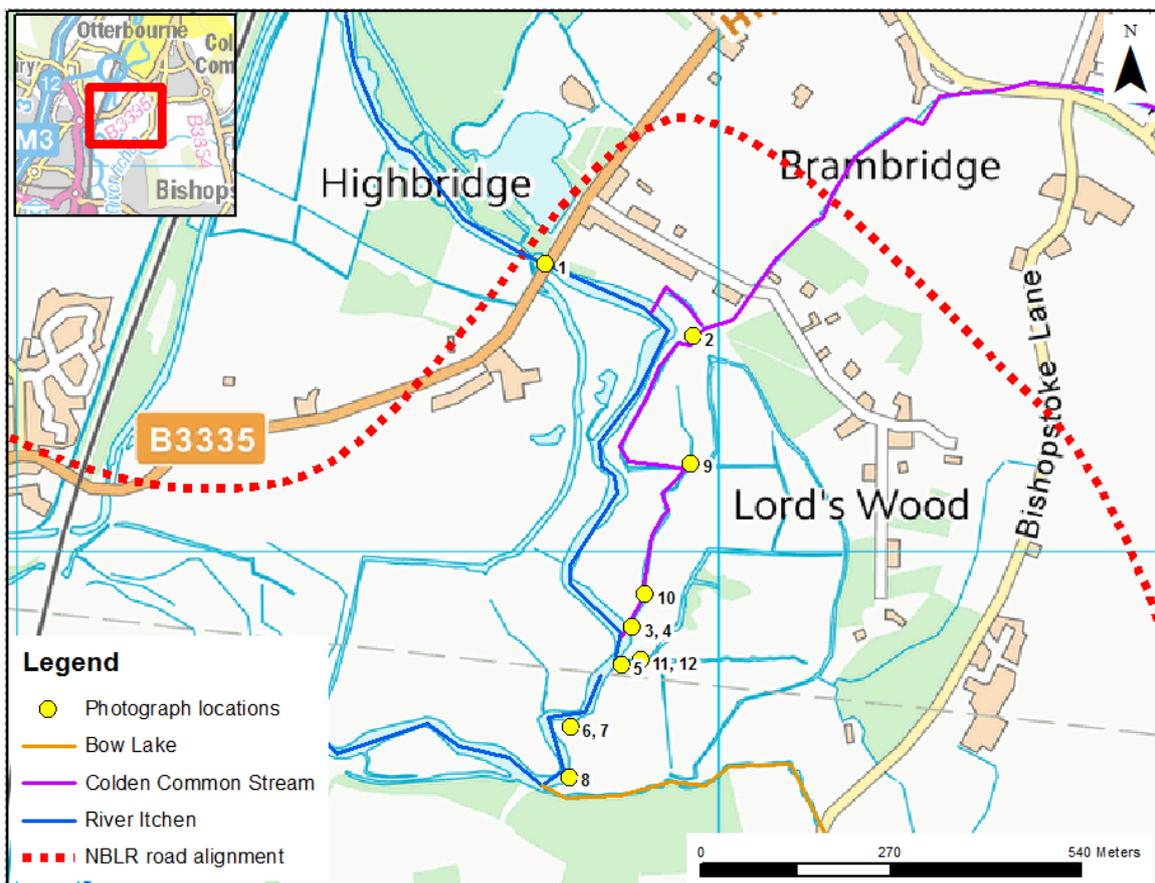
4.1 Overview

The geomorphology walkover survey focussed on the crossing points of the proposed NBLR alignment, as well as upstream and downstream where access permitted. These areas are discussed below for the River Itchen, Bow Lake and the Colden Common Stream.

4.2 River Itchen

The walkover survey focussed on the River Itchen to the west of Lord's Wood (Figure 4-1). This area contains a complex of drains and small tributaries which feed into the River Itchen. The proposed NBLR alignment crosses the north of the existing road bridge, however, access to this area was not permitted, therefore the walkover survey examined the Itchen floodplain downstream of the road bridge, which has a number of public footpaths crossing the site.

Figure 4-1: River Itchen and tributaries in the vicinity of Lord's Wood. Labelled points relate to the location of the photographs presented in Figure 4-2 and Figure 4-3.

