A46 Newark Bypass

TR010065/APP/6.3

6.3 Environmental Statement

Appendix 8.13 River Physical Habitat Technical Report

APFP Regulation 5(2)(a)

Planning Act 2008

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The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

A46 Newark Bypass

Development Consent Order 202[x]

ENVIRONMENTAL STATEMENT

APPENDIX 8.13 RIVER PHYSICAL HABITAT TECHNICAL REPORT

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1 Introduction

1.1 Background and scope of works

1.1.1 As part of the A46 Newark Bypass Scheme (the Scheme), condition assessment surveys and river habitat walkover surveys were undertaken to inform the biodiversity assessment reported in Chapter 8 (Biodiversity) of the Environmental Statement (ES) **(TR010065/APP/6.1)**.

1.1.2 Chapter 2 (The Scheme) of the ES **(TR010065/APP/6.1)** provides the background and a description of the Scheme. The information described in this appendix provides a baseline of river physical habitat within the Order Limits used to inform the Environmental Impact Assessment (EIA) for the Scheme.

1.1.3 This appendix reports on the surveys for river physical habitat undertaken in 2022. All river reaches within the Order Limits were surveyed, using the methodologies described in Section 3 of this appendix.

1.1.4 Assessment of the Old Trent Dyke is included in this appendix. This waterbody was previously a secondary channel of the River Trent and has characteristics of streams and ditches. Other ditches which are entirely artificial are not included in this appendix.

1.1.5 This appendix includes:

- Relevant legislation
- Methods for desk and field-based assessments
- Competencies of the ecologists involved in undertaking the above surveys
- Limitations to the surveys undertaken and any assumptions made as a result of incomplete data
- Survey results

2 Legislation and policy

2.1 Legislation

2.1.1 The assessments described within this report have been undertaken within the context of the following relevant legislative instruments:

2.1.2 The Natural Environment and Rural Communities (NERC) Act 2006[1] places additional responsibilities on local planning authorities in discharging their planning duty, namely, to consider species which are listed on Section 41 of the NERC Act as Species of Principal Conservation Importance in England. With respect to the Scheme, this would apply to any species residing in or utilising river habitat which may be affected.

2.1.3 Under the Salmon and Freshwater Fisheries Act 1975 (as amended)[2] it is an offence to disturb any spawning fish (includes any spawning fish, fish about to spawn, fish that have recently spawned or fish that have not yet recovered from spawning) or immature fish. Under this act it is also an offence to pollute a watercourse with the result of poisoning or causing injury to fish, spawning habitat, spawn or food sources. It is also unlawful to disturb the food resource of freshwater fish.

2.1.4 In addition, the following legislation relating to invasive non-native species (INNS) must be considered in the implementation of the Scheme. High priority INNS are frequently encountered in rivers or their riparian zones.

- Under the Wildlife and Countryside Act 1981 (as amended)[3], it may be an offence to:
    - Release or allow to escape into the wild any animal which 'is of a kind which is not ordinarily resident in and is not a regular visitor to Great Britain in a wild state'; or is included in Part I of Schedule 9.
    - Plant or otherwise cause 'to grow in the wild any plant which is included in Part II of Schedule 9'.
- Under the Invasive Alien Species (Enforcement & Permitting) Order 2019[4], it may be an offence to release, cause to escape, plant, or grow species of animal or plant 'not ordinarily resident in' and 'not a regular visitor to Great Britain in a wild state', or otherwise listed in Schedule 2.

[1] Natural Environment and Rural Communities (NERC) Act 2006.
[2] Salmon and Freshwater Fisheries Act, 1975
[3] The Wildlife and Countryside Act 1981 (as amended).
[4] Invasive Alien Species (Enforcement & Permitting) Order, 2019

2.2 Policy framework

2.2.1 National policies relevant to biodiversity are not provided here. These are evaluated in Chapter 8 (Biodiversity) of the ES **(TR010065/APP/6.1)**.

2.2.2 The assessment has been undertaken within the context of Nottinghamshire Biodiversity Action Plan (BAP)[5] which includes Habitat Action Plans (HAPs) relating to rivers and streams, and ditches; and Species Actions Plans (SAPs) which includes species which may utilise physical river or ditch habitats.

[5]Nottingham Biodiversity Action Group (2023). [online] Available at: [redacted] (Last accessed 10 January 2023).

3 Methodology

3.1 Study area

3.1.1 The study area for this report included all river reaches within the Order Limits, including rivers with bank tops falling within 10 metres of the Order Limits. These comprised:

- The 'Kelham channel' (as named within this report): a northern arm of the River Trent flowing from approximate Ordnance Survey National Grid Reference (OS NGR) SK 77104 53579 to SK 80253 56350; including two distinct reaches (referred to as 'Kelham channel upstream', and 'Kelham channel downstream').
- The River Trent: comprising two separate reaches within the Order Limits – an upstream reach between the upstream ends of the Kelham channel (referred to as 'River Trent main channel upstream') and Old Trent Dyke, and a downstream reach in the vicinity of the eastern A46 crossing (referred to as 'River Trent main channel downstream').
- The Old Trent Dyke: previously a secondary channel of the River Trent originating at SK 78367 53024 and discharging at SK 79987 55429.
- The Slough Dyke from SK 81171 55806 to SK 81072 56231.
- The Fleet from SK 81588 55978 to SK 81456 56240.

3.1.2 The Order Limits have been amended as the project design has developed. Some surveyed habitats now fall outside the study area associated with the current Order Limits; however, the results have been included within this report for completeness.

3.2 River Condition Assessment

Field survey scoping and design

3.2.1 River Condition Assessments (RCA) were undertaken along all river reaches within the Order Limits in order to provide an assessment of river physical habitat, and to enable the calculation of river biodiversity units for Biodiversity Net Gain (BNG) calculations.

3.2.2 As such, RCAs were conducted for all reaches of the River Trent, Slough Dyke, and The Fleet within the Order Limits, as they clearly fit the definitions given in Biodiversity Metric 3.1 guidance (Panks et al., 2022[6]) as a watercourse 'through which water flows (i.e. with a hydraulic function)'.

3.2.3 The Old Trent Dyke was historically a secondary channel of the River Trent, connected to the north bank of the river within the Order Limits. Prior to human intervention, it is uncertain whether it actively

conveyed river flows at any time or was a defunct palaeochannel. As such, its correct assignment as a river, stream, ditch or other habitat type was uncertain.

3.2.4 At the time of survey there was no evidence of the Old Trent Dyke functioning as a secondary channel of the River Trent, as the upper reach was entirely dry and colonised by terrestrial vegetation, indicating that it rarely, if ever contains water. Furthermore, no indication of fluvial activity such as erosion, deposition, sediment sorting, or geomorphic features, was observed.

3.2.5 As features associated with flowing water were not observed, it was considered more appropriate to assess the Old Trent Dyke using the ditch condition assessment methodology (see Section 3.4). Its function as a watercourse is likely to strongly influenced by human intervention (particularly overdeepening) so that it can perform the hydraulic function of land drainage.

3.2.6 The ditch condition assessment of the Old Trent Dyke is included within this technical appendix due to its riverine origins, and to present the rationale for subjecting it to the alternative ditch condition assessment. Other ditches which are entirely present due to human intervention are not included in this appendix.

3.2.7 River Condition Assessments are informed by Modular River Physical (MoRPh) surveys, undertaken in contiguous clusters of 5 to form 'MoRPh5 sub-reaches'. MoRPh surveys were undertaken during August and September 2022 for all river reaches located in the Order Limits. MoRPh5 sub-reach NGRs and survey dates are shown in Table 3-1. The location of the MoRPh modules for each sub-reach are also shown in Appendix A A-1 (River Condition Assessment MoRPh Survey Locations) of this report.

3.2.8 With respect to assessing river biodiversity units for BNG the Scheme area was divided into seven distinct river reaches: 2 within the Kelham channel, 3 within the main River Trent, one comprising a section of Slough Dyke, and another within The Fleet (see below). To achieve the minimum 20% coverage required to assess river biodiversity units for BNG calculations (Panks et al., 2022[6]), each distinct reach contained 1 or 2 MoRPh5 sub-reaches, with 12 MoRPh5 surveys undertaken in total.

[6] Panks S, White N, Newsome A, Nash M, Potter J, Heydon M, Mayhew E, Alvarez M, Russel T, Cashon C, Goddard F, Scott J S, Heaver M, Scott H S, Treweek J, Butcher B and Stone D. (2022). Biodiversity metric 3.1: Auditing and accounting for biodiversity – Technical Supplement. Natural England. [online] Available at: https://publications.naturalengland.org.uk/publication/6049804846366720 (Last accessed November 2023).

Table 3-1: MoRPh survey locations

Reach name	Sub-reach name	Module 3 mid-point	Survey date
Kelham channel upstream	Kelham channel 1 (KC1)	SK 77150 53738	26/08/2022
Kelham channel downstream	Kelham channel 2 (KC2)	SK 77396 54684	06/09/2022
Kelham channel downstream	Kelham channel 3 (KC3)	SK 77627 55454	06/09/2022
River Trent upstream Newark	Main channel 1 (MC1)	SK 77391 53675	24/08/2022
River Trent upstream Newark	Main channel 2 (MC2)	SK 77684 52936	26/08/2022
River Trent A46 west	Main channel 3 (MC3)	SK 78155 52887	24/08/2022
River Trent A46 east	Main channel 4 (MC4)	SK 80115 54791	25/08/2022
River Trent A46 east	Main channel 5 (MC5)	SK 80155 55244	25/08/2022
Slough Dyke	Slough Dyke 1 (SD1)	SK 81178 55849	17/05/2023
Slough Dyke	Slough Dyke 2 (SD2)	SK 81229 56017	17/05/2023
Slough Dyke	Slough Dyke 3 (SD3)	SK 81108 56191	18/05/2023
The Fleet	The Fleet 1 (F1)	SK 81516 56137	18/05/2023

Guidance documents

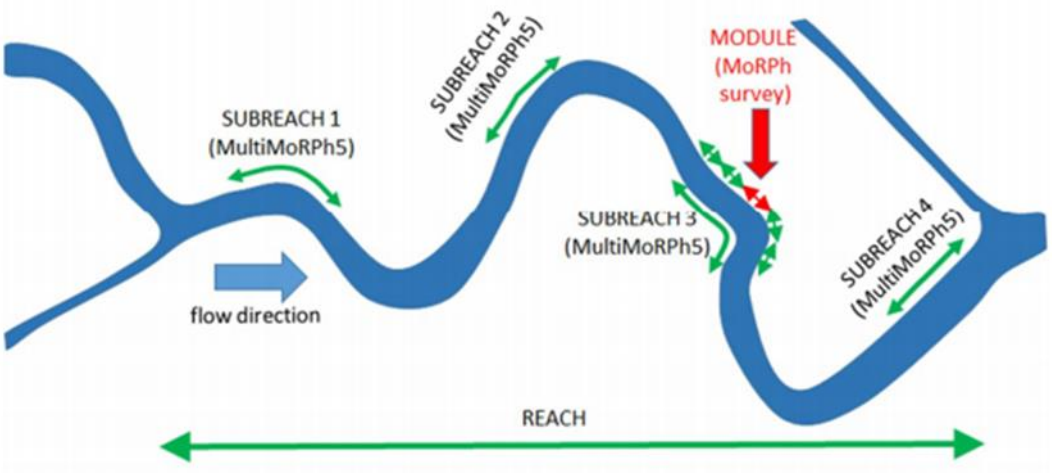
3.2.9 The MoRPh surveys were undertaken in accordance with the 2022 MoRPh survey technical reference manual (Gurnell and Shuker, 2022[7]).

Field survey methodology

3.2.10 A River Condition Assessment (RCA) requires both a field assessment and a desk study. The field assessment was based on the use of the MoRPh survey technique, with 5 contiguous MoRPh surveys (or 'modules') required to form a MoRPh5 sub-reach, the survey units needed to inform a RCA (see Figure 3-1 below). The length of each MoRPh module and therefore each MoRPh5 sub-reach was determined by river width and type. A river type desk study was used to predict the expected quality of river habitat and provides the benchmark against which the results of MoRPh surveys can be compared.

[7] Gurnell, A and Shuker, L. (2022). The MoRPh Survey. Technical Reference Manual. 2022 Version. [online]. Available at: https://modularriversurvey.org/professional-help/ (Last accessed November 2023).

Figure 3-1: MoRPh survey arrangement for RCA (Gurnell et al., 2020a[8])



- In accordance with the prescribed methodology, the following characteristics of the river channel and corridor were assessed:

- Overview
    - Bed visibility and any adverse conditions affecting the survey
    - Channel dimensions

- Banktops (within 10 metre)
    - Artificial/managed ground cover
    - Terrestrial vegetation structure
    - Non-native invasive plant species (NNIPS)
    - Water-related features (ponds, side channels, wetlands)

- Bank faces
    - Natural and artificial bank profiles
    - Natural and artificial bank face materials
    - Bank reinforcement extent and type
    - Natural physical features (bars, berms, benches, eroding and stable cliffs, toes, animal nests and burrows, marginal backwaters, and tributary junctions)
    - Artificial physical features (pipes, outfalls, jetties, and deflectors)
    - Terrestrial vegetation structure
    - Aquatic vegetation at the bank-water margin
    - NNIPS

- Channel
    - Channel bed natural materials

[8] Gurnell, A., England, J., Shuker, L., & Wharton, G. (2020a). The MoRPh Survey. Technical Reference Manual. 2020 Version. [online] Available at: https://modularriversurvey.org/wp-content/uploads/MoRPh-Manual-ver-12.pdf (Last accessed November 2023).

- Channel bed reinforcement type
- Water surface flow patterns
- Channel bed natural features (exposed bedrock, boulders, bars, islands, cascades, pools, riffles, steps, and waterfalls)
- Channel bed artificial features (large trash, weirs, bridge piers within the channel, bridge shadows, and culverts)
- Channel bed vegetation types
- Vegetation interactions within wetted channel (such as shading, tree roots, large wood, and discrete accumulations of organic material)
- NNIPS

Data processing

3.2.11 In order to contextualise the MoRPh survey results, a river type desk study was undertaken to classify river reaches into a river type (navigable river/canal, or 1 of 13 near-natural river types (types A to M)), based on sediment type, sinuosity, channel confinement, and the extent of any braiding or anabranching. The methodologies used for determining each of the river type parameters are shown in Table 3-2.

Table 3-2: River type parameter calculation methodologies

Parameter	Method of calculation/determination
River Category	The options for this category are 'Navigable river/canal', 'Large river', and 'Other river' which is determined principally on the basis of field observations.
A1: Braiding Index	Using ESRI aerial imagery[9], plot the centre line of the river, plot ten equally spaced points along this line, and average the number of channels separated by vegetated bars or islands at each point.
A2: Sinuosity Index	Use ESRI aerial imagery to measure the River Reach Length and River Valley Length; then divide the River Reach Length by the River Valley Length to give the Sinuosity Index.
A3: Anabranching Index	Using Google Earth Pro, plot the centre line of the river, plot ten equally spaced points along this line, and average the number of channels at each point.
A4: Level of Confinement	Use ESRI aerial imagery to determine extent to which the river is laterally confined by topography, with options being 'Confined', 'Partly Confined', or 'Unconfined'.
A5: River Reach Gradient	Use ESRI aerial imagery to estimate the elevation at the upstream and downstream extents of the River Reach, measure the River Reach Length between these 2 points; then divide the difference in elevation by the River Reach Length.
A6: Bedrock Reach	Value taken from output of MoRPh5 survey.
A7: Coarsest Bed Material	Value taken from output of MoRPh5 survey.

3.2.12 River condition is assessed using 32 condition indicators that are generated by MoRPh5 field surveys. Some of these indicators are positive, representing physical habitats offered by vegetation,

[9] Esri, 2023 Esri (2022). Esri Aerial Imagery. [online] Available at: https://www.arcgis.com/home/item.html?id=10df2279f9684e4a9f6a7f08febac2a9 (Last accessed November 2023).

sediment, related physical features, and hydraulic habitats that can be observed at low flow. These positive indicators are assigned a score from 0 to 4, depending on their diversity (richness) and abundance (extent). The remaining are negative indicators which assess the extent and severity of local human interventions or pressures, reflected in scores between 0 and -4.

3.2.13 A Preliminary Condition Score was calculated for each MoRPh5 sub-reach, by summing the average of the positive condition indicator scores and the average of the negative condition indicator scores for the sub-reach.

