

Malvern and Brueton Park Restoration

Feasibility Study
Phase 1 - Baseline Study

Warwickshire Wildlife Trust

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1. Project Background

AECOM have been commissioned to carry out a feasibility study to assess potential restoration options on the River Blythe as it flows through Malvern and Brueton Park, Solihull (Figure 1.1). Warwickshire Wildlife Trust (WKWT) and Solihull Metropolitan Borough Council (SMBC), along with the Environment Agency (EA) and Natural England (NE), have funding from the EA and Water Environment Grant (WEG) to carry out work on the River Blythe. The aim is to improve the Water Framework Directive (WFD) status of the river and feed into objectives for the Site of Scientific Interest (SSSI).

The River Blythe is a lowland river that rises at Spring Brook, near Earlswood Lakes, and flows in a predominantly northerly direction before discharging into the River Tame north east of Coleshill. The river has been designated a SSSI and is cited as an exceptional and rare example of Britain's semi lowland rivers on clay, supporting a wide range of flora and fauna¹. The section of the River Blythe assessed as part of this study forms Reach 9 of the River Blythe Management Plan² and seeks to identify opportunities for restoration of the watercourse within the Malvern and Brueton Park area.

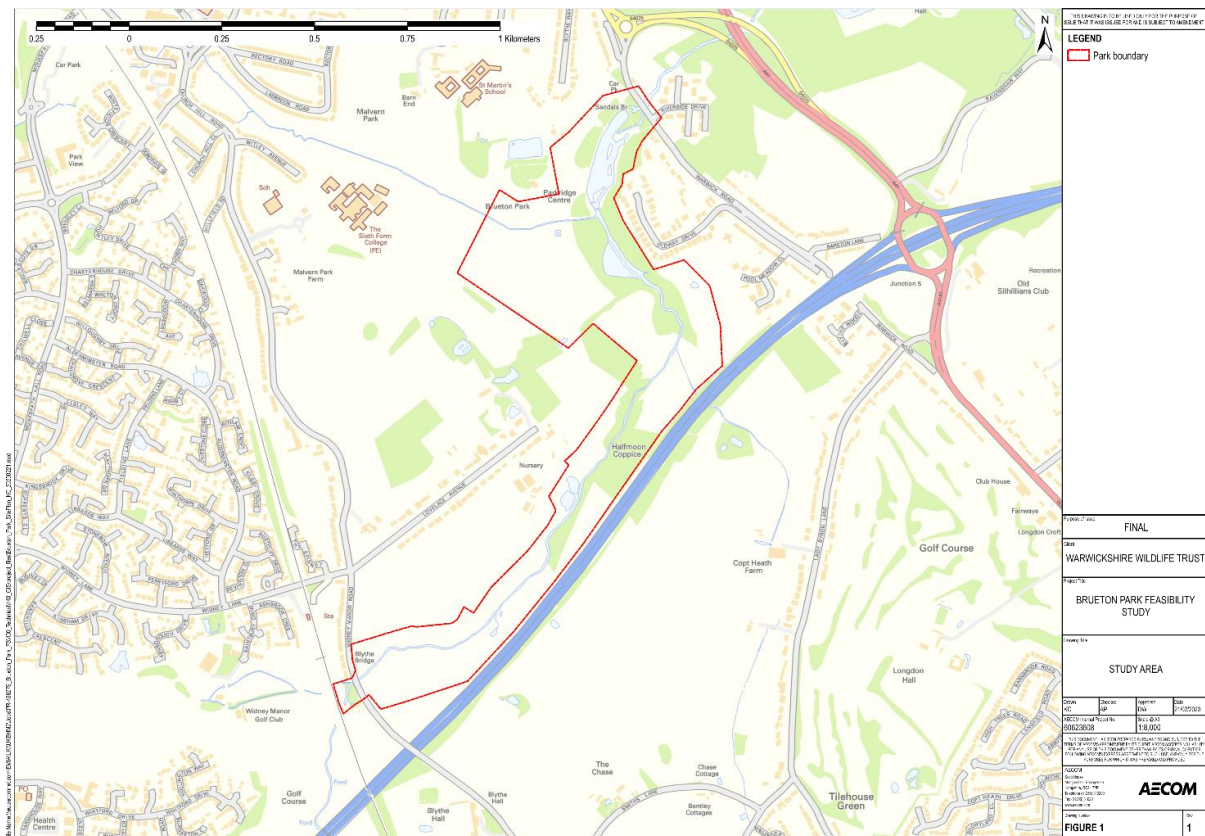


Figure 1.1. River Blythe Restoration study area

The following report contains a summary of the studies that have been carried out as part of the Malvern and Brueton Park Restoration Feasibility Study. These include;

- Preliminary Risk Assessment
- Heritage Baseline
- Geomorphology Baseline
- Engineering Assessment
- Water Quality Assessment
- WFD Baseline
- Phase 1 Habitat Survey
- Hydraulic Modelling Baseline

¹ <https://designatedsites.naturalengland.org.uk/PDFsForWeb/Citation/1001772.pdf> Accessed: 07.08.2020

² JBA Consulting (2017) *River Blythe Restoration Management Plan*

The summaries included within this report are supported by the baseline reports included in Appendices A – F.

The findings of these baseline assessments will be used in Phase 2 of the project (Option Development) to develop restoration options and select a Preferred Option for delivery on the River Blythe through Malvern and Brueton Park.

2. Preliminary Risk Assessment

2.1 Development History

The historical Ordnance Survey (OS) maps obtained with the Landmark Envirocheck report date between 1880 and 2016. Table 2.1 summarises the immediate site history of a 1km radius, also referred to as the study area, around the River Blythe.

Table 2.1. Summary of Historical OS Mapping

| Year | Features on-site | Features off site (wider study area) |
|-----------|---|---|
| 1886-87 | <ul style="list-style-type: none"> - The River Blythe flows along the eastern boundary of the Malvern Hall grounds. - The immediate area around the River is marked as liable to flood. - There are a number of areas designated as deciduous woodland along the River. - The southern extent of the river is intersected by the Oxford and Birmingham Branch railway line. | <ul style="list-style-type: none"> - There are a number of marked quarries within the 1km radius of the river. - The grounds of Malvern Hall contain a surface water body referred to as a boiling pool. |
| 1905 | <ul style="list-style-type: none"> - The site remains generally unchanged except an extension of the area encapsulated by Malvern park and hall. | <ul style="list-style-type: none"> - The area surrounding the site remains generally unchanged. - Increase in the size of the Blythe Hall grounds. |
| 1920-1921 | <ul style="list-style-type: none"> - The maps are incomplete during this period (south western extent of River) - The area surrounding the site remains generally unchanged. | <ul style="list-style-type: none"> - The area surrounding the site remains generally unchanged. |
| 1938 | <ul style="list-style-type: none"> - The site remains generally unchanged except for altered vegetation cover in the park (reduced woodland). | <ul style="list-style-type: none"> - Increase in urban area of Solihull to the north of study area. |
| 1955 | <ul style="list-style-type: none"> - The site remains generally unchanged except for reduced vegetation cover. - Marshy area to the north of study area referred to as Lake. | <ul style="list-style-type: none"> - Increase in residential areas around the site. |
| 1968 | <ul style="list-style-type: none"> - Reduction of woodland area along the river. | <ul style="list-style-type: none"> - Clay pit to the north of the River. - Increase in urbanisation and residential areas around the River. - Possible Infilling of Boating Pool to the west of the River. |
| 1973-1978 | <ul style="list-style-type: none"> - Reduction of woodland area along the river. - Construction of motorway parallel to river. | <ul style="list-style-type: none"> - Increase in urbanisation and residential areas around the River. |
| 1990-1992 | <ul style="list-style-type: none"> - The site remains generally unchanged. | <ul style="list-style-type: none"> - Increase in urbanisation and residential areas around the River. |
| 1999 | <ul style="list-style-type: none"> - The site remains generally unchanged. | <ul style="list-style-type: none"> - Generally unchanged. |
| 2006 | <ul style="list-style-type: none"> - The site remains generally unchanged. | <ul style="list-style-type: none"> - Generally unchanged. |
| 2020 | <ul style="list-style-type: none"> - The site remains generally unchanged. | <ul style="list-style-type: none"> - Generally unchanged. |

2.2 Geology

The regional geology of the area has been interpreted from the British Geological Survey (BGS) 1:625,000 and 1:50,000 scale maps available on the BGS online map viewer 'GeoIndex'.