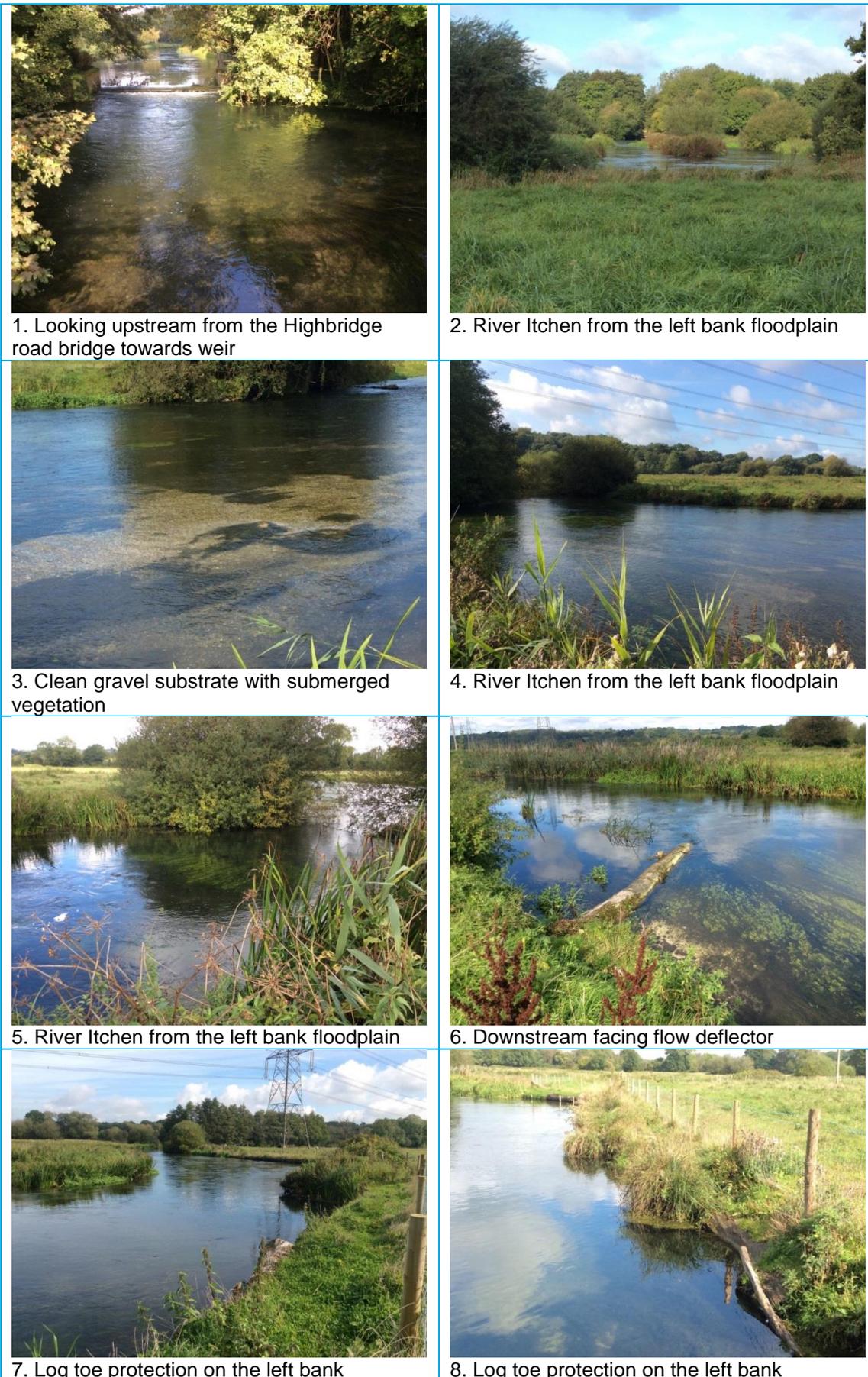


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The channel is exhibiting chalk stream characteristics, with a clean gravel bed and an abundance of in-stream vegetation. Flows through the survey extent were characterised by long glides, and a lack of riffled sections. There were no exposed gravel bars, although the clarity of the water meant that it was possible to observe the bed, which displayed elevation heterogeneity with accumulations of gravel on the inside of meander bends as well as mid-channel submerged bars. The channel was well-connected to the floodplain through the reach.

Bank restoration works, in the form of a log toe, and fencing appear to have been installed recently, presumably to counteract livestock poaching. The fence line has been set-back from the channel, but there is relatively little in terms of riparian vegetation. A downstream facing flow deflector has also been installed to provide flow diversity within the reach. This is trapping gravels on the upstream face and reducing channel width to encourage a more sinuous flow path.

Figure 4-2: Photographs of the River Itchen in the vicinity of Lord's Wood



The various channels joining the River Itchen on the left bank were found to be displaying standing water in most instances, with a bed substrate of organic material (Photographs 9-12).