3.2.14 This Preliminary Condition Score was translated into a Final Condition Score (5 – Good, 4 – Fairly Good, 3 – Moderate, 2 – Fairly Poor, 1 – Poor) using the previously determined river type (see supporting information for Gurnell, et al., 2020b[10]). This calculation was undertaken automatically within the online recording system, based on the thresholds detailed in Table 3-3. The thresholds were used to determine the Final Condition Score depending on the river type of the reach surveyed. The RCA results are shown in Section 4.1. The geomorphic nature of the possible River Types (A to M) is shown in Appendix B (RCA River Types) of this report.

[10] Gurnell, A., Scott, S., England J, Gurnell, D., Jeffries, R., Shuker, L., & Wharton, G. (2020b). Assessing River Condition: A multiscale Approach Designed for Operational Application in the Context of Biodiversity Net Gain. River Research and Applications. 36 (8), pp. 1559-1578.

Table 3-3: Final Condition Score thresholds

River type	Likely best average condition score	Lower threshold for 5 – Good	Lower threshold for 4 – Fairly Good	Lower threshold for 3 – Moderate	Lower threshold for 2 – Fairly Poor	Likely worst average condition score, 1 – Poor
Canal/navigable	1.8	1.4	0.7	-0.1	-1.2	-2.5
Large river	2.5	2.0	1.3	0.3	-1.0	-2.5
A	2.4	1.9	1.2	0.2	-1.0	-2.5
B	2.7	2.2	1.4	0.2	-0.9	-2.5
C	2.7	2.2	1.4	0.2	-0.9	-2.5
D	2.7	2.2	1.4	0.2	-0.9	-2.5
E	2.7	2.2	1.4	0.2	-0.9	-2.5
F	2.8	2.3	1.5	0.4	-0.9	-2.5
G	3.0	2.5	1.6	0.5	-0.9	-2.5
H	2.9	2.4	1.6	0.5	-0.9	-2.5
I	3.1	2.5	1.7	0.6	-0.8	-2.5
J	2.8	2.3	1.5	0.4	-0.9	-2.5
K	2.4	1.9	1.2	0.2	-1.0	-2.5
L	2.4	1.9	1.2	0.2	-1.0	-2.5
M	2.4	1.9	1.2	0.2	-1.0	-2.5

3.2.15 Following the revisions made in BNG Metric 3.1 (Panks et al., 2022[6]) the Final Condition Score can be adjusted by a reduction of 1 condition class if after it is calculated the sub-reach is overdeep, making it hydrologically and ecologically disconnected from the riparian margin and floodplain. This may occur in the reaches which are of relatively low gradient, unconfined or partly confined, alluvial rivers. This adjustment is only applicable to sub-reaches which were initially assessed to be of Good or Fairly Good Final Condition Score. The river channel indicators 'average width' and 'river shape' are used to calculate whether a channel is overdeep. These values are calculated from the channel dimensions. If river shape has a value of <2 the river is almost certainly overdeep. If river shape has a value of <4 and the channel is less than 10 metres wide, the river is highly likely to be overdeep.

3.3 River habitat walkover surveys

Field survey scoping and design

3.3.1 River habitat walkover surveys were conducted along all reaches of the River Trent within the Order Limits, to identify potential constraints and opportunities in relation to the Scheme works. NGRs and surveys dates are shown in Table 3-4. The locations of the walkover features are shown in Appendix A A-2 to A-6 (River Habitat Walkover Survey) of this report.

3.3.2 In order to fully describe the waterbodies being assessed, the surveys were not limited to a particular length of survey but aimed to capture the entirety of the stretches of interest.

Table 3-4: Site information for walkover surveys

Broad area within Order Limits	Reach name	Survey date	U/S NGR	D/S NGR	Survey length
Kelham channel	Kelham channel upstream	26/08/2022	SK 42181 95834	SK 43027 94947	0.24km
	Kelham channel downstream	06/09/2022	SK 76996 54626	SK 77576 55664	1.49km
River Trent main channel upstream	River Trent upstream Newark	24/08/2022	SK 77175 53635	SK 77983 52835	1.51km
	River Trent A46 west	24/08/2022	SK 77983 52835	SK 78372 53032	0.43km
River Trent main channel downstream	River Trent A46 east	25/08/2022	SK 80030 54697	SK 77175 53635	0.77km

Field survey methodology

3.3.3 River habitat walkover surveys were undertaken to assess the habitat quality for fish and other ecological receptors, in order to identify potential constraints and opportunities in relation to the Scheme. The surveys aimed to characterise river reaches so changes in general character over the reaches or specific features of interest were recorded.

3.3.4 Surveys were conducted on foot by accessing river banks in order to view each river reach and record its features. Features of interest were photographed and NGRs were collected for these features using a hand-held GPS-capable device. Features and characteristics of interest included:

- General character of river section and changes to this character
- Bankside and surrounding land-use
- Approximate width and depth
- In-channel features such as pools, bars, or islands
- Substrate composition
- Flow types and diversity
- Riparian vegetation and shading
- In-channel vegetation
- Areas of cover for fish, such as woody debris and overhanging vegetation
- Channel and bank modification, such as artificial structures or channel re-alignment
- Lateral connectivity to other aquatic habitats such as wetland areas
- Connectivity to other watercourses
- Outfalls or inputs from other sources
- Opportunities for enhancement
- Notable features to be protected
- Any other features or considerations noted on site – such as protected, notable or invasive species

3.4 Ditch condition assessment (Old Trent Dyke)

Field survey scoping and design

3.4.1 As described in Section 3.2, the Old Trent Dyke was previously a secondary channel of the River Trent. However, it showed no evidence of conveying river flows and was therefore subject to a ditch condition assessment. This ditch condition assessment is included within this technical appendix due to its riverine origins. Assessment of other ditches which are entirely the result of human intervention are not included in this technical appendix and are instead included within the overarching BNG assessment for the Scheme (see Appendix 8.14

(Biodiversity Net Gain Technical Report) of the ES Appendices **(TR010065/APP/6.1)**).

3.4.2 All reaches of the Old Trent Dyke within the Order Limits were assessed. One reach just outside of the Order Limits – named the Old Trent Dyke Cullen Close reach (see Table 3-5) was also assessed. This was due to its distinct nature, being somewhat wider, deeper, and supporting more macrophytes, and its greater potential to support species and assemblages of conservation importance.

3.4.3 For the purpose of informing a BNG assessment, the Old Trent Dyke was divided into smaller units, delineated by major structures such as the A46 and rail crossings.

3.4.4 The reaches which were surveyed for condition assessment are shown in Table 3-5 and Appendix A A-7 (Ditch Reach Locations) of this report.

Table 3-5: Ditch survey locations

Reach name	Start NGR	End NGR	Survey date	Reach length (m)
Old Trent Dyke – Cullen Close	SK 79146 54254	SK 79312 54266	10/11/2022	170
Old Trent Dyke – Kelham Road Area	SK 78853 54017	SK 79115 54220	08/09/2022	440
Old Trent Dyke – A46 culvert	SK 78723 54242	SK 78724 54160	08/09/2022	80
Old Trent Dyke – A46 to railway	SK 78257 53622	SK 78065 53901	07/09/2022	800
Old Trent Dyke – River Trent to A46	SK 78353 53036	SK 78302 53596	07/09/2022	800

Guidance documents

3.4.5 Guidance for assessing the condition of ditches is included in the Biodiversity Metric 3.1 Technical Supplement (Panks et al., 2022[6]).

Field survey methodology

3.4.6 The ditch condition assessments aimed to establish the condition of the Old Trent Dyke within the Order Limits and with respect to BNG by examining the ditch against eight criteria, which are assessed on a pass/fail basis (Panks et al., 2022[6]).

3.4.7 The criteria which inform condition are shown in Table 3-6 below.

3.4.8 Surveys were conducted on foot to view the ditch from the bank top. Representative photos, in addition to photos of any specific features of interest, were taken.

3.4.9 Any protected, notable, or non-native species observed were recorded, and the potential of ditch reaches to support protected or notable species was assessed.

Data processing

3.4.10 The results of the field survey are used to establish whether the ditch surveyed passes the eight criteria identified. For the ditch to be given a condition of Good it must pass all eight criteria outlined in Table 3-6. For a Moderate condition assessment score, it must pass at least six of the criteria; if less than six are passed then a condition assessment score of Poor is given.

Table 3-6: Ditch condition assessment criteria

Criteria	Requirement
1	The ditch is of good water quality, with clear water (low turbidity) indicating no obvious signs of pollution. This was assessed on a visual basis, with 'low turbidity' defined by visibility of the bed being either unimpeded or only slightly obscured by suspended matter in the water column.
2	A range of emergent, submerged and floating leaved plants are present. (>10 species in a 20m section).
3	There is less than 10% cover of filamentous algae and/or duckweed.
4	A fringe of marginal vegetation is present along more than 75% of the ditch.
5	Physical damage evident along less than 5% of the ditch.
6	Sufficient water levels are maintained. (Minimum summer depth of 50cm in minor ditches and 1m in main drains).
7	Less than 10% of the ditch is heavily shaded.
8	There is an absence of non-native plant and animal species.

Source: Panks et al., 2022[6]

3.5 Competence of surveyors

3.5.1 All RCAs were undertaken by certified RCA surveyors. River habitat walkovers and ditch condition assessments were undertaken by competent freshwater ecologists with extensive experience in undertaking similar assessments.

3.6 Survey limitations

3.6.1 The ideal months for MoRPh surveys to be undertaken are May, June and October when all vegetation is visible but not so well developed that it limits visibility and accessibility (Gurnell & Shuker, 2022[7] and Panks et al., 2022[6]). Surveys were undertaken during August and September and dense vegetation may have made observation of some physical features difficult and limited the accessibility of the banks for survey.

3.6.2 The ditch condition assessment on the Old Trent Dyke – Cullen Close reach was undertaken in November. The presence or abundance of

native and non-native plant species may have been affected due to seasonality.

4 Results

4.1 River Condition Assessment

Field surveys

4.1.1 Within this section, the results of the 12 MoRPh5 surveys undertaken are discussed in 3 separate sections aligned with the following 3 broad areas within the Order Limits:

- Kelham channel
- River Trent main channel upstream
- River Trent main channel downstream
- Slough Dyke
- The Fleet

Kelham channel

Bank top

4.1.2 The bank top indicator scores for the Kelham channel reach are shown in Table 4-1.

Table 4-1: Bank top indicator scores for the Kelham channel

River Condition Indicator	KC1	KC2	KC3
B1 – Bank top vegetation structure	4	2	2
B2 – Bank top tree feature richness	1	0	0
B3 – Bank top water-related features	0	2	0
B4 – Bank top NNIPS cover	-4	-3	0
B5 – Bank top managed ground cover	-3	-2	-4

4.1.3 The positive bank top indicator scores (B1, B2 and B3) are shown in green in Table 4-1:

- The bank top vegetation structure indicator scores for the Kelham channel varied, with the upstream sub-reach KC1 having the highest number of vegetation structural types present with an indicator score of 4, compared to the downstream sub-reaches which both had indicator scores of 2.
- The bank top tree feature richness indicator scores were low for all sub-reaches with KC1 having the highest indicator score of 1, compared to the downstream sub-reaches which both scored 0 as no tree features were recorded on the bank top.
- The bank top water-related features indicator score for the Kelham channel was highest for the sub-reach KC2 as wetland shrubs and trees were recorded on the left bank top of module 2 (see Photo 4-1). No bank top water related features were recorded within sub-reaches KC1 and KC3.

4.1.4 The negative bank top indicator scores (B4 and B5) are shown in red in Table 4-1:

- The bank top non-native invasive plant species (NNIPS) cover indicator score was lowest in sub-reach KC1 as Himalayan balsam *Impatiens glandulifera* was recorded extensively on the bank top. Himalayan balsam was also recorded on the bank top of KC2. No NNIPS were recorded in KC3.
- The bank top managed ground cover indicator score was lowest in sub-reach KC3 as transport infrastructure was extensive on the right bank top (see Photo 4-2).

Photo 4-1: KC2 module 5 bank top

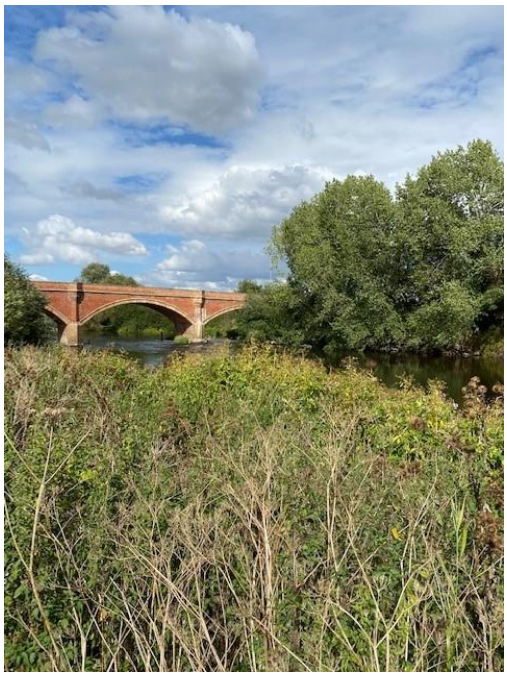


Photo 4-2: KC3 module 5 facing downstream

Bank face

4.1.5 The bank face indicator score for the Kelham channel are shown in Table 4-2.

Table 4-2: Bank face indicator scores for the Kelham channel

River Condition Indicator	KC1	KC2	KC3
C1 – Bank face riparian vegetation structure	2	2	2
C2 – Bank face tree feature richness	1	1	1
C3 – Bank face natural profile extent	2	2	3
C4 – Bank face natural profile richness	3	2	2
C5 – Bank face natural channel material richness	3	3	1
C6 – Bank face bare sediment extent	1	1	1
C7 – Bank face artificial profile extent	-4	0	0
C8 – Bank face reinforcement extent	-2	-1	-2
C9 – Bank face reinforcement material severity	-2	-2	-2

River Condition Indicator	KC1	KC2	KC3
C10 – Bank face NNIPS cover	-3	-3	-3

4.1.6 The positive bank face indicator scores (C1 to C6) are shown in green in Table 4-2:

- The bank face riparian vegetation structure indicator scores were the same for all 3 sub-reaches as short/creeping herbs/grasses, tall herbs/grasses, scrub/shrubs, and saplings/trees were recorded on the bank face.
- The bank face tree feature richness indicator scores were consistent for all 3 sub-reaches on the Kelham channel as tree/shrub branches trailing into channel were recorded as well as leaning trees in the sub-reach KC2.
- The bank face natural profile extent indicator scores ranged from 2 to 3 for the 3 sub-reaches within the Kelham side channel. The sub-reach KC3 had the largest sum of the abundance of natural bank profiles reflected in the indicator score of 3.
- The bank face natural profile richness indicator scores also ranged from 2 to 3 with the greatest diversity encountered in sub-reach KC1, where steep, gentle and composite bank profiles were observed (see Photo 4-4).
- The bank face natural channel material richness indicator scores were highest for the sub-reaches KC1 and KC2 as earth, gravel-pebble and sand were recorded in both sub-reaches whereas earth was the only bank material recorded in sub-reach KC3.
- The bank face bare sediment extent indicator scores were consistent for all 3 sub-reaches with all of them achieving a score of 1.

4.1.7 The negative bank face indicator scores (C7 to C10) are shown in red in Table 4-2:

- The bank face artificial profile extent indicator score was only negative in the sub-reach KC1 as the artificial bank profile ‘obviously reshaped’ was recorded as extensive on the left bank face.
- The bank face reinforcement extent indicator scores were lowest for the sub-reaches KC1 and KC3 which both had a score of -2 (see Photo 4-4). Reinforcement was also recorded in the sub-reach KC2.
- The bank face reinforcement material severity indicator scores were consistent for all 3 of the sub-reaches with -2 recorded due to the presence of concrete, rip-rap and brick.
- The bank face NNIPS cover indicator scores were -3 for all sub-reaches on the Kelham channel as Himalayan balsam was recorded.

Photo 4-3: KC1 module 1 bank face

Photo 4-4: KC3 module 1 facing downstream

Channel margin

4.1.8 The channel margin indicator scores for the Kelham channel are shown in Table 4-3:

Table 4-3: Channel margin indicator scores for the Kelham channel

River Condition Indicator	KC1	KC2	KC3
D1 – Channel margin aquatic vegetation extent	3	3	2
D2 – Channel margin aquatic vegetation morphotype richness	2	3	3
D3 – Channel margin physical feature extent	1	1	2
D4 – Channel margin physical feature richness	1	2	2
D5 – Channel margin artificial features	0	0	0

4.1.9 The positive channel margin indicator scores (D1 to D4) are shown in green in Table 4-3:

- The channel margin aquatic vegetation extent indicator scores were highest for sub-reach KC1 and KC2 as a greater amount of channel margin vegetation was recorded reflected by the indicator scores of 3 (see Photo 4-5).
- The channel margin aquatic vegetation morphotype richness indicator scores were highest for the sub-reaches KC2 and KC3. Both sub-reaches achieved scores of 3 as emergent linear-leaved, amphibious, and emergent broad-leaved vegetation morphotypes were present within the channel margin.
- The channel margin physical feature extent indicator scores were highest in the sub-reach KC3 as a berm was recorded as extensive along the bank face of modules 4 to 5 as well as a gravel-pebble

vegetated side bar and eroding cliff in module 1 reflected in the indicator score of 2.