Regionally the bedrock is dominated by the Simouth Mudstone Formation and Merica Mudstone Group comprising primarily mudstone and siltstones. There is also a small area to the north of the study area mapped as the Arden Sandstone formation which comprises mudstones interbedded with siltstones and fine to medium-grained sandstones.

Partly overlying the bedrock formations are superficial deposits which are mapped as alluvium and river terrace deposits along the route of the River Blythe. Additionally, there are areas mapped as glaciofluvial deposits listed as comprising sand and gravel. There is a north west to south east trending fault to the north of the study area. A summary of the geology is presented in Table 2.2 below.

Table 2.2. Geological Setting

| Group | Formation | Lithological Description | Thickness (m) |
|-----------------------|---|-----------------------------------|---------------|
| Superficial Deposits | Alluvium | Clay, Silt, Sand and Gravel | unknown |
| | Glaciofluvial deposits, mid pleistocene | Sand and Gravel | unknown |
| | River terrace deposits | Sand and Gravel | unknown |
| Mercia Mudstone Group | Arden Sandstone Formation | Sandstone, Siltstone and Mudstone | 2 - 20m |
| | Sidmouth Mudstone Formation | Mudstone | 120 - 130 |
| | Mercia Mudstone Group | Mudstone | 1350m+ |

2.3 Hydrogeology

Groundwater flow beneath the study area is within Mudstone of the Mercia Mudstone Group, Sidmouth Mudstone Formation and within the more permeable bands of the Arden Sandstone Formation. These aquifers would be expected to have a low intergranular permeability with the bulk of any groundwater flow as a result of the secondary permeability due to the presence of fractures, fissures. However, it is considered that the bedrock underlying the site and surrounding area is relatively impermeable with limited groundwater potential.

The superficial deposits that overlie the Mudstone bedrock and Arden Sandstone Formation largely consist of sands, gravels, silts and clays which will enable groundwater flow locally within the higher permeable sands and gravels. A summary of the aquifer and their respective aquifer designation is presented in Table 2.3 below.

Table 2.3. Environment Agency Aquifer designation

| Group | Formation | Aquifer Designation |
|----------------------|---|---------------------|
| Superficial Deposits | Alluvium | Secondary A |
| | Glaciofluvial deposits, mid pleistocene | Secondary A |
| | River terrace deposits | Secondary A |
| | Till, mid pleistocene | Secondary B |
| Bedrock | Arden Sandstone Formation | Secondary A |
| | Sidmouth Mudstone Formation | Secondary B |
| | Mercia Mudstone Group | Secondary B |

There is no site-specific data available for the hydraulic properties of the bedrock or superficial aquifers. There are no Source Protection Zone (SPZ) mapped within the study area. The nearest Source Protection Zone (SPZ3) is mapped approximately 7.5km to the north east. No groundwater abstraction licences are reported within the study area. There is one potentially active borehole identified just outside 1km radius relating to Copt Heath Golf Club. However, no further details are available on the status of this borehole.

2.4 Review of Geo-environmental Risk

This section is aimed at identifying possible risks, if any, arising from substances used or deposited on-site, or from other sources of land contamination. Both past and current potentially contaminative land uses have been considered.

Table 2.4. Contamination Setting

| Previous uses along the reach (see Table 2.1) | Potential Contaminants | Source Pathway Receptor | Risk consideration / Potentially unacceptable risks |
|--|--|---|--|
| <ul style="list-style-type: none"> - Agriculture - Recreational park and gardens (including Made Ground) - Ornamental Lake - Residential - Landfill | <p>No site or installations with hazard substances are reported in the 1km buffer zone either side of the reach by Envirocheck.</p> <p>Historic landfill sites present in 1km buffer zone either side of the reach:</p> <ol style="list-style-type: none"> 1. Historical EA and Local Authority registered landfill, licence ended in 1975, Inert waste. 2. Historical EA, BGS and Local Authority registered landfill, licenced from 1968 to 1979, Inert waste. 3. Historical EA and Local Authority registered landfill licenced from 1986 to 1994, Inert waste, industrial and liquid sludge. <p>There are five discharge consents referenced as Sewage Discharges and other Matter registered to Severn Trent. Two are marked as revoked.</p> <p>Agriculture/Allotments/Recreational Park – nutrients / fertilisers / pesticides / insecticides</p> <p>Recorded Pollution Incidents (NIRS):</p> <ol style="list-style-type: none"> 1. 2703145, 23/01/98 – Chemicals - Detergents/Surfactant (Accidental Spillage/Leakage) – Category 3 (Minor Incident). 2. 2703475, 24/07/97, Miscellaneous – Natural, Miscellaneous/Other Pollution Type – Category 3 (Minor Incident). | <p>Source:</p> <ul style="list-style-type: none"> - Potentially contaminated surface water (River Blythe and drainage ditches). - Potentially contaminated groundwater (superficial layers are Secondary A & B) Aquifer and may provide localised aquifers and baseflow; bedrock aquifer is Mudstone bedrock and classified as Secondary B aquifer. Small outcrop of the Arden Sandstone which is classified as a secondary A aquifer). - Water Mains pipeline (below ground). - Foul sewer pipeline (below ground). - Surface Sewer pipeline - Permitted discharges to surface water (3 potentially active licences). - Potentially contaminated effluent/ leachate from 3 mapped historical landfills. <p>Pathways</p> | <p>Human Health Receptors:</p> <p><i>Construction and maintenance workers - moderate risk</i> - further chemical testing of soil/sediments is necessary to characterise possible contamination and/or health risk before any works.</p> <p>If soils are to be disturbed and/or re-used, then an intrusive ground investigation including chemical testing of soils may be necessary to further quantify and characterise possible contamination.</p> <p>If soils or sediments are found to be contaminated, then appropriate mitigation measures will be required to ensure that health and safety risks are minimised during construction.</p> <p><i>Final End Users/Adjacent Site Users – low risk.</i> It is assumed that publicly accessible sites will be covered with hardstanding (or equivalent) and that there will be no pathway between end users and potentially contaminated soils/sediment. <i>(To be reviewed once final options decided, and if hardstanding is not proposed in publicly accessible areas further risk assessment will be required to determine</i></p> |