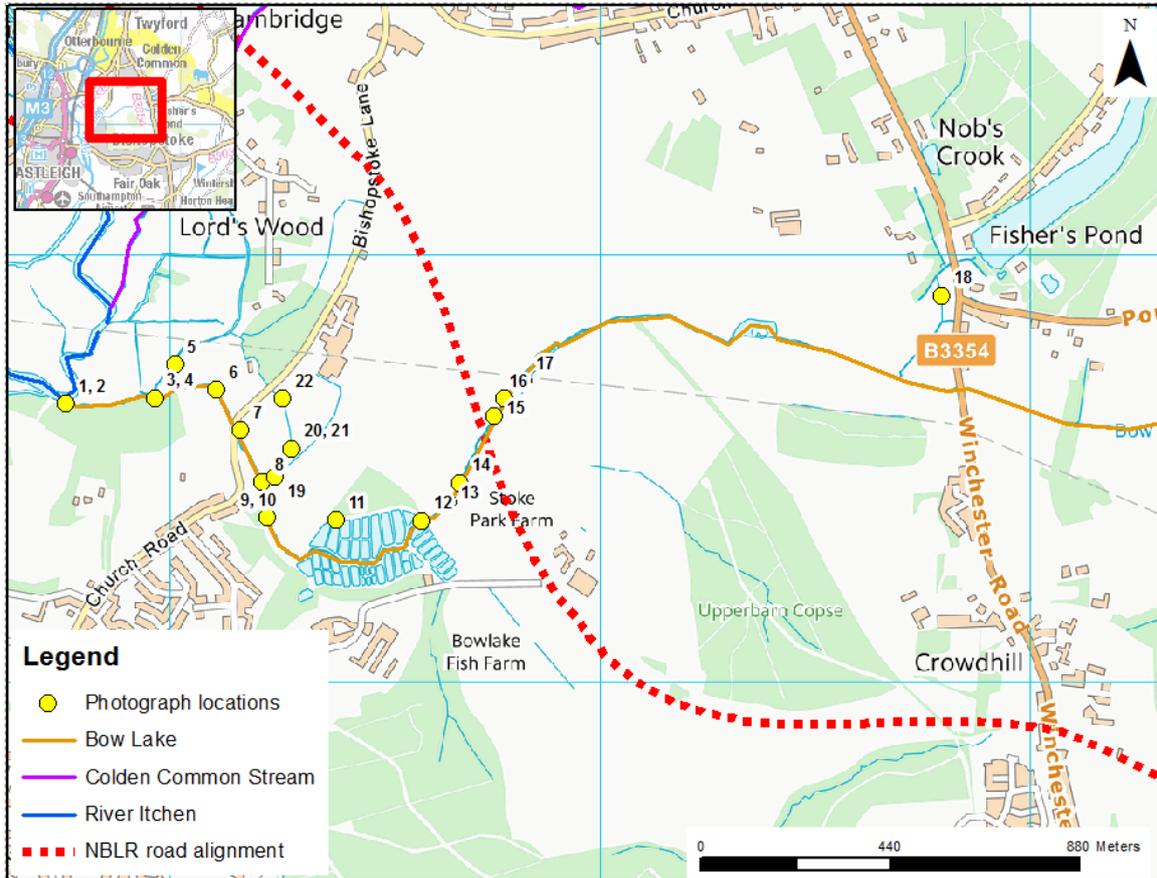
Figure 4-3: Photographs of tributaries of the River Itchen in the vicinity of Lord's Wood



4.3 Bow Lake

The walkover survey focussed on the Bow Lake to the south and east of Lord's Wood (Figure 4-4). This reach includes small tributaries which feed into the Bow Lake on the right bank.

Figure 4-4: Bow Lake and tributaries in the vicinity of Lord's Wood. Labelled points relate to the location of the photographs presented in Figure 4-5.



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There is a stark contrast between the clear waters of the River Itchen and the turbid waters of the Bow Lake, its left bank tributary. The Bow Lake has high levels of suspended sediment within the water column, obscuring the view of the bed (Photos 1 and 2).

Ground on the left bank rises sharply away from the channel and is densely wooded. The right bank is fenced, however in places this is broken / missing, and consequently, the ground is heavily poached right up to the edge of the channel, with sections of vertical, exposed banks, devoid of vegetation (Photos 3, 4 and 6).

The channel is overdeep and the morphology is dominated by gliding flows (Photo 7). Away from the heavily poached sections at the downstream end, the riparian vegetation is well developed. A water treatment plant is located adjacent to Bishopstoke Lane. The channel is obscured by vegetation and not accessible however a structure, such as a weir, is thought to be present at this location. The flow remains turbid upstream of the water treatment plant.

The Bow Lake channel passes through the Bowlake Fish Farm (Photo 11) and is not visible from the footpath through this section. Upstream of Bowlake Fish Farm, the channel remains incised, although moderately less so than downstream reaches. The morphology is dominated by gliding flows, with some narrowing by vegetation creating moderately faster flow sections. Gravels are visible in the shallower sections, and the morphology is displaying some underdeveloped riffle pool characteristics.

Further upstream, in the vicinity of the B3354 road, a tributary of the Bow Lake was examined. This was found to be a densely vegetated, drain like channel with no discernible flow (Photo 18).

Other channels / drains that are indicated on mapping to join the Bow Lake from the right bank floodplain between the Bowlake fish farm and the water treatment plant were examined. Only one of these was found to contain a small amount of standing water, with the rest no longer existent (Photos 19-22).

Figure 4-5: Illustrative photographs of Bow Lake and tributaries: locations are shown in Figure 4-4