- The channel margin physical feature richness indicator scores were highest for both KC2 and KC3 reflected in the scores of 2. 3 channel margin natural physical features including a berm, gravel-pebble vegetated side bar and an eroding cliff were recorded in KC3. Within sub-reach KC2, a gravel-pebble unvegetated side bar, marginal backwater and a berm were recorded (see Photo 4-6).

4.1.10 The negative channel indicator score (D5) is shown in red in Table 4-3:

- The channel margin artificial features indicator scores were 0 for all 3 sub-reaches as no artificial features were recorded in the 3 sub-reaches.

Photo 4-5: KC1 module 1 facing downstream

Photo 4-6: **KC2 module 1 facing downstream**

Channel bed

4.1.11 The channel indicator scores for the Kelham channel are shown in Table 4-4:

Table 4-4: Channel bed indicator scores for the Kelham channel

River Condition Indicator	KC1	KC2	KC3
E1 – Channel aquatic morphotype richness	3	2	0
E2 – Channel bed tree features richness	2	1	0
E3 – Channel bed hydraulic features richness	2	1	0
E4 – Channel bed natural features extent	3	1	0
E5 – Channel bed natural features richness	1	0	0
E6 – Channel bed material richness	3	3	2
E7 – Channel bed siltation	0	0	0
E8 – Channel bed reinforcement extent	0	0	0
E9 – Channel bed reinforcement severity	0	0	0
E10 – Channel bed artificial features severity	-2	0	0
E11 – Channel bed NNIPS cover	-3	0	0
E12 – Channel bed filamentous algae extent	-1	0	0

4.1.12 The positive channel bed indicator scores (E1 to E6) are shown in green in Table 4-4:

- The channel aquatic morphotype richness indicator score was highest for the KC1 as liverworts/mosses/lichens, amphibious, emergent linear-leaved, and floating leaved (rooted) vegetation morphotypes were present within the channel reflected in a score of 3.
- The channel bed tree features richness indicator score was also highest for the sub-reach KC1 as vegetation shading channel and a fallen tree were recorded within the channel.
- The channel bed hydraulic features richness indicator score was highest for the sub-reach KC1 as the flow types rippled, smooth and no perceptible flow were recorded as present or extensive.
- The channel bed natural features extent indicator score was also highest for KC1 as an island was recorded as extensive in modules 1 to 3 as well as traces of exposed unvegetated boulders and a trace island in module 4.
- The channel bed natural features richness indicator score was highest for KC1 with a score of 1. Two natural physical features, an island and unvegetated exposed boulders, were recorded within the channel. No natural physical features were recorded as present or extensive for the sub-reaches KC2 and KC3 (see Photo 4-7).
- The channel bed material richness indicator scores ranged from 2 to 3. Cobble, gravel-pebble, sand and silt were present or extensive in KC1, whereas KC2 recorded clay as present and no cobble substrate.

4.1.13 The negative channel bed indicator scores (E7 to E12) are shown in red in Table 4-4:

- The channel bed siltation indicator scores were 0 for all sub-reaches as no overlying or patchy silt was recorded within any modules.
- The channel bed reinforcement extent indicator scores were 0 for all sub-reaches as no reinforcement was recorded within the channel.
- The channel bed reinforcement severity indicator score was also 0 for all sub-reaches as there was no reinforcement recorded.

- The channel bed artificial features severity indicator score was lowest for the sub-reach KC1 as six bridge piers in the riverbed were recorded within the channel of module 5 which is where the railway bridge crosses the channel (see Photo 4-8).
- The channel bed NNIPS cover indicator score was lowest for the sub-reach KC1 as Himalayan balsam was recorded within the channel.
- The channel bed filamentous algae extent indicator score was also lowest for the sub-reach KC1 as trace filamentous algae was recorded in module 2.

Photo 4-7: KC1 module 5 downstream

Photo 4-8: KC3 module 3 midpoint

River Trent main channel upstream

Bank top

4.1.14 The bank top indicator scores for the River Trent main channel upstream section of the reach are shown in Table 4-5.

Table 4-5: **Bank top indicator scores for the upstream section of the River Trent main channel reach**

River Condition Indicator	MC1	MC2	MC3
B1 – Bank top vegetation structure	2	2	4
B2 – Bank top tree feature richness	0	0	0
B3 – Bank top water-related features	0	0	0
B4 – Bank top NNIPS cover	-3	-3	-3
B5 – Bank top managed ground cover	-3	-3	-4

4.1.15 The positive bank top indicator scores (B1 to B3) are shown in green in Table 4-5:

- The bank top vegetation structure indicator score was highest for the sub-reach MC3 with a score of 4 as short/creeping herbs/grasses, tall herbs/grasses, scrub/shrubs and saplings/trees vegetation morphotypes were recorded on both bank tops (see Photo 4-9).
- The bank top tree feature richness indicator score was 0 for all 3 sub-reaches as no bank top tree features were recorded as present or extensive.
- Bank top water-related features indicator scores were 0 for all sub-reaches as none were recorded on the bank tops.

4.1.16 The negative bank top indicator scores (B4 to B5) are shown in red in Table 4-5:

- The bank top NNIPS cover indicator score was -3 for all 3 sub-reaches as Himalayan balsam was recorded on the bank tops in all sub-reaches.
- The bank top managed ground cover indicator score was lowest for the sub-reach MC3 with a score of -4. Extensive transport infrastructure was recorded on both bank tops in module 2 which has the highest severity weighting (Photo 4-10).

Photo 4-9: MC1 module 2 facing upstream

Photo 4-10: MC3 module 2 facing downstream

Bank face

4.1.17 The bank face indicator scores for the River Trent main channel upstream section of the reach are shown in Table 4-6:

Table 4-6: Bank face indicator scores for the upstream section of the River Trent main channel reach

River Condition Indicator	MC1	MC2	MC3
C1 – Bank face riparian vegetation structure	3	2	3
C2 – Bank face tree feature richness	2	1	2
C3 – Bank face natural profile extent	2	1	1
C4 – Bank face natural profile richness	4	2	1
C5 – Bank face natural bank material richness	1	1	1
C6 – Bank face bare sediment extent	1	0	0
C7 – Bank face artificial profile extent	-3	-4	-4
C8 – Bank face reinforcement extent	-1	-1	-4
C9 – Bank face reinforcement material severity	-2	-2	-4
C10 – Bank face NNIPS cover	-3	-3	-3

4.1.18 The positive bank face indicator scores (C1 to C6) are shown in green in Table 4-6:

- The bank face riparian vegetation structure indicator scores ranged from 2 to 3 for the 3 sub-reaches. Both MC1 and MC3 achieved a score of 3 as the vegetation types short/creeping herbs/grasses, tall herbs/grasses, scrub/shrubs, and saplings/trees were recorded on both bank faces as well as mosses/lichens for MC1.
- The bank face tree feature richness indicator scores ranged from 1 to 2 with the sub-reaches MC1 and MC3 both achieving scores of 2. Leaning trees, and trees tree/shrub branches trailing into channel were recorded as well as j-shaped trees which were recorded in MC1 (see Photo 4-11).
- The bank face natural profile extent indicator score was highest for MC1 with a score of 2 as the greatest proportion of natural bank profiles were present within the sub-reach.
- The bank face natural profile richness indicator score was also highest for MC1 as gentle, steep, and vertical-with-toe natural bank profiles were recorded.
- The bank face natural channel material richness indicator scores were all 1 as only earth was recorded as the bank face natural material for all sub-reaches.
- The bank face bare sediment extent indicator score was highest for MC1 which had a score of 1 as unvegetated bare earth was recorded as trace in modules 1 and 4. The other sub-reaches in the upstream section of the main channel had no bare sediment present on the bank face.

4.1.19 The negative bank face indicator scores (C7 to C10) are shown in red in Table 4-6:

- The bank face artificial profile extent indicator scores ranged from -3 to -4. The sub-reach MC3 was obviously reshaped along the right bank. The sub-reach MC2 was obviously reshaped on both the left and right bank face (see Photo 4-12).

- The bank face reinforcement extent indicator score was lowest for MC3 as concrete reinforcement was recorded extensively along both bank faces in module 2.
- The bank face reinforcement material severity indicator scores ranged from -2 to -4. MC3 had the lowest score as concrete was extensive along the whole extent of both bank faces in module 2.
- The bank face NNIPS cover indicator scores were consistently -3 for all sub-reaches as Himalayan balsam was present on the bank face.

Photo 4-11: MC3 module 3 midpoint

Photo 4-12: MC2 module 2 midpoint

Channel margin

4.1.20 The channel margin indicator scores for the River Trent main channel upstream section of the reach are shown in Table 4-7.

Table 4-7: Channel margin indicator scores for the upstream section of the River Trent main channel reach

River Condition Indicator	MC1	MC2	MC3
D1 – Channel margin aquatic vegetation extent	3	3	3
D2 – Channel margin aquatic vegetation morphotype richness	2	2	2
D3 – Channel margin physical feature extent	0	1	0
D4 – Channel margin physical feature richness	0	1	0
D5 – Channel margin artificial features	0	0	-1

4.1.21 The positive channel margin indicator scores (D1 to D4) are shown in green in Table 4-7:

- The channel margin aquatic vegetation extent indicator scores were consistent for all sub-reaches. The accumulated amount of the aquatic morphotypes remained within the boundary for an indicator score of 3.
- The channel margin aquatic vegetation morphotype richness indicator scores were consistently 2 for all 3 sub-reaches within the upstream section of the main channel. Both amphibious vegetation and emergent linear-leaved vegetation were recorded in MC1, MC2 and MC3 (see Photo 4-13 and Photo 4-14).
- The channel margin physical feature extent indicator score was highest for the sub-reach MC2 with a score of 1, whereas the other sub-reaches did not have any natural physical features in the channel margin.
- The channel margin physical feature richness indicator score was highest for the sub-reach MC2 with a score of 1 as a toe was recorded on the left bank in modules 2, 3, 4 and 5 and on the right bank face in module 1.

4.1.22 The negative channel indicator score (D5) is shown in red in Table 4-7:

- The channel margin artificial features indicator score was only negative for the sub-reach MC3 with a score of -1 as 2 outfalls and a jetty were present on the right bank of modules 2 and 3.

Photo 4-13: MC2 module 4 facing upstream

Photo 4-14: MC3 module 5 midpoint

Channel bed

4.1.23 The channel bed indicator scores for the upstream section of the River Trent main channel are shown in Table 4-8:

Table 4-8: Channel bed indicator scores for the upstream section of the River Trent main channel reach

River Condition Indicator	MC1	MC2	MC3
E1 – Channel aquatic morphotype richness	3	4	3
E2 – Channel bed tree features richness	1	0	0
E3 – Channel bed hydraulic features richness	0	1	0
E4 – Channel bed natural features extent	0	0	0
E5 – Channel bed natural features richness	0	0	0
E6 – Channel bed material richness	3	3	3
E7 – Channel bed siltation	0	0	0
E8 – Channel bed reinforcement extent	0	0	-1
E9 – Channel bed reinforcement severity	0	0	-2
E10 – Channel bed artificial features severity	0	0	0
E11 – Channel bed NNIPS cover	0	0	0
E12 – Channel bed filamentous algae extent	0	0	0

4.1.24 The positive channel bed indicator scores (E1 to E6) are shown in green in Table 4-8:

- The channel aquatic morphotype richness indicator scores ranged from 3 to 4 for the 3 sub-reaches. The sub-reach MC2 had the highest score of 4 as submerged fine/linear/broad-leaved vegetation, emergent linear/broad-leaved vegetation, floating leaved (rooted), and amphibious vegetation were all recorded in the channel (see Photo 4-15).
- The channel bed tree features richness indicator scores ranged from 0 to 1. Tree features within the channel bed were recorded in MC1 within vegetation shading the channel observed in modules 3, 4 and 5.
- The channel bed hydraulic features richness indicator scores also range from 0 to 1 with the sub-reach MC2 achieving the highest score of 1 as it recorded smooth and no perceptible flow.
- The channel bed natural features extent indicator scores were all 0 for the 3 sub-reaches (see Photo 4-16). The channel bed natural features richness indicator scores were also 0 for the 3 sub-reaches.
- The channel bed material richness indicator scores were consistently 3 for the 3 sub-reaches. Gravel-pebble, sand and silt substrate was present in all sub-reaches. Clay was also recorded in MC2.

4.1.25 The negative channel bed indicator scores (E7 to E12) are shown in red in Table 4-8:

- The channel bed siltation indicator score was 0 for all 3 sub-reaches in the upstream section of the River Trent main channel.
- The channel bed reinforcement extent indicator scores ranged from 0 to -1 for the sub-reaches. The MC3 sub-reach had the lowest score as channel bed reinforcement was present in module 2.
- The channel bed reinforcement severity indicator score was lowest for MC3 as this sub-reach had concrete and washed-out reinforcement in module 2.

- The channel bed artificial features severity indicator scores were all 0 for the 3 sub-reaches as there were no artificial features recorded in the channel. The channel bed NNIPS cover indicator scores were all 0 as none were recorded within the channel.
- The channel bed filamentous algae extent indicator scores were all 0 as none was recorded within any of the sub-reaches.

Photo 4-15: MC2 module 3 midpoint

Photo 4-16: MC3 module 2 midpoint

River Trent main channel downstream

Bank top

4.1.26 The bank top indicator scores for the River Trent main channel downstream section of the reach are shown in Table 4-9.

Table 4-9: Bank top indicator scores for the downstream section of the River Trent main channel reach

River Condition Indicator	MC4	MC5
B1 – Bank top vegetation structure	3	1
B2 – Bank top tree feature richness	0	0
B3 – Bank top water-related features	0	0
B4 – Bank top NNIPS cover	0	0
B5 – Bank top managed ground cover	-4	-4

4.1.27 The positive bank top indicator scores (B1 to B3) are shown in green in Table 4-9:

- The bank top vegetation structure indicator scores varied for the downstream section of the River Trent main channel. The sub-reach

MC4 had the highest count of vegetation structural types on the bank top as short/creeping herbs/grasses, tall herbs/grasses, scrub/shrubs, and saplings/trees were recorded as present or extensive.

- The bank top tree feature richness indicator scores were 0 for both sub-reaches as tree features recorded as present or extensive on the bank tops.
- The bank top water-related features indicator scores for both sub-reaches were 0 as no water related features were recorded on the bank tops.

4.1.28 The negative bank top indicator scores (B4 and B5) are shown in red in Table 4-9:

- The bank top NNIPS cover indicator scores were both 0 as none were present on the bank tops of both sub-reaches.
- The bank top managed ground cover indicator score was -4 for both sub-reaches as building infrastructure was present on the bank top (Photo 4-17 and Photo 4-18).

Photo 4-17: MC4 module 5 midpoint

Photo 4-18: MC5 module 3 facing downstream

Bank face

4.1.29 The bank face indicator scores for the River Trent main channel downstream section of the reach are shown in Table 4-10:

Table 4-10: Bank face indicator scores for the downstream section of the River Trent main channel reach

River Condition Indicator	MC4	MC5
C1 – Bank face riparian vegetation structure	2	2
C2 – Bank face tree feature richness	1	0
C3 – Bank face natural profile extent	1	1
C4 – Bank face natural profile richness	1	1
C5 – Bank face natural bank material richness	1	1
C6 – Bank face bare sediment extent	1	0
C7 – Bank face artificial profile extent	-4	-4
C8 – Bank face reinforcement extent	-3	-4
C9 – Bank face reinforcement material severity	-3	-4
C10 – Bank face NNIPS cover	-2	-1

4.1.30 The positive bank face indicator scores (C1 to C6) are shown in green in Table 4-10:

- The bank face riparian vegetation structure indicator scores were consistently 2 for both sub-reaches as short/creeping herbs/grasses, tall herbs/grasses, scrub/shrubs, and saplings/trees were recorded on both bank faces.
- The bank face tree feature richness indicator scores varied from 1 to 0 for the 2 sub-reaches in the downstream section of the River Trent. In the sub-reach MC4, tree/shrub branches trailing into channel were recorded on the right bank in modules 2, 3, 4 and 5.
- The bank face natural profile extent indicator scores were the same for both sub-reaches with natural bank profile recorded as sub-dominant on both bank faces.
- The bank face natural profile richness indicator scores were 1 for both sub-reaches, as the natural bank profile type steep was recorded in both sub-reaches (Photo 4-19).
- The bank face natural channel material richness indicator scores for the 2 sub-reaches were also 1, as earth was the only bank face sediment recorded.
- The bank face bare sediment extent indicator scores dropped from 1 to 0 from the sub-reach MC4 to MC5 as there were trace amounts of unvegetated bare soil recorded in modules 1 and 2 on both bank faces in the sub-reach MC4.