| | | | |
|--|---|---|--|
| | <ol style="list-style-type: none"> 3. 2702370, 23/01/97, Miscellaneous – Foam, Deliberate Disposal To Drain – Category 3 (Minor Incident). 4. 2703367, 01/10/97, Miscellaneous – Foam, Other Incident/Unknown – Category 3 (Minor Incident). 5. 2001522, 24/11/96, Crude Sewage, Blocked Sewer – Category 3 (Minor Incident). 6. 2702000, 10/12/96, Miscellaneous - Inert Suspended Solids, Other Incident/Unknown – Category 3 (Minor Incident). 7. 1700712, 10/11/95, Oils – Unknown, Other Incident/Unknown 8. 2001671, 25/01/97, Oils - Diesel (Including Agricultural), Collision – Category 3 (Minor Incident). – Category 3 (Minor Incident). 9. 2702411, 24/01/97, Oils - Diesel (Including Agricultural), Other Incident/Unknown – Category 3 (Minor Incident). 10. 2702491, 27/02/97, Oils – Unknown, Other Incident/Unknown – Category 3 (Minor Incident). | <ul style="list-style-type: none"> - Surface water run-off and/or direct percolation from surface. - Leaching of contaminants and vertical migration of groundwater. - Lateral migration of groundwater providing baseflow to surface watercourses. - Direct human or animal contact with soil/sediment (ingestion and dermal). <p>Human Health Receptors:</p> <ul style="list-style-type: none"> - Final End Users. - Adjacent Site users. - Maintenance Workers. - Construction Workers. <p>Water receptors:</p> <ul style="list-style-type: none"> - Surface Water (River Blythe). - Secondary (A and B) superficial deposits Aquifer. - Arden Sandstone which is classified as a secondary A. - Current surface water or groundwater abstractions (1 surface water. <p>Vegetation/Ecosystem Receptors:</p> <ul style="list-style-type: none"> - River Blythe ecosystem. - Recreational Park vegetation. <p>Property Receptors:</p> <ul style="list-style-type: none"> - Future proposed services and structures - Existing services and structures. | <p><i>whether contaminated soils would need covering or removal).</i></p> <p>Water receptors: <i>Surface Water - Low Risk:</i> Implement mitigation measures during construction phase to minimise the risk of surface run-off entering surface water courses, and to minimise risk of leaching and vertical migration. <i>(To be reviewed once final options decided).</i></p> <p><i>Groundwater – Low Risk Nothing obvious.</i></p> <p>Vegetation/Ecosystem Receptors: <i>Low Risk:</i> Implement mitigation measures during construction phase to minimise the risk of surface run-off entering surface water courses and thereby impacting aquatic ecosystems. Efforts should be made to restrict animal access to works.</p> <p>Property: <i>Low Risk:</i> Works are constrained by known existing structures.</p> |
|--|---|---|--|

3. Heritage Baseline

3.1 Heritage Background

The River Blythe was first recorded as Blitha, meaning “calm flowing”, in the 12th century. The river and riparian zone have undergone significant physical changes that illustrate the interaction between the river and the people over the years. Such changes include the construction of bridges and fords, the straightening and widening of channels associated with mill ponds and mill leats during the 18th century, as well as significant straightening and realignment in parts to accommodate the construction of major roads and railways. Therefore, structures associated with these events may hold historic, archaeological, architectural or artistic interest (heritage significance).

The study area falls within Malvern and Brueton Park. The park is associated with Malvern Hall, constructed in 1690 by Humphrey Greswold who later became High Sheriff of Warwickshire. The Hall was substantially extended in 1702 and 1726 and again following a survey commissioned by Marshall Greswold, Humphrey's brother, the area around the Hall was developed as parkland. The park was extensively planted with non-native trees. When the Hall was remodelled and enlarged in about 1789, Sir John Soane, the architect responsible for the remodelling, also undertook extensive work in the park.

In 1896, the Hall and part of the park, including the woodland areas was sold by the Greswold family to Mr David Troman. The estate was sold in 1915 to Mr Horace Brueton. In 1926, Warwickshire County Council bought Malvern Park and Hall from Mr Brueton and built houses in Brueton Avenue and Park Avenue. The Hall eventually became Saint Martin's School for Girls.

In 1944, Mr Brueton gave his remaining land to the people of Solihull and it was consequently named after him. Malvern Park and Brueton Park were linked in 1963.

3.2 Designated Heritage Assets

There are no designated heritage assets within the study area, however, there are a number of designated heritage assets that, due to their location in close proximity to the study area or due to their location within or association with Malvern and Brueton Park, will need to be taken into consideration in future proposals. These include the following listed buildings and conservation areas (The numbers in the list below correspond to the asset locations shown in Figure 3.1):

1. Statue of Horse and Horse Tamer at Malvern Park (Grade II, NHLE 1342851)
2. North Blocks (Grade II, NHLE 1076727) at Malvern Hall
3. South Block (Grade II, NHLE 1203359) at Malvern Hall
4. Malvern Hall (Grade II*, NHLE 1031791) and associated Forecourt Piers (Grade II, NHLE 1342862)
5. 936 Warwick Road (Grade I, NHLE 1203586)
6. Ice House about 200m south of Malvern Hall (Grade II, NHLE 1261865)
7. Malvern Park Farmhouse (Grade II*, NHLE 1342882)
8. No. 79 Lovelace Avenue (Grade II, NHLE 1408522)

Malvern Hall and Brueton Avenue Conservation Area
Malvern Park Farm Conservation Area

3.3 Non-designated Heritage Assets

A number of non-designated assets are present within the study area. These include Malvern and Brueton Park which, although is not designated, holds some historic interest due to its association with Malvern Hall estate. The structural condition assessment (Chapter 4, Figure 5.1) has identified 13 structures along the River Blythe that fall within the study area. It is possible that some of these assets are of heritage significance. In particular the Sandalls Bridge (Structure 13) which carries Warwick Road, is considered to have historic interest. The bridge carried the road from Solihull to Warwick (part of the A41 London-Birmingham-Birkenhead trunk route) across the River Blythe until 1976, when it was bypassed. The bridge was already in place by 1855 when the county was discussing its repair. The original structure is supported by three semi-circular arches, of local sandstone, and incorporates a blue brick parapet and coping probably dating from 1924 when the road was widened.