7. Turbid nature of Bow Lake



8. Bow Lake upstream of water treatment works



9. Bow Lake between water treatment works and fish farm



10. Bow Lake between water treatment works and fish farm



11. Bowlake fish farm



12. Bow Lake on entrance to Bowlake fish farm



13. Bow Lake upstream of fish farm



14. Bow Lake upstream of fish farm



15. Riffle-type features



16. Bow Lake upstream of fish farm -
vegetation narrowing channel



17. Bow lake upstream of fish farm



18. Tributary of Bow Lake adjacent to B3354



19. Ditch along field boundary



20. Lack of drainage channels shown on
mapping



21. Lack of drainage channels shown on
mapping

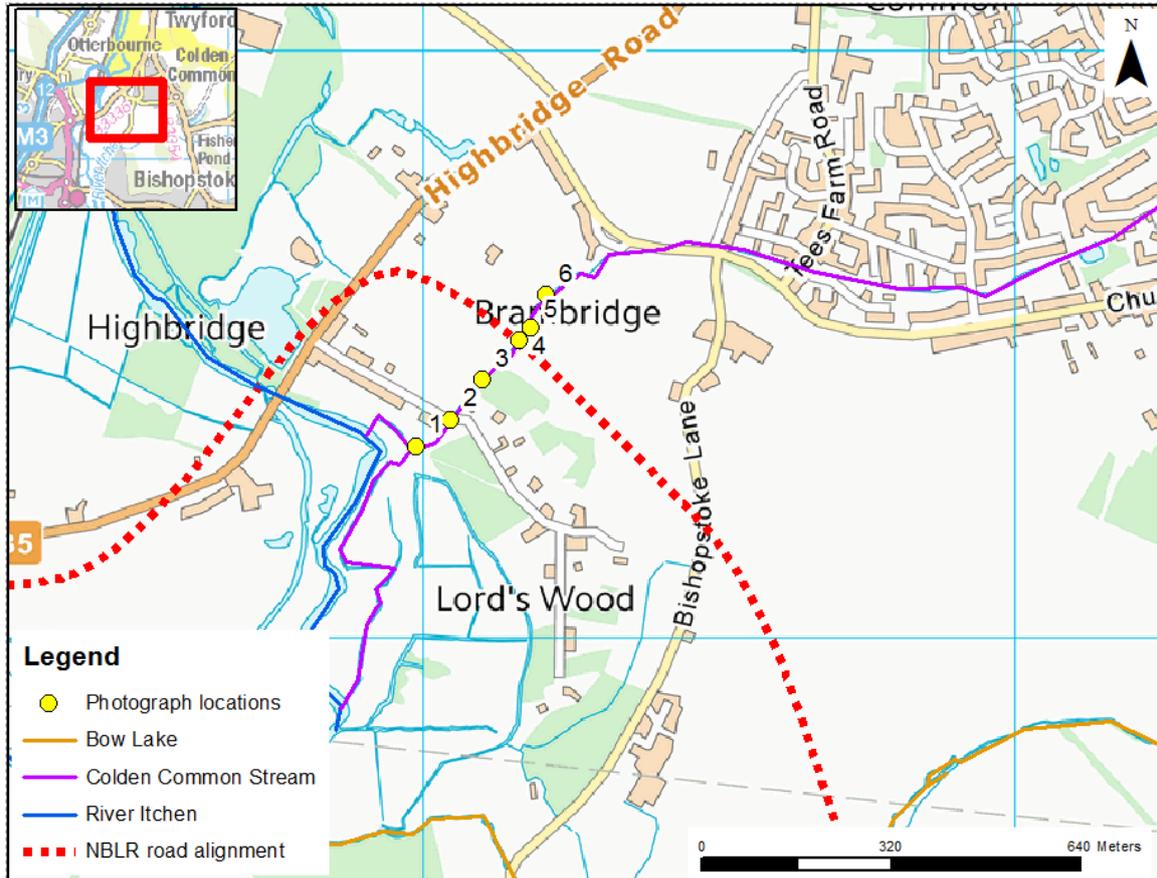


22. Lack of drainage channels shown on
mapping

4.4 Colden Common Stream

The walkover survey focussed on the Colden Common Stream to the southwest of Colden Common (Figure 4-6).

Figure 4-6: Colden Common Stream in the vicinity of Brambridge. Labelled points relate to the location of the photographs presented in Figure 4-7



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The Colden Common Stream is a single thread, small, gravel-bedded stream (Photos 1 and 2). The channel is generally well-connected through the survey extent running primarily through pasture land and a small pocket of woodland adjacent to property (Photo 3). In the upper section of the survey extent, the channel is slightly poached as it runs through the pasture land (Photo 5).

Figure 4-7: Photographs of the Colden Common Stream



5 Current ecological condition

5.1 Overview

The walkover survey focussed on the crossing points of the proposed NBLR alignment options. These areas are discussed below for the River Itchen, Bow Lake and the Colden Common Stream.

5.2 River Itchen ecology walkover

5.2.1 Habitats

5.2.1.1 River Itchen - Lord's Wood

The habitats located at the existing Highbridge Road crossing at SU 46753 21410 consisted of both mature and sub-mature tree cover along the both banks of the River Itchen. Species included Ash *Fraxinus excelsior*, Sycamore *Acer pseudoplatanus*, Alder *Alnus glutinosa* and Hawthorn *Crataegus monogyna*. The Alder trees were noted to have dense Ivy *Hedera helix* cover. Bramble *Rubus fruticosus* agg. scrub was present in the understory. A weir structure is also located upstream of the road bridge. No water Crowfoot *Ranunculus* sp. vegetation, which is associated with the SAC and SSSI designations, was recorded in the watercourse at this reach. However, other macrophytic species were recorded including Unbranched Bur-reed *Sparganium emersum*, Common Club-rush *Schoenoplectus lacustris* and Common Duckweed *Lemna minor*. Filamentous Algae was also present both up and downstream of the existing bridge structure.

Further downstream towards Lord's Wood, the River Itchen takes a sharp meander south and the wider habitat in the vicinity of this reach is characterised by overhanging Grey Willow *Salix cinerea*, with Common Reedmace *Typha latifolia* and Branched Bur-reed *Sparganium erectum* present on the banks. The floodplain in this section was characterised as swamp habitat and was dominated by reedbeds with species including Common Reed *Phragmites australis*, Reed Sweet-grass *Glyceria maxima* and Yellow Flag Iris *Iris Pseudoacorus*.