4.1.31 The negative bank face indicator scores (C7 to C10) are shown in red in Table 4-10:

- The bank face artificial profile extent indicator scores were -4 for both sub-reaches as the dominant bank profile was obviously reshaped on the right and left banks (Photo 4-20). The left bank of MC5 module 2 was also poached.
- The bank face reinforcement extent indicator scores dropped from sub-reach MC4 to MC5 from -3 to -4 as there was a greater amount of reinforcement present in MC5.

- The bank face reinforcement material severity indicator scores were lower for the sub-reach MC5 as both sheet piling and concrete were recorded, which have the highest severity level.
- The bank face NNIPS cover indicator scores were lower for sub-reach MC4 as a greater amount of Himalayan balsam was recorded on the bank face.

Photo 4-19: MC5 module 2 facing upstream

Photo 4-20: MC4 module 1 midpoint

Channel margin

4.1.32 The channel margin indicator scores for the River Trent main channel downstream section of the reach are shown in Table 4-11:

Table 4-11: Channel margin indicator scores for the downstream section of the River Trent main channel reach

River Condition Indicator	MC4	MC5
D1 – Channel margin aquatic vegetation extent	3	3
D2 – Channel margin aquatic vegetation morphotype richness	2	3
D3 – Channel margin physical feature extent	1	1
D4 – Channel margin physical feature richness	1	1
D5 – Channel margin artificial features	0	-1

4.1.33 The positive channel margin indicator scores (D1 to D4) are shown in green in Table 4-11:

- The channel margin aquatic vegetation extent indicator scores were the same for both reaches as the amount of vegetation recorded was within the same indicator score range.

- The channel margin aquatic vegetation morphotype richness indicator scores were marginally different as 3 vegetation types; emergent broad/linear vegetation, and amphibious vegetation were recorded within the sub-reach MC5. Only emergent linear and amphibious vegetation types were observed in sub-reach MC4 (see Photo 4-21).
- The channel margin physical feature extent indicator scores were 1 at both sub-reaches as the total extent of the physical features on the bank face were within the same range as physical features were limited.
- With respect to channel margin physical feature richness, sub-reach MC5 had both a toe and eroding cliff present, whilst a toe feature was observed in sub-reach MC4 (Photo 4-22), leading to a low score of channel margin physical feature richness score of 1 for both sub-reaches.

4.1.34 The negative channel indicator score (D5) is shown in red in Table 4-11:

- The channel margin artificial features indicator score was lowest for the sub-reach MC5 with a score of -1 as 1 outfall was recorded in module 4 on the right bank.

Photo 4-21: MC4 module 1 facing downstream

Photo 4-22: MC5 module 2 facing downstream

Channel bed

4.1.35 The channel bed indicator scores for the downstream section of the River Trent main channel are shown in Table 4-12:

Table 4-12: Channel bed indicator scores for the downstream section of the River Trent main channel reach

River Condition Indicator	MC4	MC5
E1 – Channel aquatic morphotype richness	3	4
E2 – Channel bed tree features richness	0	0
E3 – Channel bed hydraulic features richness	0	3
E4 – Channel bed natural features extent	0	0
E5 – Channel bed natural features richness	0	0
E6 – Channel bed material richness	3	3
E7 – Channel bed siltation	0	0
E8 – Channel bed reinforcement extent	-1	-2
E9 – Channel bed reinforcement severity	-1	-2
E10 – Channel bed artificial features severity	-1	-4
E11 – Channel bed NNIPS cover	-1	0
E12 – Channel bed filamentous algae extent	0	-1

4.1.36 The positive channel bed indicator scores (E1 to E6) are shown in green in Table 4-12:

- The channel aquatic morphotype richness indicator scores ranged from 3 to 4. The sub-reach MC5 had a greater diversity of aquatic vegetation in the channel.
- The channel bed tree features richness indicator score was 0 for both sub-reaches as no tree features were recorded as present or extensive within the channel.
- The channel bed hydraulic features richness indicator score was highest for MC5 with a score of 3 as the freefall, chute, unbroken standing wave, rippled and smooth flow types were recorded in module 5. Only smooth flow type was recorded in MC4 (Photo 4-23).
- The channel bed natural features extent indicator scores were 0 for both sub-reaches as no natural features were recorded within the channel. The channel bed natural features richness indicator scores were also 0 as no natural feature types were recorded within the channel.
- The channel bed material richness indicator scores were both 3. Both sub-reaches had the substrates silt, sand, and gravel-pebble present. The sub-reach MC4 also had clay as an extensive substrate and the sub-reach MC5 was observed to have cobble substrate present.

4.1.37 The negative channel bed indicator scores (E7 to E12) are shown in red in Table 4-12:

- The channel bed siltation indicator scores for the sub-reach were 0 as no silt overlying coarser material was recorded within the sub-reaches.
- The channel bed reinforcement extent indicator score was lowest for the sub-reach MC5 with a score of -2 as a greater amount of reinforcement on the channel bed was recorded.
- The channel bed reinforcement severity indicator score was also lowest for the sub-reach MC5 as rip-rap was recorded as present in

module 1 and washed-out reinforcement was recorded as present in module 5.

- The channel bed artificial features severity indicator score was lowest for the sub-reach MC5 as a major weir was present and there were eight bridge piers within the channel bed (Photo 4-24).
- The channel bed NNIPS cover indicator score was lowest for the sub-reach MC4 as Nuttall's waterweed (*Elodea nuttallii*) was recorded within the channel.
- The channel bed filamentous algae extent indicator scores was lowest for the sub-reach MC5 as trace amounts within the channel were recorded.

Photo 4-23: MC4 module 1 facing upstream

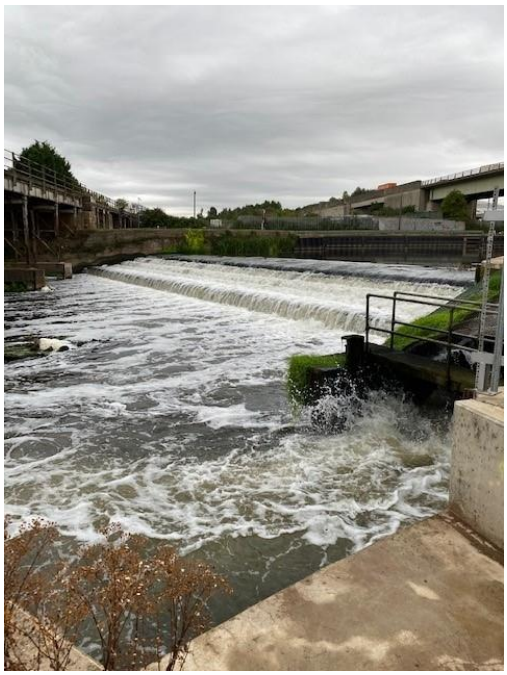


Photo 4-24: MC5 module 5 midpoint

Slough Dyke

Bank top

4.1.38 The bank top indicator scores for the 3 sub-reaches on the Slough Dyke are shown in Table 4-13.

Table 4-13: Bank top indicator scores for the Slough Dyke

River Condition Indicator	SD1	SD2	SD3
B1 – Bank top vegetation structure	2	2	2
B2 – Bank top tree feature richness	0	0	0
B3 – Bank top water-related features	0	0	0
B4 – Bank top NNIPS cover	0	0	0
B5 – Bank top managed ground cover	-3	-4	-3

4.1.39 The positive bank top indicator scores are shown in green (B1 to B3) in Table 4-13:

- The bank top vegetation structure for the Slough Dyke was consistent throughout the sub-reaches with an indicator score of 2 recorded. Short/creeping herbs/grasses, scrub/shrub, saplings and trees and tall herbs and grasses were observed on both bank tops.
- No bank top tree features such as fallen trees, leaning trees, j-shaped trees, tree/shrub branches trailing into the river channel, or large wood was observed.
- No bank top water related features were recoded.

4.1.40 The negative bank top indicator scores are shown in red (B4 to B5) in Table 4-13:

- There were no non-native invasive plant species observed in the 3 sub-reaches.
- The bank top managed ground cover was negative for all 3 of the sub-reaches. The watercourse ran alongside the A1 road on the right bank top and the left bank top was a arable field. (See Photo 4-25 and Photo 4-26).

Photo 4-25: SD1 module 2 right bank top

Photo 4-26: SD2 module 4 facing downstream

Bank face

4.1.41 The bank face indicator scores for the sub-reaches assessed on the Slough Dyke are shown in Table 4-14.

Table 4-14: Bank face indicator scores for the Slough Dyke.

River Condition Indicator	SD1	SD2	SD3
C1 – Bank face riparian vegetation structure	3	2	2
C2 – Bank face tree feature richness	0	1	0
C3 – Bank face natural profile extent	1	0	0
C4 – Bank face natural profile richness	1	0	0
C5 – Bank face natural bank material richness	1	1	1
C6 – Bank face bare sediment extent	1	1	2
C7 – Bank face artificial profile extent	-4	-4	-4
C8 – Bank face reinforcement extent	0	-1	-2
C9 – Bank face reinforcement material severity	0	-1	-2
C10 – Bank face NNIPS cover	0	0	0

4.1.42 The positive bank face indicator scores for the Slough Dyke are shown in green (C1 to C6) in Table 4-14:

- The bank face riparian vegetation structure indicator scores were consistent for SD2 and SD3. The sub-reach SD1 had a slightly higher diversity of vegetation with an indicator score of 3 reflecting that tall herbs/grasses, scrub/shrubs, saplings/trees and short/creeping herbs/grasses were recorded on both bank faces throughout the sub-reach (see Photo 4-27).
- SD2 was the only sub-reach in which the tree feature exposed bankside roots was recorded, being observed on the right bank face of module 3.
- The sub-reach SD1 was the only 1 to include a natural bank face profile – composite, on the right bank of module 3. The extent was limited and therefore bank face natural profile richness and extent scores were both 1 in this sub-reach. The absence of natural bank profiles led to a score of 0 for these indicators in sub-reaches SD2 and SD3.
- All sub-reaches were observed to have earth present as the predominant bank face material for the top and the bottom sections which resulted in an indicator score of 1.
- The bank face bare sediment extent was greatest for SD3 which had an indicator score of 2 compared to 1 for the 2 upstream sub-reaches.

4.1.43 The negative indicator scores for the bank face are shown in red (C7 to C10) in Table 4-14:

- All sub-reaches were observed to be obviously reshaped on both bank faces throughout, therefore they all had a negative indicator score of -4.
- Bank face reinforcement extent was lowest for the sub-reach SD3 as module 5 included extensive brick/laid stone for the whole of the bank face. SD2 also included concrete in module 1 where an outfall was present (see Photo 4-28).
- Bank face reinforcement severity was also lowest for the sub-reach SD3 as brick/laid stone was recorded as extensive in module 5.

- No non-native invasive plant species were recorded in any of the 3 sub-reaches.

Photo 4-27: SD1 module 1 facing downstream

Photo 4-28: SD2 module 1 outfall

Channel margin

4.1.44 The channel margin indicator scores for the Slough Dyke are shown in Table 4-15.

Table 4-15: Channel margin indicator scores for the Slough Dyke

River Condition Indicator	SD1	SD2	SD3
D1 – Channel margin aquatic vegetation extent	2	2	2
D2 – Channel margin aquatic vegetation morphotype richness	2	1	2
D3 – Channel margin physical feature extent	3	1	1
D4 – Channel margin physical feature richness	2	1	1
D5 – Channel margin artificial features	0	-1	0

4.1.45 The positive channel margin indicator scores for the channel margin are shown in green (D1 to D4) in Table 4-15.

- The channel margin aquatic vegetation extent indicator score was 2 throughout all 3 sub-reaches.
- The channel margin aquatic vegetation morphotype richness was lowest for sub-reach SD2 with an indicator score of 1. Emergent broad-leaved and emergent linear-leaved vegetation morphotypes were observed as present in SD1 and SD3. In SD2 only amphibious vegetation was observed in the channel margin (see Photo 4-29).
- The channel margin physical feature extent was highest for sub-reach SD1 with an indicator score of 3 compared to 1 for SD2 and SD3.

- The channel margin physical feature richness score was also highest for the sub-reach SD1 which had an indicator score of 2. Unvegetated side bars composed of silt were observed in all 5 modules. A berm was present in module 1 along the right bank, whilst module 3 included a vegetated silt side bar (see Photo 4-30).

4.1.46 The negative channel margin indicator score is shown in red (D5) in Table 4-15:

- The sub-reach SD2 was observed to have 1 outfall present in module 1 and had an indicator score of -1. No artificial channel margin features were recorded in the other 2 sub-reaches.

Photo 4-29: SD3 module 5 facing upstream

Photo 4-30: SD1 module 1 midpoint

Channel bed

4.1.47 The channel bed indicator scores for the Slough Dyke are shown in Table 4-16.

Table 4-16: Channel bed indicator scores for the Slough Dyke

River Condition Indicator	SD1	SD2	SD3
E1 – Channel aquatic morphotype richness	3	3	3
E2 – Channel bed tree features richness	1	1	1
E3 – Channel bed hydraulic features richness	1	2	0
E4 – Channel bed natural features extent	1	1	0
E5 – Channel bed natural features richness	0	1	0
E6 – Channel bed material richness	2	3	1
E7 – Channel bed siltation	0	-2	0
E8 – Channel bed reinforcement extent	0	0	-2
E9 – Channel bed reinforcement severity	0	0	-2
E10 – Channel bed artificial features severity	0	0	-4
E11 – Channel bed NNIPS cover	0	0	0
E12 – Channel bed filamentous algae extent	-1	-4	-3

4.1.48 The positive indicator scores for the channel bed are shown in green (E1 to E6) in Table 4-16:

- The channel bed aquatic morphotype richness was high for all the sub-reaches with an indicator score of 3 recorded for each. Emergent broad-leaved, emergent linear-leaved, amphibious, submerged broad-leaved, submerged fine-leaved and floating-leaved (rooted) morphotypes were observed in the channel (see Photo 4-31).
- All the sub-reaches generated channel bed tree features richness indicator scores of 1. Vegetation was observed as shading the channel in all the sub-reaches surveyed.
- The channel bed hydraulic features richness varied for the 3 sub-reaches; the highest indicator score was recorded in sub-reach SD2 which had an indicator score of 3, compared to the lowest score in sub-reach SD3 which had an indicator score of 0. SD2 was observed to have the flow types smooth, rippled and no perceptible; whereas, for SD3 only no perceptible flow was observed.
- The channel bed natural features extent had an indicator score of 1 for both the sub-reach SD1 and SD2, whereas the sub-reach SD3 had an indicator score of 0. A mid channel bar was recorded as trace in several modules of SD1
- The channel bed natural features richness score was 0 for the sub-reaches SD1 and SD2, as no of the features were recorded as present or extensive. However, for SD2 a pool was observed in module 1 and so the indicator score was 1.
- Channel bed material richness indicator scores ranged from 1 in sub-reach SD3 to 3 in sub-reach SD2. The substrate types present in SD2 included gravel/pebble, sand and silt; whereas SD1 only included silt as present or extensive, with gravel/pebble was observed in trace amounts; whilst in sub-reach SD3 only silt substrate was observed.

4.1.49 The negative channel bed indicator scores are shown in red (E7 to E12) in Table 4-16:

- The channel bed siltation indicator score was 0 for sub-reaches SD1 and SD3, but was recorded as -2 for the sub-reach SD2 as a continuous silt layer and patchy silt layer were observed in the sub-reach.
- Only 1 of the sub-reaches was observed to have reinforcement present within the channel and this was SD3 as the culverted section at the bridge location in module 5 was made of sheet piling (see Photo 4-32).
- Sub-reach SD3 had a reinforcement severity score of -2 due to the extensive sheet piling observed in module 5.
- The channel bed artificial features severity indicator score for the SD3 sub-reach was also the lowest of the 3 surveyed due to the culvert in module 5 which resulted in a score of -4.
- There were no NNIPS observed within the channel.