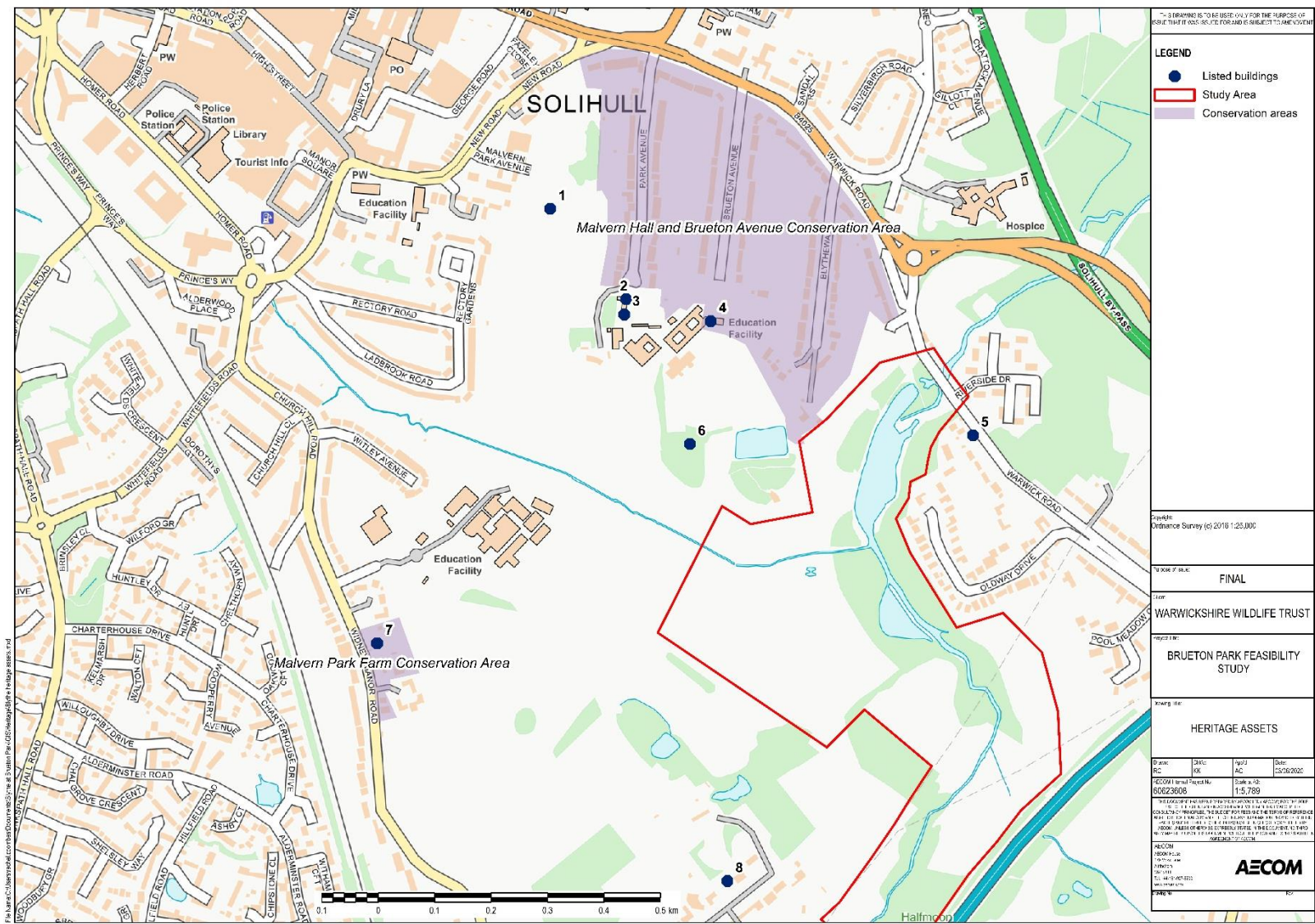


Figure 3.1 Designated heritage assets within study area

3.4 Heritage Considerations

- The proposals should take into account the setting of designated and non-designated heritage assets. Adverse impacts should be avoided or minimised as appropriate, and opportunities to enhance the setting of designated assets should be sought.
- 936 Warwick Road (Grade I, NHLE 1203586) was originally a gatehouse, built in 1798, for the Malvern Hall estate by Sir John Sane who was also responsible for extensive remodelling of the Hall and associated parkland. A holistic approach needs to be undertaken that takes into consideration the historic extent of the parkland and its association with the Hall.
- The setting of Malvern hall estate will need to be taken into consideration in any proposals at Brueton Park.
- Opportunities are present where proposed woodland and riparian planting has the potential to screen designated and non-designated cultural heritage assets from surrounding developments and infrastructure
- Opportunities also include the protection of heritage assets from riverine erosion through erosion of historic fabric or erosion of the setting of heritage assets.
- Proposed changes in the structures associated with the River Blythe should take into account the age of such structures and their potential historic, archaeological, architectural or artistic interest. An assessment of the significance of the structures that are likely to be impacted by proposals should be undertaken at early stages in order to inform the proposed design.
- There is a risk to the archaeological resource where the proposed management plan would require or result in intrusive disturbance of subsoil deposits. This could occur in planned areas of groundworks (SuDS, drainage channels, river and floodplain restoration) where overflow areas and outlets would result in localised erosion.
- Risks to the historic environment also include changes to the water table that could alter the stability and/or preservation of subsoil deposits of archaeological significance. Where intrusive groundworks are planned, or where there is a potential for the resulting changes to the local hydrology to impact archaeological remains, an archaeological evaluation and further mitigation excavations may be required.

4. Geomorphology

4.1 Overview

A geomorphological walkover was carried out on 29th January 2020 to understand the channel form and processes occurring on the River Blythe through the study area. This report provides a geomorphology baseline for the Brueton and Malvern Park Feasibility study, which aims to identify restoration enhancements that can be implemented to support the restoration of the River Blythe SSSI. This hydromorphological assessment has been undertaken to outline 'how to work with' the river to restore more natural river processes that will provide self-regulating and sustainable habitats.

4.2 Baseline

The River Blythe through Malvern and Brueton Park is a sinuous, single thread channel draining a catchment area of approximately 50km² at the downstream extent of the study site. The river flows through a predominantly rural catchment with mixed farming and part of the urban areas of Solihull and Dorridge. The channel passes through a low-lying valley characterised by superficial deposits of alluvium underlain by mudstone (Mercia Mudstone Group and Sidmouth Mudstone formation) and sandstone (Arden Sandstone Formation).

The watercourse through this reach has been highly modified by historic activities associated with the expansion of infrastructure (M42 and railway), agriculture and the development of the Malvern Hall estate.

The River Blythe at Malvern and Brueton Park is a SSSI at less than favourable condition and in Poor WFD condition. The River Blythe through Malvern and Brueton Park falls within "Blythe from Source to Cuttle Brook" waterbody and is not classified as artificial or heavily modified. The WFD citation classes hydromorphological supporting elements as 'Supports Good' for both the hydrological regime and morphology.

The channel would have historically followed a more sinuous path, and meander cut offs (palaeochannels) remain evident in the topography of the floodplain. The natural watercourse would have been sinuous in planform, with pools, riffles and bars, and complex morphology around woody material with connected wetlands. The lowland geological setting with clays means that it would not have actively moved across the floodplain.

The present watercourse is largely uniform, with gliding flow and a balance transport sediment regime, tending towards depositional as a result of high levels of impoundment. Fine material is naturally present throughout the reach, but excessive in the channel due to catchment urbanisation and channel modifications. Fine sediment completely covers bed gravels / habitats for large extents to the detriment of aquatic species.

The riparian areas are generally a combination of open agricultural land, woodland and parkland. There are two relatively short reaches with complex continuous assemblages of trees that represent the pre-modified vegetation and vegetation-driven channel morphology.

4.3 Restoration approaches

Restoration measures have been suggested for each sub-reach with a view to restoring the River Blythe through Malvern and Brueton Park to a more natural state and addressing some of the issues associated with management of the SSSI and WFD objectives.

The general aim should be to increase aquatic habitat diversity. The channel is overly uniform and degraded for large extents but is much more diverse where riparian trees and woody material increase flow complexity. Morphology and ecology are clearly vegetation driven. The lowland, low gradient catchment setting means the river is a low energy system, where natural recovery to favourable conditions will progress at a very slow rate. Naturalisation could be promoted much more effectively with intervention measures such as using large woody material. This could result in a narrower, more sinuous course with multiple channel threads, cleaner bed gravels, varied flow and bedforms (pools, riffles and bars), and connected wetlands and wet woodland.

Suggested restoration measures therefore include:

- Installing large woody material, for example by selective felling of existing trees.
- Increasing sinuosity by reconnecting palaeochannels.
- Reconnecting of the River Blythe with its floodplain.
- Creating backwaters to retain marginal areas as refugia for fish and macroinvertebrates.

- Creating islands to increase flow complexity in wide, silted areas and to create extra habitat.
- Fencing and installation of buffer strips to reduce fine sediment input to the channel through the study reach.
- Creating controlled channel access points to limit poaching.
- Removing bank protection if feasible, although it may be necessary to retain some channel training.
- Replacing wooden boards with greener bank protection such as spiling.
- Removing or modifying of structures creating an impounding effect on water levels upstream.

The impact of the measures suggested need to be understood in terms of the likely morphological response and changes to the hydrological regime, particularly where structures are involved. Hydraulic modelling, coupled with further assessments of geomorphology, ecology, flood risk and natural flood management, should be used to steer development and design of any selected options.