Downstream of this reach the river begins to meander towards the west. Within this section, additional macrophytic species were recorded including Mare's Tail *Hippuris vulgaris* and Club rush. Water Crowfoot was still recorded in this reach, along with numerous overhanging Alder trees on both banks.

5.2.1.2 Bow Lake

A small tributary of the River Itchen which runs alongside a woodland (see Figure 4-5 Bow Lake) between SU 46764 20665 - SU 47099 20692 was found to be heavily incised and overshadowed. Consequently, the banks of this reach were bare and very steep. Within the watercourse no in-channel vegetation was recorded.

The surrounding area in this reach was primarily semi-improved grazed grassland which contained species associated with enrichment including Perennial Rye-grass *Lolium perenne*, Broad-leaved Dock *Rumex obtusifolius*, Spear Thistle *Cirsium vulgare* and Creeping Buttercup *Ranunculus repens*. Small pools of ephemeral standing water were also noted within the fields, with heavily poached areas.

Further east along the Bow Lake survey section, the watercourse was noted to contain Brooklime *Veronica beccabunga* and Yellow Flag Iris, with a riparian margin of Bramble, Nettle *Urtica dioica*, Common Hogweed *Heracleum sphondylium*, Common Comfrey *Symphytum officinale* and Bindweed *Convolvulus arvensis*.

Bow Lake passes through a fish farm and Himalayan Balsam *Impatiens glandulifera* was noted to become apparent, and more dominant in this reach. Other species recorded in this reach included Branched Bur-reed and Reed Sweet-grass. The bank tops were dominated by treelines and hedges.

The middle section of Bow Lake was narrow and shallow in places, and was overshadowed with overgrown ruderal vegetation. Himalayan Balsam was still present in this reach. Species recorded included Brooklime, Yellow Flag Iris, Water Speedwell and Water Starwort. The surrounding area was dominated by improved grassland fields.

The end section of Bow Lake is located adjacent to the B3354 Winchester Road and was found to be very overgrown with ruderal species and contained a very low water level at the time of the

survey. Species present included Branched Bur-reed, Bindweed, Broad-leaved Dock, Nettle, Water Forget-me-not *Myosotis scorpioides* and Reed Sweet-grass.

5.2.1.3 Colden Common Stream

Within the drainage ditches adjacent to Lord's Wood (see Figure 4-7 Colden Common Stream) Fool's Water Cress *Apium nodiflorum*, Starwort *Callitriche* sp. Branched Bur-reed, Purple Loosestrife *Lythrum salicaria* and Common Reed were all recorded. Where this drainage section joins the River Itchen, areas of *Ranunculus* sp. were recorded. The non-native invasive species Orange Balsam *Impatiens capensis* was present in this reach along the main river and drainage ditch banks. The wider area is characterised by semi-improved grassland which is intersected by treelines and hedgerow. A mature Goat Willow tree line intersects the drain at approximately SU 46923 21014.

5.2.2 Protected species

5.2.2.1 Birds

Several bird species were recorded during the site visit including:

- Swan *Cygnus olor*
- Heron *Ardea cinerea*
- Greater Spotted Woodpecker *Dendrocopos major*
- Crow *Corvus corone*
- Unknown Warbler *Acrocephalus* sp.
- Woodpigeon *Columba palumbus*

5.2.2.2 Amphibians

No amphibians were recorded during the site walkover. However, a number of slow flowing or stagnant drains are present in the vicinity of the River Itchen, Lord's Wood and Bow Lake, which should not be devalued as potential amphibian breeding habitat. Within some of the grassland fields, several ephemeral pools were recorded. These were shallow and not permanent in nature and were considered unlikely to support breeding amphibians. OS mapping showed several waterbodies present within 500m, which are outlined in Table 5-1 below.

Table 5-1: Locations of ponds within 500m of road routes

Reference	Grid Reference	Additional comments
1	SU 46755 21169	
2	SU 46841 21234	Possibly connected to watercourse. Potential for fish
3	SU 47312 20201	
4	SU 47605 20112	
5	SU 47845 20369	Three small waterbodies

5.2.2.3 Reptiles

The areas surrounding each proposed road route are suitable to support reptile populations with areas of scrub, woodland and tall ruderal grass habitat present for refugia and foraging. The watercourses and drainage ditches are also optimal habitat for reptiles such as Grass Snake *Natrix natrix*.

5.2.2.4 Bats

No specific bat surveys were carried out as part of the walkover survey. However, there are several mature tree lines located across the survey route, woodland copses and the river itself which all offer bat roosting and/or foraging habitat.

5.2.2.5 Badger

No evidence of badgers was observed during the site visit; however, the habitat was assessed as being suitable for this species considering the local topography and presence of woodland copses, open grassland fields and arable land.

5.2.2.6 Water Vole

A detailed Water Vole survey was not conducted as part of the site walkover, however a habitat appraisal for this species highlighted that the River Itchen and Colden Common Stream were suitable to support this species. Small areas of Bow Lake surveyed were considered to have low potential due to the high level of overshadowing in places.

5.2.2.7 Otter

The three watercourse reaches surveyed were all considered optimal to support Otter, due to the level of overhanging vegetation and available food sources. The banks were accessed where possible on each watercourse surveyed, however no evidence of this species was recorded.

5.2.2.8 Invasive Non-native Species

Extensive stands of Himalayan Balsam, with occasional Orange Balsam were recorded across the survey extent on the banks of both the River Itchen and smaller tributaries. Locations are detailed in Table 4 2 below.