4.1.50 Filamentous algae was observed in all 3 sub-reaches. The greatest amount was seen in the sub-reach SD2 which had an indicator score of -4.

Photo 4-31: SD1 module 1 facing upstream

Photo 4-32: SD3 module 4 facing downstream

The Fleet

Bank top

4.1.51 The bank top indicator scores for the Fleet sub-reach are shown in Table 4-17 below.

Table 4-17: Bank top indicator scores for the Fleet

River Condition Indicator	F1
B1 – Bank top vegetation structure	2
B2 – Bank top tree feature richness	0
B3 – Bank top water-related features	0
B4 – Bank top NNIPS cover	0
B5 – Bank top managed ground cover	-2

4.1.52 The positive bank top indicator scores are shown in green (B1 to B3) in Table 4-17:

- The bank top vegetation indicator score for F1 the sub-reach F1 was 2, as short/creeping herbs/grasses, tall herbs/grasses and saplings and trees were recorded on the bank top (see Photo 4-33).
- The bank top tree feature richness indicator score for the sub-reach F1 was 0 as none were observed on the bank top.
- There were no bank top water-related features in this sub-reach as no fallen trees, leaning trees, j-shaped trees, tree/shrub branches trailing into the river channel or large wood were recorded, therefore the indicator score was 0.

4.1.53 The negative bank top indicator scores are shown in red (B4 to B5) in Table 4-17.

- There were no NNIPS observed on the bank top of the F1 sub-reach.

Photo 4-33: F1 module 4 facing upstream

Bank face

4.1.54 The bank face indicator scores for the Fleet reach are shown in Table 4-18.

Table 4-18: Bank face indicator scores for the Fleet

River Condition Indicator	F1
C1 – Bank face riparian vegetation structure	2
C2 – Bank face tree feature richness	1
C3 – Bank face natural profile extent	1
C4 – Bank face natural profile richness	2
C5 – Bank face natural bank material richness	1
C6 – Bank face bare sediment extent	3
C7 – Bank face artificial profile extent	-4
C8 – Bank face reinforcement extent	-2
C9 – Bank face reinforcement material severity	-2
C10 – Bank face NNIPS cover	0

4.1.55 The positive bank face indicator scores are shown in green (C1 to C6) in Table 4-18:

- The bank face riparian vegetation structure indicator score was 2 for sub-reach F1; vegetation types observed included short/creeping herbs/grasses, scrub/shrubs and saplings/trees.
- The bank face tree feature richness indicator score was 1 for the sub-reach F1 as exposed tree roots were observed on the bank face in modules 1 and 5. Leaning trees were also observed on the left bank face of modules 2 and 3 (see Photo 4-34).

- The bank face natural profile extent was 1 for sub-reach F1 as the natural bank face profile steep was observed as sub-dominant in modules 3 and 4. A gentle bank profile was also observed as sub dominant in module 1 (see Photo 4-35).
- The bank face natural profile richness indicator score for the F1 sub-reach was 2. This was due to gentle and steep bank profiles being observed in the sub-reach.
- The bank face natural bank material richness indicator score was 1 for the sub-reach F1 as only earth was observed as a bank face material in the top and bottom sections.
- The bank face bare sediment extent had an indicator score of 3 for sub-reach F1; unvegetated bare earth was observed in modules 2, 3, 4 and 5.

4.1.56 The negative bank face indicator scores are shown in red (C7 to C10) in Table 4-18:

- The bank face artificial profile extent was -4 for this sub-reach as it was observed to be obviously reshaped throughout.
- The bank face reinforcement extent was -2 as reinforcement was observed in the middle of the bank face in modules 2, 3, 4 and 5.
- The bank face reinforcement material severity was -2 as concrete was observed on the left bank in modules 2, 3, 4 and 5.
- No NNIPS were observed on the bank faces of this sub-reach.

Photo 4-34: F1 module 3 facing upstream

Photo 4-35: F1 module 1 midpoint

Channel margin

4.1.57 The channel margin indicator scores for the sub-reach F1 are shown in Table 4-19 below.

Table 4-19: Channel margin indicator scores for the Fleet

River Condition Indicator	F1
D1 – Channel margin aquatic vegetation extent	2
D2 – Channel margin aquatic vegetation morphotype richness	1
D3 – Channel margin physical feature extent	1
D4 – Channel margin physical feature richness	1
D5 – Channel margin artificial features	-1

4.1.58 The positive indicator scores are shown in green (D1 to D4) in Table 4-19:

- The channel margin aquatic vegetation extent indicator score for the sub-reach F1 was 2 as amphibious vegetation was recorded in the channel margin throughout the sub-reach. Liverworts, mosses and lichens were also recorded as trace on the right channel margin of module 1 (see Photo 4-36).
- The channel margin aquatic vegetation morphotype richness indicator score was 1 as amphibious vegetation was the only type to be observed in present or extensive coverage within this sub-reach.
- The channel margin physical feature extent had an indicator score of 1 as several features including nest holes, stable cliff, eroding cliff and toe were observed, though each with less than 5% bank coverage.

- The channel margin physical feature richness indicator score was 1 for the sub-reach F1 due to the presence of a gravel/pebble unvegetated side bar on the right bank face of module 1.

4.1.59 The negative indicator score for the channel margin is shown in red (D5) in Table 4-19:

- The channel margin artificial features indicator score was -1 as an outfall was recorded on the right bank face of module 1.

Photo 4-36: F1 module 1 facing upstream

Channel bed

4.1.60 The channel bed indicator scores for the F1 sub-reach are shown in Table 4-20 Table 4-below.

Table 4-20: Channel bed indicator scores for the Fleet

River Condition Indicator	F1
E1 – Channel aquatic morphotype richness	1
E2 – Channel bed tree features richness	2
E3 – Channel bed hydraulic features richness	1
E4 – Channel bed natural features extent	0
E5 – Channel bed natural features richness	0
E6 – Channel bed material richness	2
E7 – Channel bed siltation	-4
E8 – Channel bed reinforcement extent	-1
E9 – Channel bed reinforcement severity	-2
E10 – Channel bed artificial features severity	0
E11 – Channel bed NNIPS cover	0
E12 – Channel bed filamentous algae extent	0

4.1.61 The positive indicator scores for the channel bed are shown in green (E1 to E6) in Table 4-20:

- The channel aquatic morphotype richness indicator score for the F1 sub-reach is 1 as only amphibious vegetation was recorded in the channel area (See Photo 4-37 and Photo 4-38).
- The channel bed tree feature richness indicator score for the sub-reach F1 was 2 as vegetation shading the channel and submerged tree roots were both recorded.
- The channel bed hydraulic features richness indicator score was 1 for the sub-reach F1 as rippled and smooth flow types were observed within the channel.
- The channel bed natural features richness and extent indicator scores were both 0 as none were observed within the sub-reach.
- The channel bed material richness indicator score was 2 as sand and gravel/pebble bed materials were recorded as present and extensive respectively.

4.1.62 The negative channel bed indicator scores are shown in red (E7 to E12) in Table 4-20:

- The channel bed siltation indicator score was -4 for sub-reach F1 as a patchy silt layer and continuous silt layer masking coarser materials were both observed within the sub-reach.
- The channel bed reinforcement extent indicator score was -1 for the sub-reach F1 as brick/laid stone was observed in trace coverage in module 1. This also resulted in a channel bed reinforcement severity score of -2.
- There were no artificial features observed within the channel bed, so the severity indicator score was 0.
- No NNIPS were observed within the channel, so the indicator score was 0.
- There was no filamentous algae observed in the channel in the sub-reach surveyed so the indicator score was 0.

Photo 4-37: F1 module 4 midpoint

Photo 4-38: F1 module 3 midpoint

River Type Desk Study

4.1.1 The river type desk study results are shown in Table 4-21.

Table 4-21: River type desk study results

River Type	River Trent main channel	River Trent Kelham channel	Slough Dyke	The Fleet
NGR u/s point	SK 73233 49481	SK 77068 53675	SK 81910 54965	SK 84511 55492
NGR d/s point	SK 80929 61144	SK 80250 56338	SK 80966 61104	SK 80966 61104
Altitude u/s point (m)	N/A	N/A	19.4	19.9
Altitude d/s point (m)	N/A	N/A	8	8
Reach length (km)	N/A	N/A	8.5	9.4
Valley length (km)	N/A	N/A	7.11	8.1
A1: Braiding Index	N/A	N/A	1	1
A2: Sinuosity Index	N/A	N/A	1.20	1.16
A3: Anabranching Index	N/A	N/A	1	1
A4: Level of Confinement	N/A	N/A	Unconfined	Unconfined
A5: River Reach Gradient m/m	N/A	N/A	0	0
Bedrock reach	N/A	N/A	No	No
Coarsest bed material	N/A	N/A	Gravel/pebble	Gravel/pebble
Average bed material	N/A	N/A	Sand	Sand
River Type	Navigable	Large	H	H

4.1.2 The River Trent main channel was identified to be a navigable river based on its function. The Kelham side channel was identified to be a large river as the reach was too wide or deep for reliable bed material information to be collected during a MoRPh field survey as it was greater than 30 metres wide. Accurate survey of bed material often becomes challenging on rivers wider than 20 metres and without a survey of bed material larger rivers cannot be allocated to 1 of river types A to M. The Slough Dyke and the Fleet watercourses were both identified to be river type H. They are unconfined reaches with a sinuosity of 1.2 and 1.16 respectively. Both reaches were observed to have an average bed material of sand and the coarsest bed material of gravel/pebble.

River condition assessment

4.1.3 The RCA results for the eight MoRPh5 sub-reaches are shown in Table 4-22. Within the Biodiversity Metric tool, it is recommended that these sub-reaches should represent 5 distinct river reaches, as shown in Table 4-23.

Table 4-22: River condition assessment results

MoRPh5 sub-reach	River Type	Positive indicators average	Negative indicator average	Preliminary Condition Score	Final Condition Class
KC1	Large river	2	-1.85	0.15	Fairly Poor
KC2	Large river	1.68	-0.85	0.84	Moderate
KC3	Large river	1.21	-0.85	0.36	Moderate
MC1	Navigable	1.42	-1.15	0.27	Moderate
MC2	Navigable	1.26	-1.23	0.03	Moderate
MC3	Navigable	1.21	-2	-0.79	Fairly Poor
MC4	Navigable	1.21	-0.33	-0.33	Fairly Poor
MC5	Navigable	1.26	-2.08	-0.81	Fairly Poor
SD1	H	1.37	-0.62	0.75	Moderate
SD2	H	1.21	-1.31	-0.10	Fairly Poor
SD3	H	0.95	-1.69	-0.74	Fairly Poor
F1	H	1.21	-1.38	-0.17	Fairly Poor

4.1.4 The Kelham channel upstream reach (KC1) was Fairly Poor as a major weir negatively impacted the score for this reach. Further downstream the sub-reaches (KC2 and KC3) both achieved Moderate Final Condition Classes.

4.1.5 The upstream reaches of the River Trent main channel (MC1 and MC2) were classified as Moderate compared to the downstream reaches (MC3, MC4 and MC5) which were Fairly Poor. The land use change of the riparian zone as the reach became more urbanised largely played a part in the obviously reshaped and reinforced nature of the channel which is likely to prevent flooding to the residential areas located along the right bank top.

4.1.6 The 3 sub-reaches within Slough Dyke were assessed as being in Fairly Poor to Moderate condition. The upstream sub-reach SD1 had a Final Condition Class of Moderate, whereas the 2 further downstream sub-reaches were both assessed as Fairly Poor. The watercourse was identified as being overdeep as indicated by a river shape value of <2; however as condition was no greater than Moderate, a reduction in class due to overdeepening was not applied.

4.1.7 The single sub-reach representing The Fleet reach was assessed as being of Fairly Poor condition. The watercourse was determined to be overdeep as indicated by a river shape value of <2; however as condition was Fairly Poor, a reduction in class due to overdeepening was not applied.

Table 4-23: Distinct river reaches and inputs recommended for the Biodiversity Metric tool

Reach	MoRPh5 sub-reaches	Estimated length	Final Condition Class
Kelham channel upstream	Kelham channel 1 (KC1)	0.24km	Fairly Poor
Kelham channel downstream	Kelham channel 2 (KC2) Kelham channel 3 (KC3)	1.49km	Moderate
River Trent upstream Newark	Main channel 1 (MC1) Main channel 2 (MC2)	1.51km	Moderate
River Trent A46 west	Main channel 3 (MC3)	0.43km	Fairly Poor
River Trent A46 east	Main channel 4 (MC4) Main channel 5 (MC5)	0.77km	Fairly Poor
Slough Dyke	Slough Dyke 1 (SD1)	0.21km	Moderate
Slough Dyke	Slough Dyke 2 (SD2) Slough Dyke 3 (SD3)	0.29km	Fairly Poor
The Fleet	The Fleet (F1)	0.19km	Fairly Poor

4.2 River habitat walkover surveys

Kelham channel upstream

4.2.1 The Kelham channel upstream reach is situated in a relatively flat landscape with no distinct valley or valley features. The left bank top was predominantly rough grassland, whilst land use on the right bank was scrub and woodland within 40 metres of the bank top, and arable agriculture beyond.

4.2.2 The upstream extent of the reach was marked by a large weir over which water flows from the southern navigable arm of the River Trent. The weir may hinder fish passage, though it may be partially breached and had a rough structure which may facilitate fish passage. The weir also provides oxygenation of water and may attract rheophilic (requiring fast flows) fish species and locally improve conditions for fish spawning.

4.2.3 The reach was not obviously overdeepened or over widened, though the impact and extent of historic modification was unclear. The left bank was approximately 4 metre high and appears reshaped with a reinforced rip-rap toe.

4.2.4 Vegetation diversity was relatively low on the left bank, with limited interactions with the channel. The right bank had a greater amount of vegetation interacting with the channel as the vegetation was denser and more varied with amphibious, emergent morphotypes present, and tree features observed such as channel shading and branches trailing into the channel. This vegetation may provide important cover for various species and life stages of fish. The right bank also had a semi-natural bank profile with shallow, steep and vertical-with-toe profiles observed.

4.2.5 The flow types present varied but was predominantly smooth, rippled, unbroken standing waves and no perceptible flow. The substrate was observed to be sandy where flows were slow or non-perceptible, but gravel-pebble was dominant with trace amounts of cobble where flows were faster. This variety may support a range of fish species and life stages, ranging from rheophilic and lithophilic spawning species (requiring coarse, stony substrates), to those with preferences for lower flows.

4.2.6 There were no in-channel (submerged) macrophytes observed, and the marginal macrophyte community was relatively sparse.

4.2.7 Woody material within the channel was relatively limited; 1 fallen tree was observed, and it is possible the woody material within the channel is managed.

4.2.8 Flow refugia for fish were observed in the form of a small marginal backwater on the right bank, marginal trees along the right bank and

on the mature island feature in the centre of the channel, and a large area of slack flow upstream of the railway bridge and adjacent to the right bank. An area of high flow diversity was evident around the railway bridge which may also provide suitable habitats for various fish species at different life stages.

4.2.9 The non-native plant species Himalayan balsam was extensive on the right bank in the vicinity of a railway bridge which crosses at SK 77107 53866.

4.2.10 Photographs and descriptions of the features recorded and the locations of these features are shown in the Appendix A, A-1 (River Condition Assessment MoRPh Survey Locations) and Appendix C, Table C-1 (River walkover tables) of this report.

Kelham channel downstream

4.2.11 Similarly, to the upstream reach, the Kelham channel downstream reach flows through a relatively flat landscape with no distinct valley or valley features. The land use type on the left bank top was arable agriculture and parks/gardens, whilst the land use type on the right bank top was predominantly arable.

4.2.12 The reach has not been obviously overdeepened or over widened, though the impact and extent of historic modification is unclear. The banks were relatively high with uncertain connectivity to the floodplain, and this may be influenced by modification of the wider River Trent for navigation. The banks exhibited a degree of morphological diversity with significant evidence of erosion and deposition indicating a geomorphic activity over time.

4.2.13 On the inside of meanders, 2 large depositional areas have created complex mosaics of exposed bars, islands, side channels, backwaters, ponds and wetland areas. These features may support a range of fish species and life cycles. It is also likely that their presence creates niches for diverse assemblages of aquatic and terrestrial invertebrates, and potentially other ecological groups. As such, these features may be of a high priority for protection.

4.2.14 Marginal trees and scrub were observed as moderately abundant along both banks, with shading and branches trailing into the channel potentially providing important fish cover.

4.2.15 The substrate was dominated by gravel/pebble with lesser amounts of sand, silt and clay observed. Flow diversity was relatively high with rippled, unbroken standing waves, smooth and no perceptible flow recorded. There were no in-channel (submerged) macrophytes observed, although the marginal macrophyte community was relatively diverse and abundant.