High quality wet woodland habitat is present in the reach and probably represents the optimum restoration target and SSSI condition for this part of the River Blythe. However, restoration to this morphologically and ecologically preferred condition needs to be balanced against existing water body uses. The amenity and landscape value of the managed grass parkland and access to the channel are also important considerations and as such a less extreme restoration target – for example woody material to narrow the channel create sinuosity within the confines of the existing channel – is likely to be more feasible.

5. Engineering Assessment

5.1 Overview

A site walk over survey was carried out on 20th February 2020 to undertake a high level assessment of the 13 in-channel structures through the Malvern and Brueton Park reach. The location of these structures along with the study reach is shown in Figure 5.1.

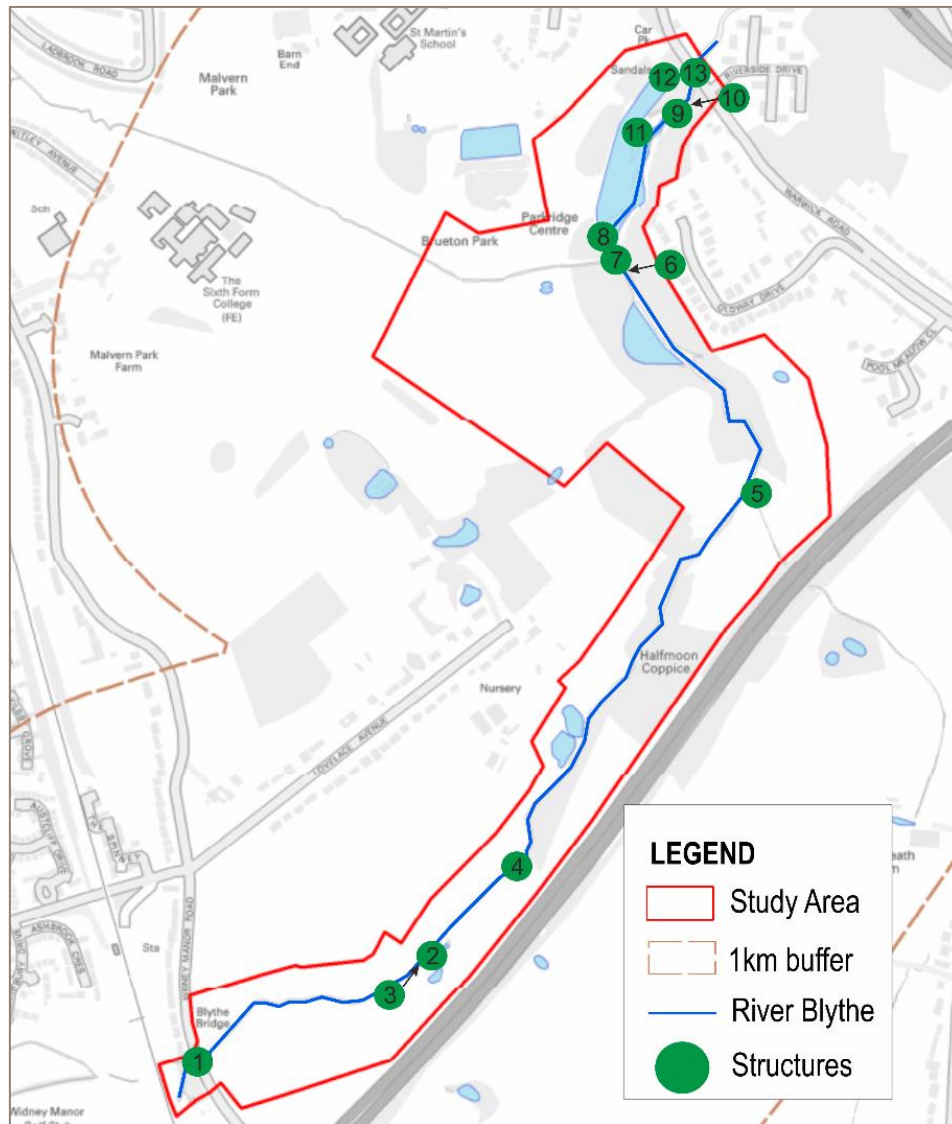


Figure 5.1 Location of structures assessed

5.2 Review

The review assessed the structures in terms of their condition and stability and consisted of a visual inspection of the visible elements of the structures viewed from the river banks and publicly assessable areas. No in-channel inspections were undertaken. During the survey each of the structures was inspected for signs of dilapidation, cracks, evidence of scour, leakage through dam and uneven crest levels on the weirs. Where significant issues were identified, recommendations for further structural investigations have been included within the report.

The Environment Agency Condition Asset Manual has been used to form the basis of the scoring assessment for the condition survey of the 13 structures. This uses 5 grades from 1 to 5 with 1 representing a structure in very good condition with only minor cosmetic defects and 5 representing a structure which is near to failure or has failed. These are presented in Table 5.1 Table 5.1 Environment Agency Visual Inspection Condition Grades

Some elements of the structures could not be inspected on the day of the survey due to water levels, build up of debris or access permissions. Where this occurred recommendations for additional work have been outlined. Table 5.2 provides a summary of structure details, condition and recommendations based on the assessment carried out. Further detail is contained in the Visual Assessment Condition Survey report in Appendix B.

Table 5.1 Environment Agency Visual Inspection Condition Grades

| Grade | Rating | Description |
|-------|-----------|--|
| 1 | Very good | Cosmetic defects that will have no effect on performance |
| 2 | Good | Minor defects that will not reduce the overall performance of the asset |
| 3 | Fair | Defects that could reduce performance of the asset. Further investigation needed. |
| 4 | Poor | Defects that would significantly reduce the performance of the asset. Further investigation needed |
| 5 | Very Poor | Severe defects resulting in complete performance failure |

Table 5.2 Summary of high-level visual assessment

| Structure ID | Structure Details | Condition | Recommendation |
|--------------|---|---|--|
| 1 | Culvert under Widney Manor Rd (SP 15577 77406) | N/A | View when better weather conditions and access granted |
| 2 | Footbridge (SP 15939 77566) | Good | Monitor erosion around abutments |
| 3 | Road drainage culvert (SP 15942 77561) | Culvert: N/A Headwall: Good | Inspect when water levels are low enough to expose structure, However, it is possible structure is regularly submerged |
| 4 | Road Drainage culvert (SP 16085 77700) | Culvert: N/A Headwall: Good | Inspect when water levels are low enough to expose structure, However, it is possible structure is regularly submerged |
| 5 | Footbridge (SP 16446 78294) | Good | N/A |
| 6 | Drainage culvert (SP 16235 78667) | Culvert: Good Headwall: Fair Apron: Very Good | Monitor headwall movement and cracking |
| 7 | Footbridge (SP 16228 78673) | Fair | Routine monitoring of cracks, particularly after flooding with action taken if movement increases |
| 8 | Brueton Park Lake weir, upstream end (SP 16218 78692) | Good, with potential to be fair | Monitor and repair downstream right bank protection |
| 9 | Arch Bridge (SP 16326 78901) | Fair, with the potential to be Poor | Inspection of the arch through the culvert when water levels permit safe access into the channel |
| 10 | Drainage culvert (SP 16330 78901) | Fair | Inspect with CCTV |
| 11 | Concrete weir, downstream end of Brueton Park Lake (SP 16277 78877) | Very Good | Repair downstream right bank protection |
| 12 | Wooden Sluice (SP 16313 78934) | Very Good | N/A |
| 13 | Sandalls Bridge (SP 16355 78947) | Good | N/A |

6. Water and Sediment Quality Assessment

6.1 Overview and Background

Water quality and sediment sampling analysis was undertaken at various locations along the River Blythe at Malvern and Brueton Park to understand potential risks to the environment and to human health. The full Water Quality report, including the output of the sampling carried out, is included as Appendix C.