Table 5-2: Locations of INNS recorded on site

Species	Location (NGR)
Orange Balsam	SU 46871 20895
Orange Balsam	SU 46875 20879
Himalayan Balsam	SU4715120609
Himalayan Balsam	SU4715120609
Himalayan Balsam	SU4722120390
Himalayan Balsam	SU4722420388
Himalayan Balsam	SU4782320701
Himalayan Balsam	SU4781720701
Himalayan Balsam	SU4781720701
Himalayan Balsam	SU4721920464

6 Geomorphological and ecological constraints

6.1 Geomorphology

6.1.1 Potential impacts

A number of potential (prior to mitigation) impacts of the proposed road routes upon the fluvial geomorphological functioning have been identified.

- Bridge crossings have the potential to influence local river conditions. Bridges that influence the channel width by constricting or widening the channel can also impact upon the steepness of the banks, size of bed sediments and the velocity / shear stress of the water both upstream and downstream of the crossing point.
- Channel widening upstream and downstream of a bridge crossing, for example, can lead to localised reductions in velocity and shear stress, which could potentially lead to an increase in fine sediment deposition and altered grain size distribution in the vicinity of the bridge.
- Local changes in flow velocity and shear stress can lead to bank and bed erosion within the locality of the structure. Bridge piers, for example, can modify channel morphology by increasing water velocity and turbulent flows, which can cause scour and bed degradation, and has the potential to modify the riffle pool spacing observed on site.
- Roads and bridges across the functional floodplain can alter the flow pathways, changing the timing of flood pulses and altering the response of the river during flood events. Poorly designed bridges can increase flood risk upstream due to a lack of capacity beneath the structure. Similarly, other structures across the floodplain which block the flow, i.e. road embankments, can cause an increase in upstream flooding.
- Due to the impacts on channel dimensions and flow conditions, bridge crossings can fragment aquatic habitats and negatively impact stream morphology. Over-widening of the channel at bridge locations can lead to a longitudinal loss of biological connectivity during low flow conditions.

6.1.2 Proposed road/bridge design advice

Improperly designed crossing structures therefore have the potential to alter geomorphological forms, processes and habitats. To mitigate the impacts of the proposed road crossings upon the fluvial geomorphological functioning of the watercourses, the following precautions should be taken:

- Road routes should be chosen that minimises the number of crossings.
- Use existing structures (if suitable), or upgrade and replace structures if environmental improvements can be made (i.e. fish and mammal passage).
- An options appraisal should be undertaken to identify a design that minimises disruption to geomorphological processes. The most suitable option is one which minimises environmental harm at a cost that is not disproportionately expensive.
- Road routes and crossings should be designed to ensure that they do not alter fluvial forms (i.e. channel width, bank slopes, floodplain connectivity etc.) or impede natural hydromorphic functioning (i.e. sediment transport, biotopes etc.).
- Bridge crossings should be designed so that the soffit elevation is above the level of the 1-in-100 year plus climate change flood level. The maximum water levels for the 1-in-100 year plus climate change flood event for the proposed NBLR route crossing locations are given in Section 3.1.5.
- Clear span structures are preferable (structures that span the width of the channel with no in-stream support). Clear span structures do not affect the bed of the river, i.e. they have no artificial invert and a natural bed is maintained. Bank habitat can also be maintained under the crossing if the abutments are set back. Making the distance between the bridge abutments as wide as possible maximises the riparian corridor and allows the river some space to move.
- The foundations of abutments (and in-stream piers, if unavoidable) should be buried deep enough to minimise or prevent the need for bed or bank reinforcement or bridge weirs or aprons. This maintains the natural bed material and bed levels, protecting habitat and

allowing fish passage. The foundations should be buried deep enough to allow for scour during high flows.

- Subject to the design of the bridge structure, it will be necessary to understand the impact of any works within the floodplain. Viaducts (a road deck spanning between piers) should be used to cross floodplains rather than embankments. This option greatly reduces the impact on the floodplain, but can have cost implications. Where embankments are unavoidable, 'normally dry culverts' in embankments can be used to connect the floodplain. There may be hydraulic design issues to overcome, which can result in reinforcement around the culverts to prevent scour and embankment failure during high flow events. If any embankments are proposed, level for level floodplain compensation will be required subject to the Environment Agency's approval.

6.1.3 Discussion of proposed road route and impacts on the River Itchen

In the vicinity of the River Itchen, the proposed route utilises the existing B3335 road, which bisects the River Itchen floodplain between Highbridge and Allbrook. At this location the route is crossing one of the widest sections of floodplain, where the floodplain width is approximately 800m (see Figure 3-7). At present, the planned route will utilise the existing bridge at Highbridge, and a new crossing will be constructed over the Itchen Navigation at Allbrook. The proposed road route will mainly utilise the existing road network through this location, apart from the section immediately east of the Itchen Navigation crossing, where the proposals include realigning approximately 500m of the road to improve the approach to the new bridge crossing and railway bridge. Although the proposed road route is crossing a wide section of floodplain, it is important to note that the existing road is currently crossing the floodplain and that, with careful design (i.e. a clear span bridge with sufficient freeboard) and suitable mitigation measure in place, potential impacts on the geomorphology of the River Itchen can be minimised.