4.2.16 The reach also included a wide section of relatively turbulent water with notably clean gravels which may be a possible fish spawning area.

4.2.17 A range of habitats and flow types which may support a variety of fish species and life stages was present in the vicinity of the A617 bridge, with higher energy flow types present upstream, and an area of marginal deadwater downstream.

4.2.18 The non-native plant Himalayan balsam was observed on both banks.

4.2.19 Photographs and descriptions of the features recorded and the locations of these features are shown in Appendix A, A-3 (River Condition Assessment MoRPh Survey Locations) and Appendix C, Table C-2 (River walkover tables) of this report.

River Trent upstream Newark

4.2.20 The River Trent upstream Newark reach flows within a relatively flat landscape with no distinct valley, valley bottom or valley features. The reach was relatively homogenous lacking distinct or isolated habitat features. It is possible the reach has been overdeepened for navigation and may also be impounded by downstream structures.

4.2.21 Land use adjacent to both banks was dominated by arable agriculture. The structure of both banks suggested that they have been historically resectioned although recovery is evident and semi-natural profiles were present, including stable and eroding cliffs on the outside of bends.

4.2.22 The vegetation on the right bank face appeared more heavily maintained than the left. Riparian trees (predominantly willows *Salix* spp.) were abundant along the left bank, though relatively isolated on the right bank. Where present, they provided marginal cover and habitat complexity in the form of semi-natural bank profiles and features such as submerged roots and marginal deadwater. These features may provide important functionality for aquatic organisms, particularly juvenile fish.

4.2.23 Willows *Salix* spp. were abundant along the left bank and were associated with complex bank profiles as the tree roots created areas of marginal deadwater which could potentially provide important habitat for juvenile fish.

4.2.24 The predominant substrate observed in the margins was sand, although other sediment/substrate types may have been present within the rest of the channel. The flow type was predominantly smooth with some areas of no perceptible flow in the channel margins; the reach is likely poorly suitable for rheophilic fish during low-to-normal flow conditions. No specific areas suitable for lithophilic spawning or rheophilic species were observed.

4.2.25 Marginal macrophytes were relatively abundant and submerged taxa were also observed. Macrophyte morphotypes observed included mosses, emergent linear, floating leaved rooted, submerged broad-leaved and submerged fine-leaved. These species may provide habitat for aquatic invertebrates, cover for fish and spawning substrate for phytophilic spawning fish species.

4.2.26 The INNS Himalayan balsam was scattered along the bank tops and faces.

4.2.27 Photographs and descriptions of the features recorded and the locations of these features are shown in Appendix A, A-4 (River Condition Assessment MoRPh Survey Locations) and Appendix C, Table C-3 (River walkover tables) of this report.

River Trent A46 west

4.2.28 This reach was distinguished from the 'River Trent upstream Newark' reach, located immediately upstream, by the urban surroundings and the associated presence of reinforced banks. The river at this location continues to flow through a relatively flat landscape with no distinct valley, valley bottom or valley features. It is possible the reach has been overdeepened for navigation and may also be impounded by downstream structures.

4.2.29 The left bank top land use was observed to be predominantly arable, whilst the right bank use was predominantly suburban/urban, gardens and roads. This reach included the western A46 crossing location, which comprised of a large bridge which may provide localised shading for fish, though was also associated with some bank and bed reinforcement.

4.2.30 The left bank structure was a mixture of reinforced, obviously resectioned and semi-natural bank profiles. The vegetation structure was moderately diverse with trees relatively abundant on the left bank only, and likely providing habitat complexity and important cover for fish where present. The right bank structure was almost entirely reinforced or in sections where it was not it was obviously resectioned.

4.2.31 The predominant observed substrate within the margins was sand, though other substrate/sediment types may be present within the rest of the channel. The predominant flow type present was smooth, with no perceptible flow in the margins. The reach is therefore likely to be poorly suitable for rheophilic fish during low-to-normal flow conditions, and no specific areas suitable for lithophilic spawning or rheophilic species were observed.

4.2.32 The abundance and diversity of both marginal and in-channel macrophytes was limited, though submerged broad-leaved and submerged fine-leaved morphotypes were observed. Where present,

these species may provide habitat for aquatic invertebrates, cover for fish and spawning substrate for phytophilic spawning fish species.

4.2.33 The INNS Himalayan balsam was present along the left bank.

4.2.34 Photographs and descriptions of the features recorded, and the locations of these features are shown in Appendix A, A-5 (River Condition Assessment MoRPh Survey Locations) and Appendix C, Table C-4 (River walkover tables) of this report.

River Trent A46 east

4.2.35 The River Trent A46 east reach is located within a mixture of urban and semi-rural surroundings and, similarly to other reaches, flows within a relatively flat landscape with no distinct valley, valley bottom or valley features. The left bank top use was predominantly rough pasture with some semi-natural woodland either side of the A46 road bridge. The right bank top use was a mixture of residential and industrial land use with some woodland downstream of the A46 road bridge. Pathways were present along both bank tops.

4.2.36 The banks in this reach have been predominantly re-shaped, and the channel itself may have been realigned, overdeepened or overwidened. Artificial reinforcement featured heavily in this reach with sheet piling, rip-rap and concrete present along both banks. Some semi-natural banks were present on the left bank face where natural recovery has occurred. Although no livestock were observed, the left bank also appears to have been influenced by livestock poaching, though this may have helped to create more complex bank profiles in the process.

4.2.37 Trees and scrub shading or trailing into the edge of the channel were relatively abundant along the right bank, and may provide important cover for fish, particularly juveniles. Shading of the channel itself was relatively sparse and likely to be important where present.

4.2.38 Trace amounts of in-channel vegetation was present, with emergent linear/broad-leaved, submerged broad-leaved, floating leaved (rooted) and free-floating morphotypes observed. The occasional stands of reeds along the channel margin may be important phytophilic fish spawning habitat.

4.2.39 The substrate was predominantly silt, sand and gravel-pebble but cobble and clay substrates were also present. The flow type was predominantly smooth. Broadly, the reach was mostly of poor suitability for rheophilic fish species. Localised higher velocity flows were observed on the outside of the bend in the vicinity of the A46 bridge, and the confluence of main river and lock channel created localised flow diversity with fish observed to be concentrated in this area.

4.2.40 The weir present will likely inhibit fish passage during most conditions, though it includes a small fish passage structure. Fish may also be able to pass through the lock channel when open. The weir was observed to provide localised flow diversity and oxygenation of water. The high flow energy and diverse area associated with the weir may support various life stages of several fish species including lithophilic spawning species.

4.2.41 Photographs and descriptions of the features recorded and the locations of these features are shown in Appendix A, A-6 (River Condition Assessment MoRPh Survey Locations) and Appendix C, Table C-5 (River walkover tables) of this report.

4.3 Ditch condition assessment (Old Trent Dyke)

4.3.1 The ditch condition assessment results are shown in Table 4-24.

Table 4-24: Ditch condition assessment results

Criteria number	Criteria description (pass)	Old Trent Dyke River Trent to A46	Old Trent Dyke A46 to Railway	Old Trent Dyke A46 culvert	Old Trent Dyke Kelham Road area	Old Trent Dyke Cullen Close
1	Water quality indicates no signs of pollution	Pass	Pass	Pass	Pass	Fail
2	Range of emergent, submerged, and free-floating vegetation	Fail	Fail	Fail	Fail	Fail
3	No signs of eutrophication	Pass	Fail	Fail	Fail	Pass
4	Marginal vegetation present	Fail	Fail	Fail	Pass	Fail
5	No physical damage	Pass	Pass	Fail	Pass	Pass
6	Sufficient water levels	Fail	Fail	Fail	Fail	Pass
7	Not heavily shaded	Pass	Pass	Fail	Fail	Pass
8	No INNS	Fail	Fail	Fail	Fail	Pass
Condition assessment score		**Poor**	**Poor**	**Poor**	**Poor**	**Poor**
Length of reach within Order Limits (m)		**800**[11]	**800**	**80**	**210**	**0**[12]

4.3.2 The five reaches of the Old Trent Dyke surveyed were all given a condition assessment score of Poor. The Old Trent Dyke Cullen

[11] May not contain water for more than 4 months of the year and therefore this length may not be considered as a ditch in Biodiversity Metric 3.1.
[12] Reach outside of the Draft Order Limits.

Close reach had the greatest number of passes for the criteria assessed; however, is outside of the Order Limits. The Old Trent Dyke A46 culvert reach had the fewest number of passes with only water quality being the only criterion which passed.

4.3.3 The Old Trent Dyke River Trent to A46 reach was dry at the time of survey and contained no wetland dependent plants. It was therefore considered likely to have been dry for a considerable period previously, and unlikely to have contained water for at least 4 of the previous 12 months. As such it may not fit the definition of a ditch as described in Biodiversity Metric 3.1 guidance (Panks et al., 2022[6]).

4.3.4 Overall, all the reaches of the Old Trent Dyke had a very limited range of emergent, submerged and floating leaved plants present. 3 of the reaches (Old Trent Dyke A46 to Railway, Old Trent Dyke A46 culvert and Old Trent Dyke Kelham Road area) were also observed to have greater than 10% filamentous algae and/or duckweed present which may indicate that these waterbodies are experiencing eutrophication. Marginal vegetation was also limited for 4 of the 5 reaches (Old Trent Dyke to A46, Old Trent Dyke A46 to Railway, Old Trent Dyke A46 culvert and Old Trent Dyke Cullen Close).

4.3.5 Two reaches (Old Trent Dyke A46 culvert and Old Trent Dyke Kelham Road area) were also impacted by shading which was above the 10% threshold. Insufficient water levels were also observed for 4 of the reaches (Old Trent Dyke to A46, Old Trent Dyke A46 to Railway, Old Trent Dyke A46 culvert and Old Trent Dyke Kelham Road area). The presence of INNS in 4 of the 5 reaches (Old Trent Dyke to A46, Old Trent Dyke A46 to Railway, Old Trent Dyke A46 culvert and Old Trent Dyke Kelham Road area) also contributed to the Poor overall condition. The reaches are shown below in Table 4-39 to Photo 4-44.

Photo 4-39: Old Trent Dyke Cullen Close

Photo 4-40: Old Trent Dyke Kelham Road Area

Photo 4-41: Old Trent Dyke Kelham Road Area

Photo 4-42: Old Trent Dyke A46 culvert

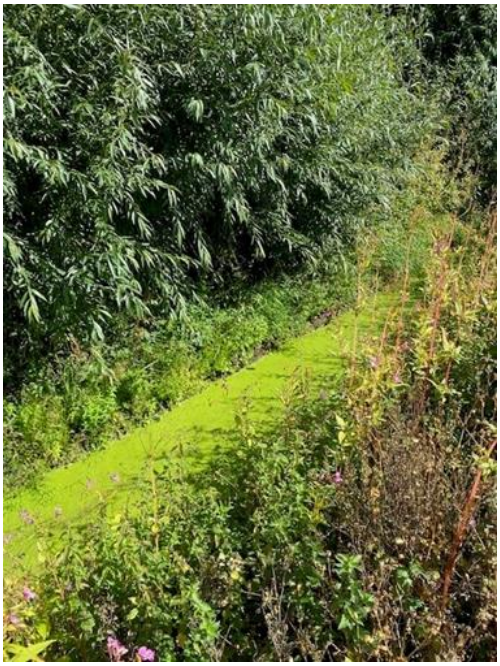


Photo 4-43: Old Trent Dyke A46 to Railway

Photo 4-44: Old Trent Dyke River Trent to A46

4.3.6 No protected or notable species were observed within the Old Trent Dyke during surveys.

4.3.7 Due to limited depth and the ability to directly observe species present, it was considered unlikely that the Old Trent Dyke supports any protected or notable aquatic or riparian plant species.

4.3.8 Due to limited macrophyte diversity, potential water quality issues, lack of depth, and substrate composition (silt-dominated), it was also considered unlikely that most reaches of the Old Trent Dyke would be able to support any protected or notable fish species. However, due to slightly greater depth, the Old Trent Dyke Cullen Close reach (see Photo 4-25) may provide sub-optimal habitat for spined loach *Cobitis taenia* (The Natural Environment and Rural Communities (NERC) S.41 Species of Principal Importance (SPI)). Surveys would be required to either confirm the presence or indicate the absence of the species in this reach.

4.3.9 The Old Trent Dyke was observed to be potentially suitable to support aquatic invertebrate species of conservation interest, in particular water beetles, as the combination of shallow water and patches of mud and dense vegetation would provide physical habitat, protection from fish predation, and varied conditions to support species with different preferences.

4.3.10 Three non-native aquatic and riparian species were identified within or adjacent to the Old Trent Dyke, as shown in Table 4-25.

Table 4-25: INNS species observed in ditches

Species	Common name	Ditch	Legislation
Impatiens glandulifera	Himalayan balsam	Old Trent Dyke to A46 Old Trent Dyke A46 to Railway Old Trent Dyke A46 culvert Old Trent Dyke Kelham Road area	UKTAG – High impact [13] Wildlife and Countryside Act 1981 Schedule 9[14] EU species of special concern[15] IAS Order 2019 Schedule 2[16]
Impatiens capensis	Orange balsam	Old Trent Dyke Kelham Road area Old Trent Dyke A46 to Railway	UKTAG – Low impact
Lemna minuta	Least duckweed	Old Trent Dyke A46 culvert	UKTAG – Unknown impact

4.3.11 Four of the five ditch reaches surveyed were found to have INNS present. This included Himalayan balsam, orange balsam *Impatiens capensis* and least duckweed *Lemna minuta*. The Old Trent Dyke Cullen Close reach did not have any INNS present at the time of survey.

[13] WFD-UKTAG listed INNS, categorised as High/Medium/Low/Unknown Impact. Taken from: WFD-UKTAG (2021). Classification of Aquatic Alien Species According to their Level of Impact. Version 8. [online] Available at: [redacted]f (Last accessed November 2023).
[14] Listed on Schedule 9 of the Wildlife & Countryside Act 1981.
[15] Invasive Non-Native Species (Amendment etc.) (EU Exit) Regulations 2019 – listed as an 'invasive alien species of union concern'.
[16] Listed on Schedule 2 of the Invasive Alien Species (Enforcement and Permitting) Order 2019.

5 Summary and conclusions

5.1 River Condition Assessments

5.1.1 The Kelham channel upstream reach and Kelham channel downstream reach were determined to be of Fairly Poor and Moderate Final Condition Class respectively. Whilst these reaches provided significant habitat diversity, they are also modified in a number of ways such as the presence of structures, which act to suppress overall condition.

5.1.2 The River Trent upstream Newark reach was also assessed as being in Moderate condition, being relatively homogenous and influenced by bank reshaping and possibly flow impoundment.

5.1.3 Both the River Trent A46 west and River Trent A46 east reaches were determined to be in Fairly Poor condition. These reaches are heavily influenced by modification and surrounding urban land use.

5.1.4 Within Slough Dyke, the upstream of the 3 sub-reaches was in Moderate condition, whilst the downstream 2 sub-reaches were Fairly Poor.

5.1.5 The Fleet was assessed as having a Final Condition Class ranging from Moderate to Fairly Poor.

5.2 River habitat walkover surveys

5.2.1 The Kelham channel upstream reach contained features and areas which should be protected. These include marginal trees interacting with the channel, a mature island, and areas of high flow and morphological diversity in the vicinity of the weir and railway bridge. The weir may enable fish passage, though further improvements may be possible.

5.2.2 The Kelham downstream reach also contained areas of significant habitat diversity where disturbance would be undesirable. Such areas include large depositional features on the inside of meanders which support diverse habitat mosaics, areas of notably clean substrate, and high flow and morphological diversity in the vicinity of the A617 bridge.

5.2.3 The River Trent upstream Newark reach was observed to be very homogenous with respect to flow and morphological diversity. Though relatively abundant, bankside trees which interact with the channel are likely to be functionally important and would ideally be retained.

5.2.4 The River Trent A46 west reach is heavily influenced by modification, in particular the banks which are heavily reinforced. Bankside trees and areas of semi-natural bank profiles may be locally important and

would ideally not be disturbed. The A46 bridge itself may be providing cover for fish, therefore disturbance in this area may affect resident species.

5.2.5 The River Trent A46 east reach was also heavily modified. Within this reach, riparian and aquatic vegetation are likely to be important where present and so disturbance to these attributes should be minimised. The weir and lock are likely to inhibit fish passage, though the weir provides localised flow diversity and morphological diversity which may support a range of fish species and life stages. The weir is located in the vicinity of the A46 bridge, and disturbance in this area may affect resident fish species.