The study area lies in the Blythe from Source to Cuttle Brook Water Framework Directive (WFD) waterbody. The waterbody is currently failing and at Poor level, with reasons for this including phosphate, fish and macrophyte statuses each being considered Poor. The phosphate failure indicates the importance of restoration improvements being designed to result in water quality improvements.

6.2 Assessment Approach

The Environment Agency undertaken routine water quality sampling immediately downstream of the study area (at Sandalls Bridge). This data has been reviewed. Results show that dissolved oxygen and orthophosphate are frequently at levels equivalent to less than Good status in the Blythe just downstream of our study area. Ammonia levels are typically at levels equivalent to at least Good status. Collectively this suggests the water quality pressure on the system may originate from predominantly wastewater sources rather than agriculture or land use.

Five water and two sediment samples (for bulk sediment and leachate analysis) were collected on the 20th February 2020 in accordance with the relevant British Standards. Figure 6.1 shows the locations at which the samples were collected.

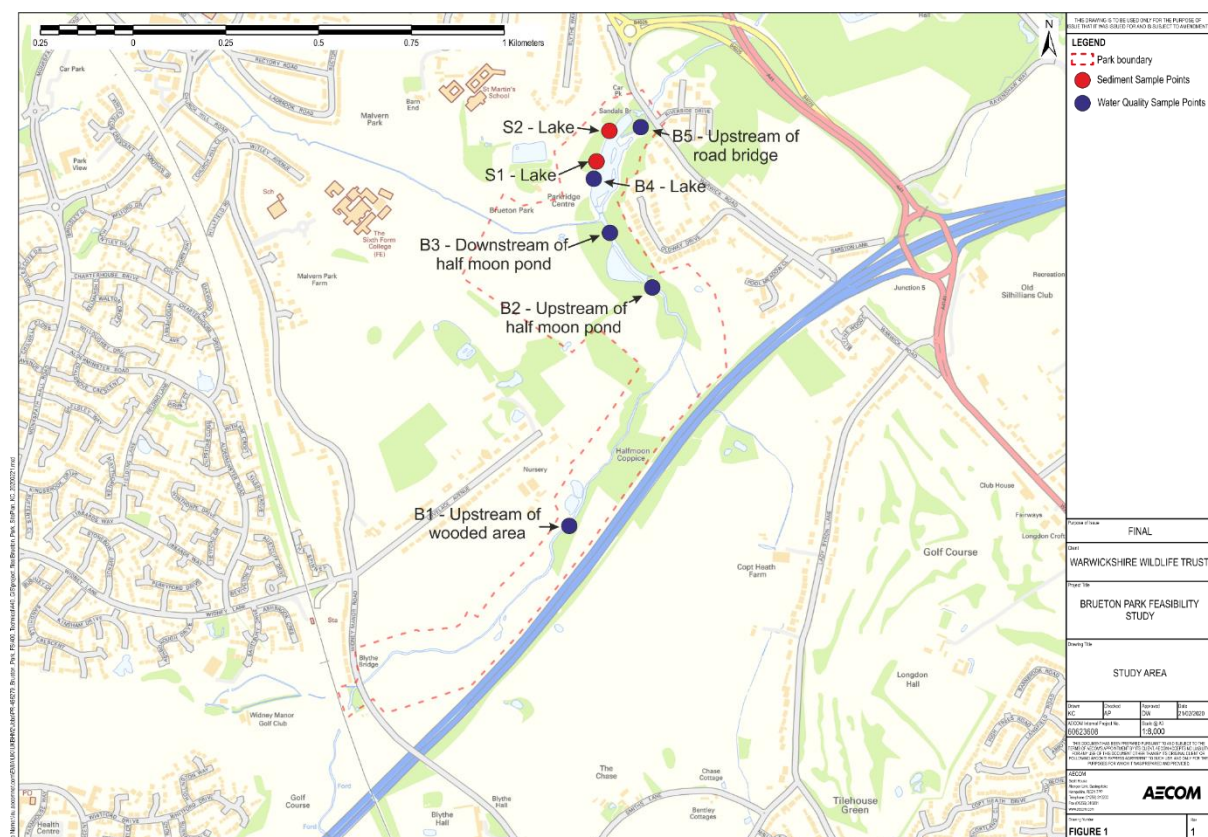


Figure 6.1 Water quality (blue) and sediment sampling (red) locations

A number of Environmental Quality Standards (EQS) exceedances for speciated Polynuclear Aromatic Hydrocarbons (PAHs) and heavy metals were observed in the silt quality results though many of the EQS are for typically applied to waters rather than soils and are probably more stringent than need be.

With regard to the water quality results, elevated phosphorous, heavy metal and microbiological levels were observed in the lake and river sites. These likely relate the upstream land uses (road and agriculture) and wet conditions on the day of the survey.

The high metal pollution in the samples obtained is considered likely to be predominantly driven by road runoff from the numerous M42 motorway outfalls upstream. As a result cleaning up these outfalls could have significant benefits in terms of delivering water quality improvement in the River Blythe. Whilst measures suggested within the immediate River Blythe corridor will make a difference in terms of removing fine sediments and potentially some agriculturally derived pollutants, the concentration of dissolved metals, hydrocarbons and de-icers (during cold periods) are likely to remain periodically high.

Given that the outfalls drain the M42 it is assumed that these are all Highways England (HE) assets. A review of the Highways Agency Drainage Data Management System (HADDMS) shows multiple outfalls from the M42 with the study area. The points shown in Figure 6.2 are the outfall locations, which HE have colour coded in terms of their priority status under the Priority Outfalls Programme.