6.2 Ecology

This section details recommendations for the potential ecological constraints identified through the desk-based and field study.

6.2.1 Statutory sites

The road crossings and enabling works are likely to take place within the River Itchen SAC and SSSI, or in the immediate surrounds of the designated sites. These features are designated due to their botanical and fish interest, and include species such as Salmon and Bullhead. It is also an important catchment for Otter, Southern Damselfly and White-clawed Crayfish.

Further assessment will be needed to ensure these sites will not be adversely affected by the proposed works. For a SSSI, this will involve liaising with the relevant Natural England officer. For the SAC, a Habitat Regulations Assessment (HRA) is required and will need to demonstrate that the features that qualify it for designation will not be adversely impacted upon as a result of the works. Reasonable time should be allowed for this exercise as approval and changes to proposed works may be required.

6.2.2 Habitats

Prior to any mitigation, habitats will be impacted by both the temporary and permanent works phases of the proposed scheme. The works are likely to cause changes to floodplain connectivity and consequently associated habitats. The works are also likely to cause habitat fragmentation due to removal of treelines and possibly woodland areas.

The temporary works phase, without mitigation, is also likely to lead to an increase in sedimentation, silt mobilisation and pollution which can have negative impacts downstream of works sites.

Habitats likely to be negatively impacted by the works include, but are not restricted to:

- River habitats
- Riparian margins
- Mature tree lines
- Hedgerows
- Wet meadows
- Areas of fen

- Ditch habitats
- Swamp
- Broad-leaved woodland copses

6.2.3 Species

Prior to mitigation, numerous protected species will be impacted by both the temporary and permanent works phases of the scheme. Therefore, works should consider the optimal mitigation periods for protected species to reduce impacts.

The temporary works are likely to cause visual, noise, dust and pollution. Species habitats and ranges may also be temporarily fragmented. Due to the works being located within a riverine habitat, there is a high likelihood that species downstream of all proposed works may be negatively impacted by the scheme. Biosecurity is also a constraint to the proposed scheme.

The permanent works will impact habitats upon which species rely and may be resident of, such as river banks (which support Water Vole and Otter), or mature trees, treelines or wooded areas which can support bats, birds and invertebrates. The permanent loss or damage to such habitats would have a negative impact on local populations, some of which are of national significance.

Species likely to be negatively impacted by the works include, but are not restricted to:

- Otter
- Water Vole
- Bats
- Badger
- Nesting Birds and Schedule 1 species associated with the River Itchen SAC SSSI
- White-clawed Crayfish
- Fish
- Amphibians and Reptiles
- Southern Damselfly

7 Recommendations

7.1 Water Framework Directive

A Water Framework Directive (WFD) assessment should be conducted in advance of works to ensure that the proposals are in line with European legislation and to mitigate against any adverse in-channel effects. WFD is a desk-based assessment which relies on information given of the status of the River Itchen as detailed within the relevant River Basin Management Plan (RBMP).

7.2 Geomorphological Assessments

Hydraulic modelling should be undertaken as part of the bridge design process to inform the options appraisal and ensure that the bridge design does not have the potential impact upon the geomorphology of the watercourses. Outputs from hydraulic modelling can be used to quantify flow velocity and shear stress at the bridge structures and assess the impacts of the proposed structure on flow and sediment dynamics. This will allow potential risks, such as localised scour/erosion and/or changes in sediment deposition patterns to be identified for each proposed bridge option. Iterative hydraulic modelling can be used to refine the bridge design, allowing these risks to be mitigated during the design process. Similarly, the proposed road route across the floodplain can be investigated using hydraulic modelling by identifying potential impacts on flood flow routes when the floodplain is inundated. For example, outputs from the hydraulic modelling can be examined to ensure that the proposed road alignment does not back up flow and cause an increase in flood risk upstream.

7.3 Ecological Assessments

In order to fully assess the impacts of the proposed scheme, additional ecological data is required. Further survey proposals are outlined in Section 7.3.1 and Section 7.3.2 below.

7.3.1 Habitats

It is recommended that further detailed surveys of habitats to be impacted by the works are conducted to allow a full assessment of impacts to be made. As a minimum, this should include:

- Macrophyte surveys of all proposed river crossings using LEAFPAC methodology which is the WFD standard, to assess the species richness and abundance in proposed critical construction areas.
- Mapping and assessment of habitat suitable to support Southern Damselfly.
- Detailed habitat assessments of all proposed works areas should be undertaken, not just in the vicinity of river crossings, as the River Itchen valley contains areas of fen, swamp, ditches and wet meadows which are not replicable habitats once altered and are influenced by changes in both water level and quality. Survey assessments should comprise of at least detailed Phase 1 habitat mapping, or preferably National Vegetation Classification (NVC) of areas to be impacted to fully assess the plant communities.

7.3.2 Protected species

The following species will require further consideration for all proposed routes:

- Bat activity and roosting surveys: dependent on level of tree removal and disturbance to foraging and commuting routes.
- Water Vole: Activity surveys at all waterbody crossing points (both up and downstream of locations).
- Otter: Activity surveys at all waterbody crossing points (both up and downstream of locations).
- Fish: Spawning season to be avoided for salmonids (November - February). All in-channel crossing will require fish passage to remain open and rescue surveys to be conducted for SAC Annex II fish species and Brook Lamprey.
- White-clawed Crayfish presence / absence Surveys at river crossings and where any works to riverbanks are taking place on River Itchen SAC, SSSI.
- Amphibians: Habitat suitability assessments of identified waterbodies.
- Badger: Activity surveys along proposed road route(s) and enabling works areas.