5.3 Ditch condition assessment (Old Trent Dyke)

5.3.1 Prior to surveys, the nature of the Old Trent Dyke was uncertain; however, it was determined to be most appropriately considered as a ditch, and was assessed as such for BNG calculations.

5.3.2 All 5 reaches of the Old Trent Dyke were assessed as being in Poor condition using the BNG metric calculations. This was influenced by limited water depth, limited vegetation diversity, signs of eutrophication, heavy shading, and the presence of non-native plant species.

5.3.3 No protected or notable species were observed within the Old Trent Dyke during surveys. It was considered unlikely that the Old Trent Dyke supports any protected or notable aquatic or riparian plant species.

5.3.4 The Old Trent Dyke Cullen Close reach may provide sub-optimal habitat for the spined loach, a NERC. S41 SPI.

5.3.5 The Old Trent Dyke was observed to be potentially suitable to support aquatic invertebrate species of conservation interest, in particular water beetles.

5.3.6 Non-native aquatic and riparian plant species observed comprised Himalayan balsam, orange balsam and least duckweed.

6 References

[1] Natural Environment and Rural Communities (NERC) Act 2006.

[2] Salmon and Freshwater Fisheries Act, 1975

[3] The Wildlife and Countryside Act 1981 (as amended).

[4] Invasive Alien Species (Enforcement & Permitting) Order, 2019

[5] Nottingham Biodiversity Action Group (2023). [online] Available at: [redacted] (Last accessed November 2023).

[6] Panks S, White N, Newsome A, Nash M, Potter J, Heydon M, Mayhew E, Alvarez M, Russel T, Cashon C, Goddard F, Scott J S, Heaver M, Scott H S, Treweek J, Butcher B and Stone D. (2022). Biodiversity metric 3.1: Auditing and accounting for biodiversity – Technical Supplement. Natural England. [online] Available at: https://publications.naturalengland.org.uk/publication/6049804846366720 (Last accessed November 2023).

[7] Gurnell, A and Shuker, L. (2022). The MoRPh Survey. Technical Reference Manual. 2022 Version. [online]. Available at: [redacted] (Last accessed November 2023).

[8] Gurnell, A., England, J., Shuker, L., & Wharton, G. (2020a). The MoRPh Survey. Technical Reference Manual. 2020 Version. [online] Available at: [redacted] (Last accessed November 2023).

[9] Esri, 2023 Esri (2022). Esri Aerial Imagery. [online] Available at: [redacted] 9 (Last accessed November 2023).

[10] Gurnell, A., Scott, S., England J, Gurnell, D., Jeffries, R., Shuker, L., & Wharton, G. (2020b). Assessing River Condition: A multiscale Approach Designed for Operational Application in the Context of Biodiversity Net Gain. River Research and Applications. 36 (8), pp. 1559-1578.

[11] [Clarification note].

[12] [Clarification note].

[13] WFD-UKTAG listed INNS, categorised as High/Medium/Low/Unknown Impact. Taken from: WFD-UKTAG (2021). Classification of Aquatic Alien Species According to their Level of Impact. Version 8. [online] Available at: [redacted] (Last accessed November 2023).

[14] [Clarification note].

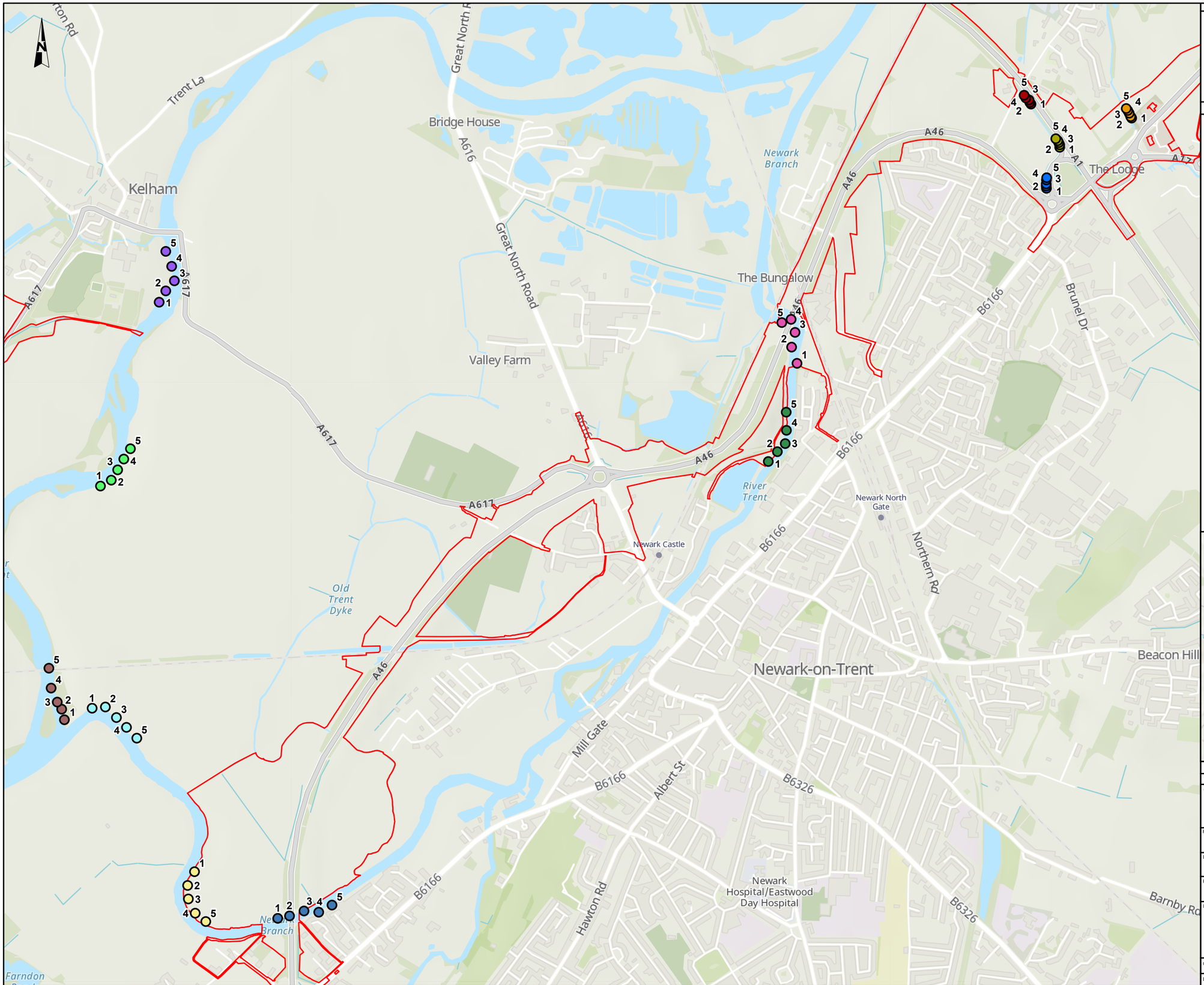
[15] [Clarification note].

[16] [Clarification note].

[17] [Clarification note].

A. Appendix : Maps

Appendix A-1: River Condition Assessment MoRPh Survey Locations



NOTES

Source
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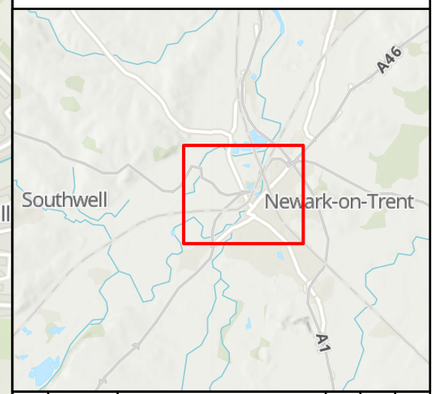
KEY TO SYMBOLS

- Order Limits

MoRPh survey sub reach location

- F1
- SD1
- SD2
- SD3
- KC1
- KC2
- KC3
- MC1
- MC2
- MC3
- MC4
- MC5



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DEVELOPMENT CONSENT ORDER NUMBER
TR010065

PROJECT TITLE
A46 NEWARK BYPASS

DRAWING TITLE
Appendix A.1
River Condition Assessments MoRPh Survey Locations

ORIGINAL SIZE A3 | SCALE 1:15,000

DRAWING NUMBER
HE PIN: HE551478 | ORIGINATOR: SKAG | VOLUME: EBD
LOCATION: CONWI_CONW | TYPE: DR | ROLE: LE | NUMBER: 00109

PROJECT REF NO. HE551478
REVISION C01

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0 500 1,000 Metres

Appendix A-2: River Habitat Walkover Survey Kelham Channel Upstream

NOTES

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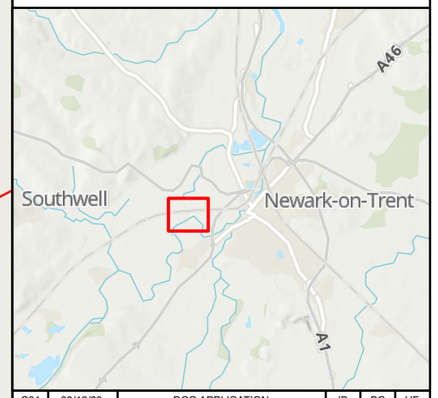
KEY TO SYMBOLS

- Order Limits
- Walkover survey point
- Walkover survey line
- Walkover survey area



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PROJECT TITLE
A46 NEWARK BYPASS

DRAWING TITLE
Appendix A.2
River Habitat Walkover Survey
Kelham Channel Upstream

ORIGINAL SIZE A3
SCALE 1:5,000

DRAWING NUMBER
HE PIN | ORIGINATOR | VOLUME
HE551478 SKAG EBD
CONWI_CONW DR LE 00034
LOCATION | TYPE | ROLE | NUMBER

PROJECT REF NO.
HE551478

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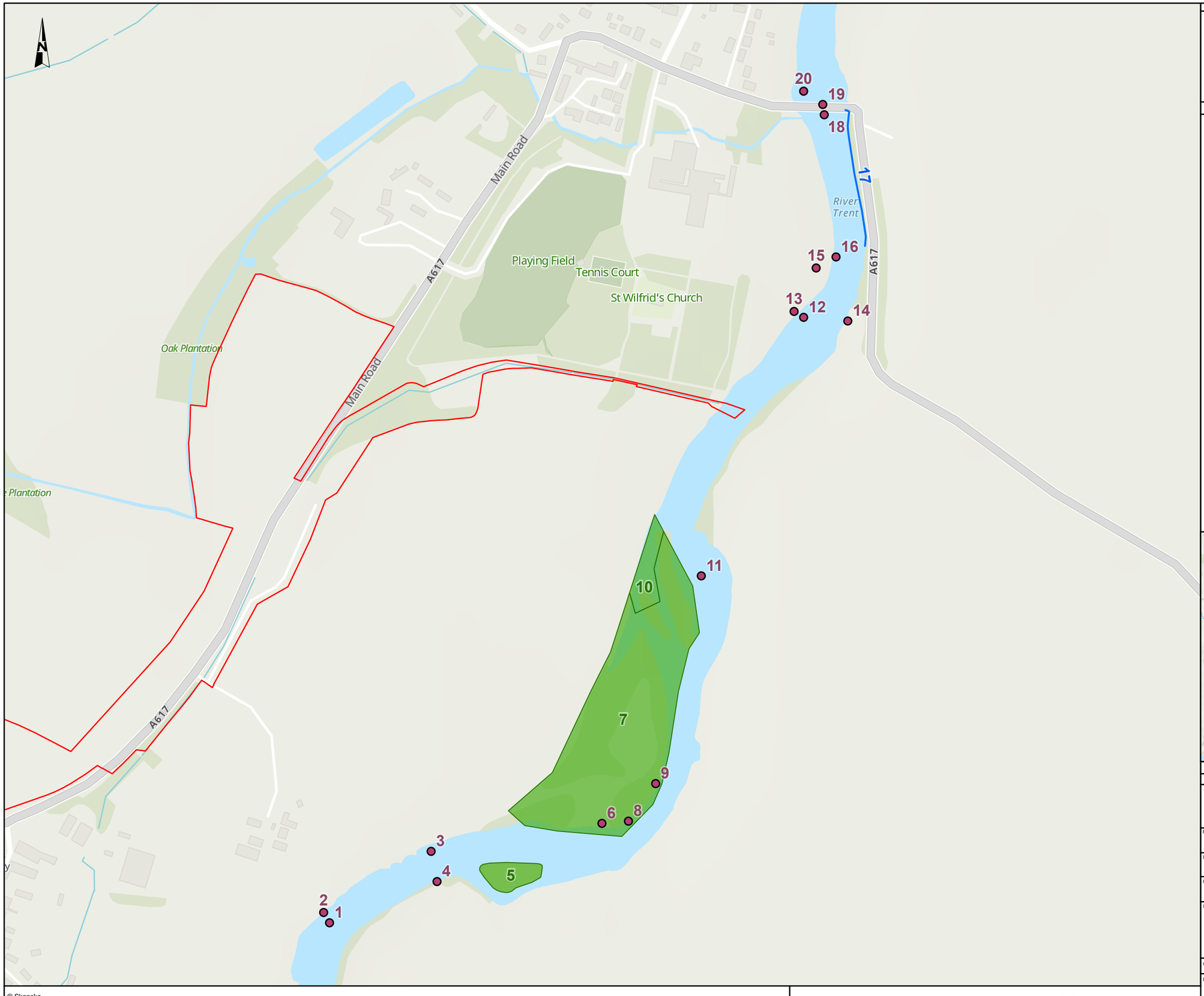
0 50 100 Metres

Appendix A-3: River Habitat Walkover Survey Kelham Channel



NOTES

Source
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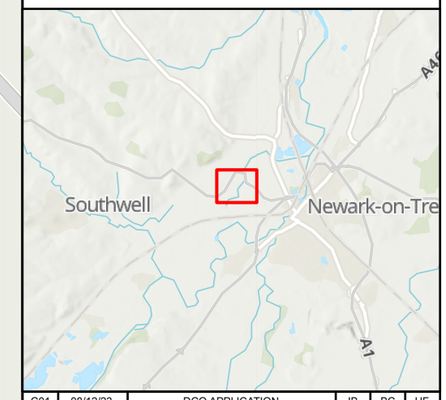
KEY TO SYMBOLS

- Order Limits
- Walkover survey point
- Walkover survey line
- Walkover survey area



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DEVELOPMENT CONSENT ORDER NUMBER
TR010065

PROJECT TITLE
A46 NEWARK BYPASS

DRAWING TITLE
Appendix A.3
River Habitat Walkover Survey
Kelham Channel Downstream

ORIGINAL SIZE A3
SCALE 1:5,000

DRAWING NUMBER
HE PIN | ORIGINATOR | VOLUME
HE551478 SKAG EBD
CONWI_CONW DR LE 00035
LOCATION | TYPE | ROLE | NUMBER

PROJECT REF NO.
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0 100 200 Metres

Downstream

Appendix A-4: River Habitat Walkover Survey River Trent Upstream Newark

NOTES

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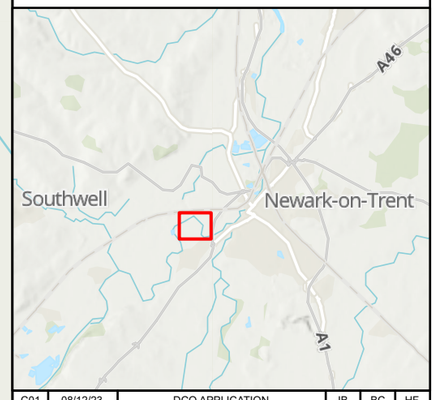
KEY TO SYMBOLS

- Order Limits
- Walkover survey point



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PROJECT TITLE
A46 NEWARK BYPASS

DRAWING TITLE
Appendix A.4
River Habitat Walkover Survey
River Trent Upstream Newark

ORIGINAL SIZE A3
SCALE 1:4,000

DRAWING NUMBER
HE PIN | ORIGINATOR | VOLUME
HE551478 SKAG EBD
LOCATION | TYPE | ROLE | NUMBER
CONWI_CONW DR LE 00110

PROJECT REF NO.
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0 100 200 Metres

Appendix A-5: River Habitat Walkover Survey River Trent A46 West

NOTES

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KEY TO SYMBOLS

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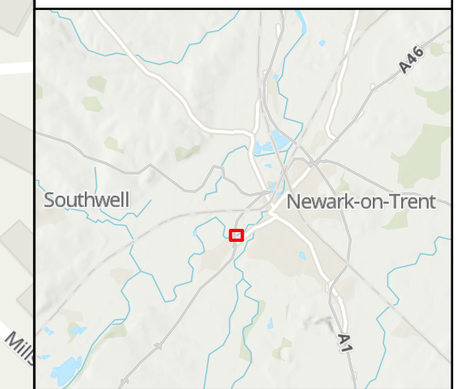