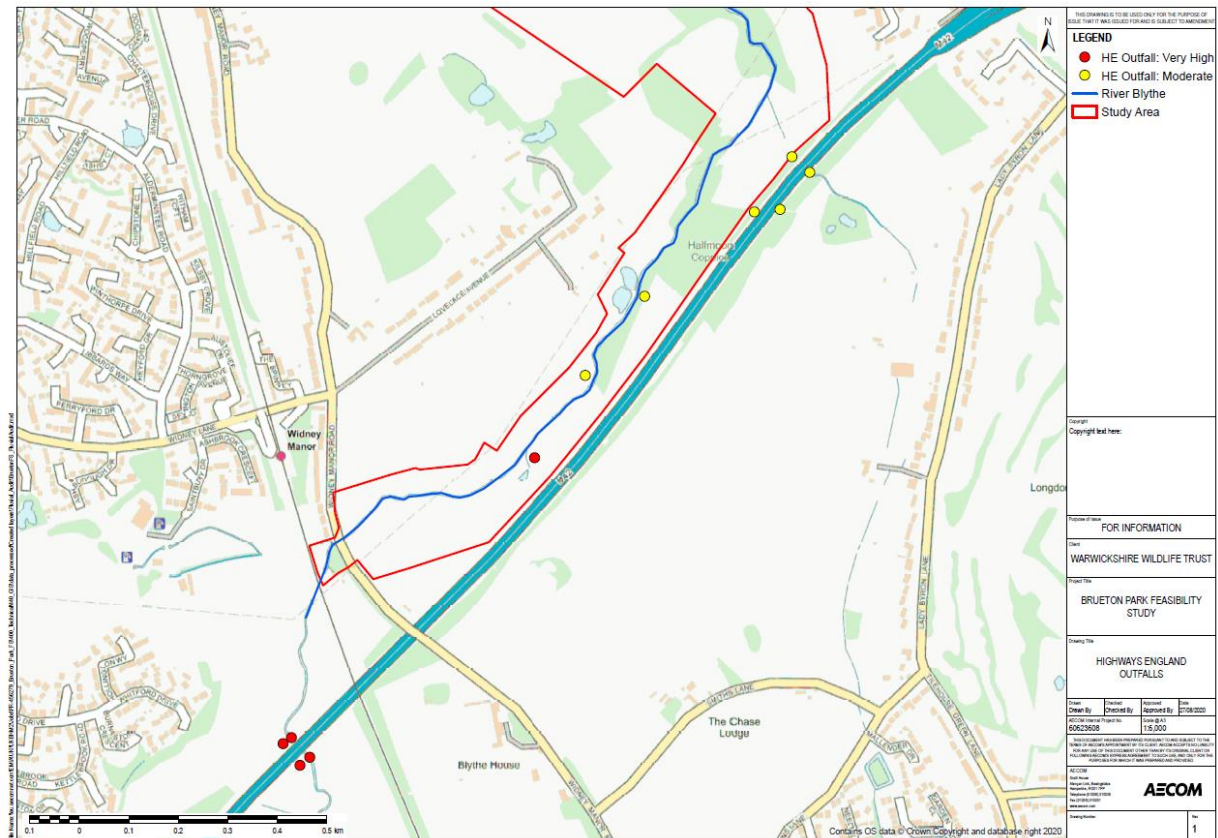


Figure 6.2 Highways England Outfalls

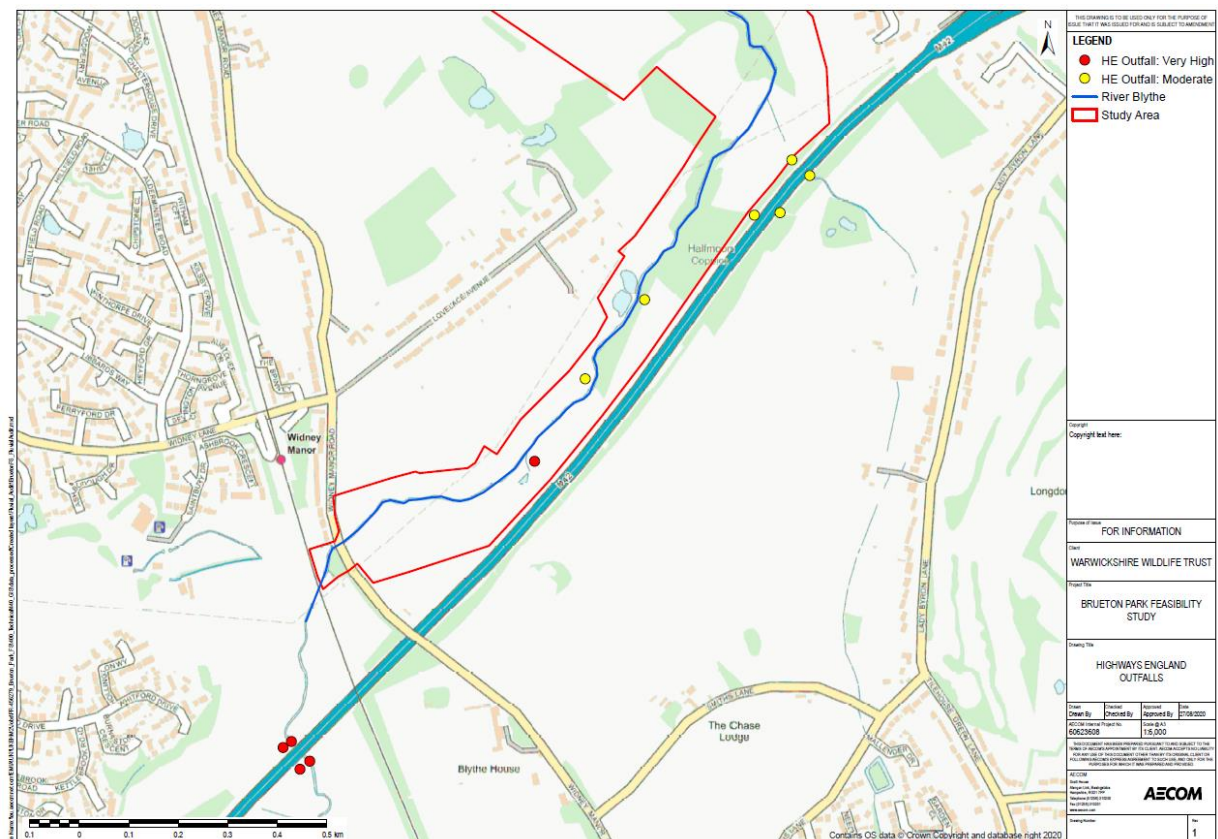


Figure 6.2 shows that within the study area there are some 'Very High' priority outfalls (red), i.e. very polluting, that discharge to the River Blythe as it crosses the motorway immediately upstream of the study area, and another within the study area. There are several 'Moderate' outfalls in the study area (yellow). Some of these appear to be piped under the surrounding fields and discharge straight into the river. Others appear to discharge

to ditches upstream of their confluence with the River Blythe. There may be potential to create an online wetland or similar along these ditches to filter out some of the pollutants before they reach the River Blythe, although treatment at source would be preferable and more effective.

HE have a programme of priority outfall improvements. The 'action status' on these outfalls suggests no treatment is in place, however some are listed as 'field study required'. As such discussion with HE regarding improving water quality through this reach is recommended.

6.3 Recommendations

Discussion with HE regarding their outfalls and improving water quality through this reach is recommended.

Further surveying during drier conditions would be valuable to inform how water quality may change. This could be done on a reduced range of determinands (with those with no apparent issues potentially being excluded).

It is suggested that the results of the sediment and water quality analyses are re-examined as the improvement measures at the site are developed. Further monitoring may be recommended dependent on the recommended measures (e.g. if silt is being moved, re-used elsewhere or requires landfilling).

7. Water Framework Directive Baseline

7.1 Overview

Restoration work related to this study would be carried out in the vicinity of the River Blythe as it flows through Malvern and Brueton Park. This stretch of the River Blythe falls within the Blythe Rivers operational catchment (Tame, Anker and Mease Management Catchment) within the Humber River Basin Management District (RBMD). The River Blythe through Malvern and Brueton Park is part of the river stretch “Blythe from Source to Cuttle Brook” and is not classified artificial or heavily modified.

A WFD baseline for the study area has been compiled and is presented in Appendix D. Summaries are provided below.

7.2 Surface Water WFD Classification

Baseline WFD data for Blythe from Source to Cuttle Brook (GB104028042400) have been summarised from the Environment Agency's Catchment Data Explorer³ in Table 7.1.

Table 7.1 Current WFD Classification for Blythe from Source to Cuttle Brook (GB104028042400)

| RBMP Parameter | Classification |
|--------------------------------------|---|
| Waterbody Name, ID, Category | Blythe from Source to Cuttle Brook, GB104028042400, River |
| Size (Length, Area) | Length: 22.85km. Area: 62.20km ² |
| Current Overall Ecological Quality | Poor |
| Current Hydromorphological Condition | Not designated artificial or heavily modified |
| Current Ecological Status | Poor |
| Current Chemical Status | Good |
| Supporting Elements | Supports Good (Hydrological Regime) Supports Good (Morphology) |
| Objectives | Moderate by 2027 |
| Protected Area Designation | Nitrates Directive |

The latest available data (2016, Cycle 2) show the waterbody to be at overall Poor status. To comply with WFD objectives, the requirement for the waterbody is to reach Moderate status by 2027.