- Reptiles: Activity surveys along proposed road route(s) and enabling works areas.
- Southern Damselfly surveys at river crossings and temporary works locations.

7.4 On site practices

7.4.1 Pollution Prevention

Appropriate mitigation measures can be implemented to ensure that habitats within proximity of the works are not degraded as a result of pollution events during the construction phase. Mitigation could include:

- Abiding by relevant pollution prevention measures e.g. CIRIA Guidance: Control of water pollution from construction sites. Guidance for consultants and contractors (C532D) (Masters-Williams, 2001). Information useful for Toolbox Talks on working near water and pollution prevention can be found at: https://www.ciria.org/Resources/All_toolbox_talks/Env_toolbox_talks/Working_on_or_near_watercourses.aspx [site accessed: 03/05/18].
- Preventing accidental oil and fuel leaks can be achieved by the following actions:
 - Any chemical, fuel and oil stores should be located on impervious bases within a secured bund with a storage capacity 110% of the stored volume.
 - Biodegradable oils and fuels should be used where possible.
 - Drip trays should be placed underneath any standing machinery to prevent pollution by oil/fuel leaks. Where practicable, refuelling of vehicles and machinery should be carried out on an impermeable surface in one designated area well away from any watercourse or drainage (at least 10m).
 - Emergency spill kits should be available on site and staff trained in their use.
 - Operators should check their vehicles on a daily basis before starting work to confirm the absence of leakages. Any leakages should be reported immediately.
 - Daily checks should be carried out and records kept on a weekly basis and any items that have been repaired/replaced/rejected noted and recorded. Any items of plant machinery found to be defective should be removed from site immediately or positioned in a place of safety until such time that it can be removed.
- Silt run off can be prevented by incorporating the following actions:
 - Silt curtains should be used where appropriate to prevent silt from the construction works entering the watercourse.
 - Exposed bare earth should be covered as soon as possible to prevent soil erosion and silt run-off. This can be achieved by selecting a fast growing and soil binding seed mix such as Boston Seed's EA Special Mixture No.10 for river bank reinstatement: <http://www.bostonseeds.com/advice/1/Grass-Seed/96/River-Bank-Reinstatement/> [site accessed: 03/05/18]. Alternatively, geotextile coverings can be used to cover any exposed earth and prevent soil erosion.
 - Water quality downstream of the works can be monitored to detect any changes in water quality that could indicate a pollution incident. Should monitoring indicate potential pollution from the construction activities, works should be stopped, and a solution found to prevent the pollution source entering the watercourse. Monitoring could include:
 - Visual monitoring to see if water colour has changed or if a plume is visible indicating sediment input.
 - Water quality meter measurements for Dissolved Oxygen and pH.

7.4.2 Biosecurity

Good biosecurity practices are vital for preventing the spread of invasive non-native species and pathogens such as waterborne fish diseases/crayfish plague. General biosecurity measures can include:

- All site personnel and visitors to be inducted in good biosecurity practices. This can include adoption of the check-clean-dry campaign <http://www.nonnativespecies.org/checkcleandry/> [site accessed: 03/05/18].

- The check-clean-dry poster could be displayed in the site office as a reminder of good biosecurity practices <http://www.nonnativespecies.org/downloadDocument.cfm?id=608> [site accessed: 03/05/18].
- If access to the water is required, particular care should be taken, and equipment and PPE can be disinfected to prevent the spread of waterborne diseases. A suitable disinfectant would be Virkon® S Aquatic. Following application of a suitable disinfectant, machinery and PPE should be allowed to fully dry for at least 72 hours before being used on another aquatic site.

7.5 Opportunities for ecological enhancement

To maximise ecological gain from these works the following opportunities for enhancement are suggested:

- Riparian planting e.g. bankside trees to provide shade and additional habitat. This can help attract species, such as otter, and can be used by bats for navigation. Riparian planting should only be taken in areas identified as suitable to support riparian mammals and not within habitat areas which support Southern Damselfly.
- Marginal planting to increase vegetation and species diversity in Colden Common Stream and Bow Lake. This habitat is utilised by invertebrates, fish, and small mammals such as water vole, and can help improve water quality. Expansion of this type of habitat should be prioritised in areas where Southern Damselfly is present to help create larger, and where possible, more connected habitats between populations.
- Increase the number and quality of slow flowing floodplain channels to increase the habitat available for Southern Damselfly on the River Itchen tributaries.
- Changes in land management – a reduction in grazing pressure where issues have been identified with excessive sediment input and bank erosion. Limitations on bankside poaching will have a positive effect on biodiversity by reducing nutrient and sediment inputs into connecting tributaries of the River Itchen.
- Increase in habitat connectivity across a catchment scale, by increasing existing habitat cover, including swamp, meadow and woodland areas.
- Explore opportunities for Natural Flood Management within the catchment which can also have beneficial impacts on niche aquatic communities.

It is assumed that additional work will be carried out for ecology in terms of a detailed mitigation and enhancement plan to ensure all habitats and species are taken into account, once details of the works are finalised.

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