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DRAWING TITLE
Appendix A.5
River Habitat Walkover Survey
River Trent A46 West

ORIGINAL SIZE A3
SCALE 1:1,500

DRAWING NUMBER
HE PIN | ORIGINATOR | VOLUME
HE551478 SKAG EBD
CONWI_CONW DR LE 00111
LOCATION | TYPE | ROLE | NUMBER

PROJECT REF NO.
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0 50 100 Metres

Appendix A-6: River Habitat Walkover Survey River Trent A46 East

NOTES

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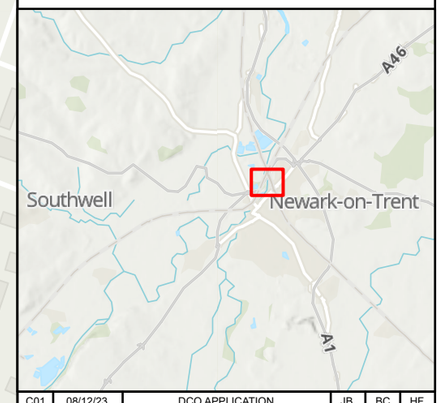

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PROJECT TITLE: A46 NEWARK BYPASS

DRAWING TITLE: Appendix A.6
River Habitat Walkover Survey
River Trent A46 East

ORIGINAL SIZE: A3

SCALE: 1:4,000

DRAWING NUMBER

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HE551478	SKAG	EBD	CONWI_CONW	DR	LE	00112

PROJECT REF NO.: HE551478

REVISION: C01

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0 100 200 Metres

Appendix A-7: Ditch Reach Locations

NOTES

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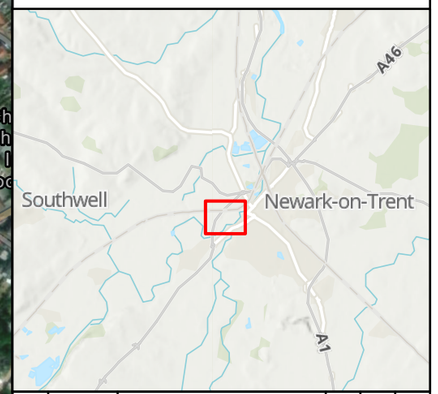
KEY TO SYMBOLS

- Order Limits

Reach name

- Old Trent Dyke - A46 culvert
- Old Trent Dyke – A46 to railway
- Old Trent Dyke – Cullen Close
- Old Trent Dyke – Kelham Road Area
- Old Trent Dyke – River Trent to A46



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DEVELOPMENT CONSENT ORDER NUMBER
TR010065

PROJECT TITLE
A46 NEWARK BYPASS

DRAWING TITLE
Appendix A.7
Ditch Reach Locations

ORIGINAL SIZE A3 | SCALE 1:5,000

DRAWING NUMBER
HE PIN | ORIGINATOR | VOLUME
HE551478 SKAG EBD
CONWI_CONW | TYPE DR | ROLE LE | NUMBER 00030
LOCATION

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0 200 400 Metres

B. Appendix: RCA River Types

B.1.0.1 Features recorded in MoRPh5 field surveys that are expected to be present (brown shading) or are typical (yellow shading) of a particular river type (A to M) when it is functioning as that type.

Appendix Table B-1: River Type and the expected confinement, thread, planform and bed material

River Type	Confinement	Threads: Single/Transitional/Multi	Planform	Coarsest bed material size class Average alluvial bed material size class
A	Confined	Single	Straight/sinuous	Bedrock
B		Single	Straight/sinuous - cascade	Boulder /Bedrock - boulder
C		Single	Straight/sinuous – step pool	Boulder /Bedrock - cobble
D		Single	Straight/sinuous - plane bed	Boulder /Bedrock - gravel
E	Confined/partly confined/ unconfined	Multi/transitional	Island braided/Wandering	Cobble - gravel
F		Single	Straight/sinuous	Cobble - gravel
G		Single	Meandering	Cobble - gravel
H		Single	Straight/sinuous	Gravel - sand
I		Single	Meandering	Gravel - sand
J		Multi	Anabranching	Gravel - sand
K		Single	Straight/sinuous	Fine sand - silt
L		Single	Meandering	Fine sand - silt
M		Multi	Anabranching	Fine sand - silt

C. Appendix: River walkover tables

Appendix Table C-1: Features recorded in the Kelham channel upstream reach during the river habitat walkover survey

Feature number	Feature type	NGR(s)	Description of ecological significance	Photograph
1	Modification	SK 76963 53487 to SK 77180 53634	Weir where viewed has solid concrete sill along the top, although aerial imagery suggests it has been eroded and breached at the eastern edge. Weir slope is covered with large, vegetated blocks which may improve passability for fish. Weir likely to provide localised oxygenation of water.	

Feature number	Feature type	NGR(s)	Description of ecological significance	Photograph
2	INNS	SK 77170 53643	Huge number of bivalve shells deposited, dominated by Asian clam (*Corbicula fluminea*).	

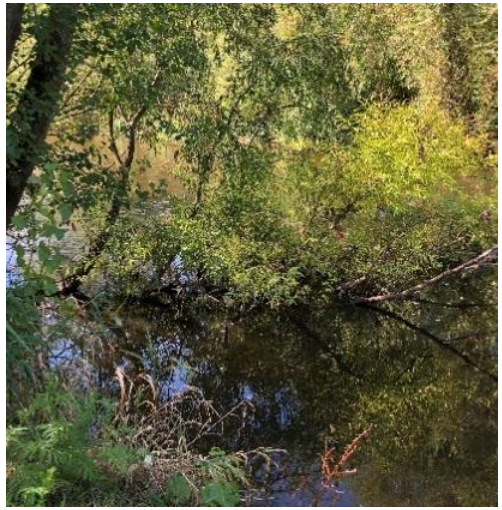
Feature number	Feature type	NGR(s)	Description of ecological significance	Photograph
3	Feature	SK 77170 53648	Several geomorphic and habitat features in the vicinity of the weir, including a marginal backwater, unvegetated side bar (comprised of gravel/pebble and sand), and a bench[17] higher up the bank.	
4	Feature	SK 77113 53572 to SK 77110 53773	Mature island, heavily colonised by trees, which may provide marginal cover for fish.	

[17] A bench is a natural channel margin feature comprised of deposited sediment which is raised clearly above the typical low flow water level but still below bank top level.

Feature number	Feature type	NGR(s)	Description of ecological significance	Photograph
5	Feature	SK 77181 53655 to SK 77175 53686	The right bank is formed of deposited river material dominated by sand, with some gravel/pebble. The bank includes a large bench and in places forms a composite (stepped) profile.	
6	Feature	SK 77109 53781	Vegetated mid-channel bar downstream of, and distinct from, larger island feature.	

Feature number	Feature type	NGR(s)	Description of ecological significance	Photograph
7	Feature	SK 77138 53830	Large area of slack flow around right bank with some associated tree cover, forming potential resting area for fish.	
8	Modification	SK 77087 53832	Rip-rap reinforcement along left bank.	

Feature number	Feature type	NGR(s)	Description of ecological significance	Photograph
9	Modification	SK 77109 53870	Railway bridge with several large in-channel supports.	
10	Feature	SK 77103 53884	Flow diversity influenced by bridge supports, creating conditions to support a variety of fish species and life stages. Likely to be a pool at this location, as deposited material was visible further downstream.	

Feature number	Feature type	NGR(s)	Description of ecological significance	Photograph
N/A	Feature	N/A	Trees providing important marginal cover were present, though extensive along the right bank. Some trees, particularly willows, provided additional complexity in the form of submerged roots.	
N/A	Feature	N/A	Right bank with semi-natural profile, varying between low and steep angles.	

Appendix Table C-2: Features recorded in the Kelham channel downstream reach during the river habitat walkover survey

Feature number	Feature type	NGR	Description of ecological significance	Photograph
1	Feature	SK 76935 54545	Woody debris within channel and clear area of gravel/pebble associated.	
2	Modification	SK 76927 54559	Failed structure in water.	

Feature number	Feature type	NGR	Description of ecological significance	Photograph
3	Modification	SK 77073 54642	Groyne in water - partially collapsed.	
4	Modification	SK 77081 54601	Steps on right bank.	

Feature number	Feature type	NGR	Description of ecological significance	Photograph
5	Feature	SK 77190 54613	Area where river activity has created mosaic of bars, backwaters, and side channels.	
6	Feature	SK 77305 54680	Discrete unvegetated gravel/pebble side bar on left bank, at margin of larger depositional feature (feature 7).	

Feature number	Feature type	NGR	Description of ecological significance	Photograph
7	Feature	SK 77353 54857	Large area where fluvial processes have created a mosaic of bars, backwaters, ponds and wetland areas (see some examples below).	
			Example of large wood and organic material deposited on large depositional feature during flooding.	

Feature number	Feature type	NGR	Description of ecological significance	Photograph
			Example of pond within the large depositional feature.	
			Example of exposed area of riverine sediment (predominantly gravel/pebble) within the large depositional feature.	

Feature number	Feature type	NGR	Description of ecological significance	Photograph
			Example of pond within the large depositional feature. Photo also shows sandy material which forms much of the larger feature.	
			Example of wetland area located within the large depositional feature.	

Feature number	Feature type	NGR	Description of ecological significance	Photograph
8	Feature	SK 77341 54683	Small, distinct side bar and backwater feature on left bank, located at edge of large depositional feature (feature 7).	
9	Feature	SK 77378 54734	Distinct area of exposed bank, revealing river deposits, including sand and gravel/pebbles, forming part of the larger depositional feature (feature 7) i. Patch may be exposed by recreational activity such as angling rather than natural processes.	

Feature number	Feature type	NGR	Description of ecological significance	Photograph
10	Feature	SK 77368 55056	Large backwater feature, likely to provide important refuge for fish.	N/A
11	Feature	SK 77440 55016	Photo looking upstream towards large in-channel bar which appears largely vegetated at time of survey, potentially indicating stabilisation.	

Feature number	Feature type	NGR	Description of ecological significance	Photograph
12	Feature	SK 77579 55367	Very wide section, but shallow and turbulent with clean gravels. Possible fish spawning area.	
13	Feature/modification	SK 77566 55375	Steps within bank and evidence of bank erosion.	

Feature number	Feature type	NGR	Description of ecological significance	Photograph
14	Modification	SK 77639 55362	Approximately 20 metres of reinforcement along right bank including concrete and sheet piling.	
15	Feature	SK 77596 55434	Large berm on left bank.	

Feature number	Feature type	NGR	Description of ecological significance	Photograph
16	Feature	SK 77623 55449	Composite (stepped) bank profile on left bank.	
17	Feature/modification	SK 77657 55469 to SK 77637 55651	Right bank rip-rap toe and other failed reinforcements present. Right bank possibly historically resectioned. Completely colonised by trees at the time of survey, with branches overhanging or trailing into the water providing important marginal cover for fish.	

Feature number	Feature type	NGR	Description of ecological significance	Photograph
18	Feature	SK 77607 55642	Flow diversity including broken standing waves evident upstream of A617 bridge.	N/A
19	Modification	SK 77605 55656	A617 bridge including significant in-channel supports.	N/A
20	Feature	SK 77579 55674	Habitat and flow diversity evident downstream of A617 bridge, including marginal deadwater area. Range of conditions may support a variety of species and life stages.	N/A

Appendix Table C-3: Features recorded in the River Trent upstream Newark reach during the river habitat walkover survey

Feature number	Feature type	NGR	Description of ecological significance	Photograph
1	Modification	SK 77187 53631	Top of weir which flows into Kelham side channel.	

Feature number	Feature type	NGR	Description of ecological significance	Photograph
2	Modification	SK 77194 53634	Left bank reinforced with sheet piling in vicinity of weir (though right bank reed-fringed).	
3	Feature	SK 77281 53703	Willows (*Salix* spp.) fairly abundant and associated with complex bank profiles, tree roots and marginal deadwater areas; potentially providing important habitat for juvenile fish.	

Feature number	Feature type	NGR	Description of ecological significance	Photograph
4	Feature	SK 77698 52899	Isolated area on inside of bend where bank profile appears very shallow and semi-natural. Other bankside/marginal features were present in the vicinity such as willow roots, leaning trees and organic accumulation (indicating flooding).	N/A

Appendix Table C-4: Features recorded in the River Trent A46 west reach during the river habitat walkover survey

Feature number	Feature type	NGR(s)	Description of ecological significance	Photograph
1	Modification	SK 78089 52858 to SK 78119 52874	Left bank wholly reinforced in vicinity of A46 bridge.	
2	Modification	SK 78039 52810 to SK 78383 52993	Right bank wholly reinforced or partially reinforced throughout majority of the reach.	N/A

Feature number	Feature type	NGR(s)	Description of ecological significance	Photograph
3	Modification	SK 78104 52866	A46 bridge, associated with reinforced banks and partial concrete bed reinforcement. Shading may provide localised cover for fish.	
4	Feature	SK 78136 52885 to SK 78274 52964	Bankside linear tree feature providing vegetation, and trailing branches in channel. May provide habitat for fish.	

Feature number	Feature type	NGR(s)	Description of ecological significance	Photograph
5	Feature	SK 78365 53023	Confluence of River Trent and Old Trent Dyke. Unsure of specific nature of connection as vegetation too dense to observe. This reach of the Old Trent Dyke was dry at the time of survey with no evidence of being wet (ie, no wetland dependent plant species observed).	

Appendix Table C-5: Features recorded in the River Trent A46 east reach during the river habitat walkover survey

Feature number	Feature type	NGR(s)	Description of ecological significance	Photograph
1	Modification	SK 80012 54674 to SK 80048 54718	Sheet piling along left bank.	
2	Feature	SK 80034 54663 to SK 80160 55042	Semi-continuous marginal trees along right bank providing potential cover for fish. Occasional stands of reeds which may be important for phytophilic fish spawning.	N/A
3	Modification	SK 80075 54708	Short, sheet-piled reach on right bank.	N/A
4	INNS	SK 80107 54788	Isolated Himalayan balsam on left bank.	N/A

Feature number	Feature type	NGR(s)	Description of ecological significance	Photograph
5	Feature/modification	SK 80118 54836 to SK 80121 55053	Left bank appears to have been poached by livestock; however marginal complexity and macrophyte diversity is relatively high.	
6	Modification	N/A	Bank along this reach is on raised embankment, disconnecting floodplain. May be possible to increase floodplain connectivity here though would require further investigation.	N/A

Feature number	Feature type	NGR(s)	Description of ecological significance	Photograph
7	Modification	SK 80123 55061 to SK 80136 55162	Sheet piling along left bank.	
8	Modification	SK 80146 55109	Minor bridge no significant impact on river.	
9	Modification	SK 80196 55264 to SK 80042 55514	Sheet piling along right bank.	N/A

Feature number	Feature type	NGR(s)	Description of ecological significance	Photograph
10	Feature	SK 80174 55302	Higher velocity flows locally present on outside of meander, possibly creating more favourable area locally for rheophilic fish.	
11		SK 80141 55316	A46 road bridge – no supports in river but present on bank top. Approximately 16 metre wide.	

Feature number	Feature type	NGR(s)	Description of ecological significance	Photograph
12	Modification	SK 80127 55310 to SK 80101 55335	Fence across water.	
13	Feature	SK 80109 55340	Confluence of main river and lock channel creating localised flow diversity with fish observed to be concentrated in this area.	

Feature number	Feature type	NGR(s)	Description of ecological significance	Photograph
14	Modification	SK 80105 55341 to SK 80040 55491	Lock channel – potentially enabling fish passage when open.	
15	Modification	SK 80076 55317	Weir, likely inhibiting fish passage during most conditions; however providing localised flow diversity and oxygenation of water.	

Feature number	Feature type	NGR(s)	Description of ecological significance	Photograph
16	Feature/modification	SK 80087 55292	Fish passage structure on weir.	
17	Feature	SK 80070 55309 to SK 80007 55490	High flow energy and diversity associated with weir. Area may support various life stages of several fish species including lithophilic spawning.	N/A
18	Modification	SK 80058 55316	Railway bridge over weir. Includes in-channel supports.	

Feature number	Feature type	NGR(s)	Description of ecological significance	Photograph
19	Modification	SK 80079 55359	Railway bridge over lock channel.	
20	Modification/ feature	SK 80042 55514	Downstream extent of walkover reaches on right bank facing downstream. With a greater distance from the weir, the watercourse is increasingly homogenous.	