Biological quality elements are currently at Poor, failing for macrophytes and phytobenthos combined (poor). Fish are classified as High and invertebrates are at Good status. Biological Quality elements are shown to be data has been assessed and found lacking both temporally and spatially. Fish data are the exception to this with survey data available from 2018 indicating presence of eight species, including Brown Trout (BAP species). It is recommended that macroinvertebrate, macrophyte and phytobenthos data is collected to understand current assemblages once a Preferred Option has been selected.

Physicochemical quality elements are at Moderate overall, failing for phosphate (Poor) and Dissolved Oxygen (Moderate). All other physico-chemical elements are classified as High. As part of this Feasibility Study Water Quality data has been collected and analysed for both the River Blythe and Ornamental lake and assessed alongside the EA data collected at Sandalls Bridge. The results indicate that most general and inorganic parameters are reasonable other than orthophosphate. It is recommended that further, more targeted sampling and / or long term monitoring could be beneficial.

Chemical quality elements are classified as Good.

The WFD citation classes hydromorphological supporting elements as ‘Supports Good’ for both the hydrological regime and morphology.

³ <https://environment.data.gov.uk/catchment-planning/WaterBody/GB104028042400>. Accessed: 22.04.2020

Reasons for Not Achieving Good are listed as point and diffuse source pollution attributed to agriculture and rural land management, urbanisation and sewage treatment.

7.3 Groundwater WFD Classification

The study area falls within the Tame Anker Mease – Secondary Combined groundwater Operational Catchment. Baseline Groundwater Body data have been summarised from the EA Catchment Data explorer⁴ and presented in Table 7.2.

Table 7.2 Current Groundwater Body Classification for Tame Anker Mease – Secondary Combined (GB40402G990800)

| GWB Parameter | Classification |
|--------------------------------|--|
| Name, ID, Category | Tame Anker Mease – Secondary Combined (GB40402G990800), Groundwater Body |
| Area (Groundwater, Surface) | Groundwater: 1140.57km ² , Surface: 1140.57km |
| Current Overall Classification | Good |
| Current Quantitative Status | Good |
| Current Chemical (GW) Status | Good |
| Objectives | No deterioration |
| Protected Area Designation | Drinking Water Protected Area Directive (UKGB40402G990800) Nitrates Directive (NVZ12GW010340, NVZ12GW010360, NVZ12GW010330) |

The latest available data (2016, Cycle 2) shows the groundwater body to be at overall Good status. To comply with WFD objectives, the requirement for the groundwater body would be no deterioration between 2015 and 2021. The scale of potential impacts means that connecting waterbodies are not considered to be at risk. The type of measures under consideration along this reach of the River Blythe are such impacts on groundwater are considered negligible and as a result groundwater has not been considered further.

7.4 Next Steps

The River Blythe at Malvern and Brueton Park is a SSSI at less than favourable condition and in Poor WFD condition. Proposals for physical restoration activities summarised in a previous feasibility study have potential to greatly improve habitats and ecology. Further WFD assessment and design is needed with regards to the ensuring any physical works protect and improve the water environment. This technical note provides a summary of the baseline from which improvements should be designed and measured.

In accordance with EA guidance further assessments are required to demonstrate that:

- Works will not lead to deterioration in the quality of any water body.
- Works will not prevent the future improvement of any water body.
- Works will not negatively impact any protected nature conservation area or priority habitat.
- Works will not impact protected or priority species.
- Heritage, landscape and fisheries interests and the need for an EIA have been considered.
- Opportunities have been sought to improve the water environment.

⁴ <https://environment.data.gov.uk/catchment-planning/WaterBody/GB40402G990800>. Accessed: 22.04.2020

8. Phase 1 Habitat Survey

An Extended Phase 1 survey has been completed to identify and assess the ecological constraints associated with the proposed river restoration scheme on the River Blythe at Malvern and Brueton Park. The survey has confirmed that there are notable habitats within the Site, comprising broad-leaved and mixed woodland, semi-improved grassland, wet grassland, swamp, eutrophic standing water and running water.

The Site provides suitable potential habitat for notable fauna including amphibians, badgers, bats, birds, hazel dormouse, reptiles, terrestrial and aquatic invertebrates and riparian mammals.

Potential additional requirements for botanical survey within woodland and grassland habitats have been identified. Surveys may also be required for individual species, including invasive plant species, amphibians, badger, otter, water vole roosting bats, barn owl, fish aquatic invertebrates and crayfish species. The scope of this survey would need to be determined prior to construction and would depend upon the Scheme design.

Best practice, including the implementation of stand-offs and safe working practices, are considered sufficient to protect habitats that are retained as part of the Scheme. The losses of any notable habitats should be replaced as part of the scheme, e.g. replacement of trees depending on scheme design.

The appropriate timing of works, pre-construction survey and ecological supervision are recommended to ensure legal compliance and best practice regarding protected / notable fauna.

There are significant opportunities for the enhancement of biodiversity as a result of the Scheme, by improving riparian habitats, which, if improved, may have the potential to support water vole habitat and improve the condition of Unit 5 within the River Blythe SSSI. Opportunities for the improvement of river morphology and riparian habitat may also be possible subject to further assessment and stakeholder agreement.

The recommendations within the report are considered sufficient to ensure that development both maintains the status of existing habitats and fauna, while also achieving benefits for biodiversity in line with the requirements of the NERC Act 2006 and, where necessary, the objectives national planning policy.

9. Next Steps

The initial studies undertaken as part of this report have provided a baseline from which the feasibility of restoration options can be considered. Following creation of a long list of measures, a workshop will be held with key stakeholders to agree a short list of potential measures to be assessed in more detail.

The key issues to be addressed based on the information gathered within this report are;

- Water Quality
- Physical modifications
- Morphology

Addressing these issues will facilitate improvement of the ecological habitat and morphological function of the watercourse, both of which are reasons for the River Blythe SSSI citation.

The following measures have been suggested as potential restoration options;

- Install large woody material, for example by selective felling of existing trees.
- Increase sinuosity by reconnecting palaeochannels.
- Reconnection of the River Blythe with its floodplain.
- Create backwaters to retain marginal areas as refugia for fish and macroinvertebrates.
- Create islands to increase flow complexity in wide, silted areas and to create extra habitat.
- Fencing and installation of buffer strips to reduce fine sediment input to the channel through the study reach.
- Create controlled channel access points to limit poaching.
- Remove bank protection if feasible, although it may be necessary to retain some channel training.
- Replace wooden boards with greener bank protection such as spiling.
- Address polluted runoff from M42 by treatment at source or through creation of wetlands at discharge locations

Discussion with HE in relation to their M42 outfalls and improving water quality through this reach is recommended. This could be the greatest contributor to reducing dissolved metals, hydrocarbons and de-icants in the River Blythe through this reach, and should be undertaken as early on as possible.

Further surveying during drier conditions would be valuable to inform how water quality may change. This could be done on a reduced range of determinands (with those with no apparent issues potentially being excluded).

Macroinvertebrate, macrophyte and phytobenthos data should be collected to understand current assemblages and provide a WFD baseline for this element.

Further WFD assessment will be required once a Preferred Option has been selected. Due to the designation of the River Blythe in this location as a SSSI and the in-channel nature of the works, a full WFD compliance assessment is likely to be required for the watercourse.

Potential additional requirements for botanical survey within woodland and grassland habitats have been identified. Surveys may also be required for individual species.

Appendix A - Geomorphology Assessment

Appendix B - Visual Assessment Condition Survey

Appendix C – Water Quality Assessment

Appendix D – Water Framework Directive Baseline

Appendix E – Phase 1 Habitat Report

