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Advisory Visit
River Doe Lea

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11/09/2023

River	River Doe Lea
Waterbody Name	Doe Lea from Source to Hawke Brook
Waterbody ID	**GB104027057290**
Management Catchment	Don and Rother
River Basin District	Humber
Current Ecological Status	Poor
U/S Grid Ref inspected	SK45862 66592 (53.194444,-1.3150000)
D/S Grid Ref inspected	SK45987 71013 (53.234167,-1.3125000)
Length of river inspected	2.3km (in sections of 1.7 km and 600m)

1 Summary

- *Significant chronic and episodic pollution limits aquatic biodiversity in the investigated reaches*
- *The channel has been extensively modified – creating habitat with reduced structural variety and an associated reduction in ecological niche opportunities*
- *Surrounding land-use typically constrains opportunities to alter the course or dimensions of the channel*
- *Sections of artificially engineered riverbed limit the diversity of substrate particle sizes. This issue is compounded both by armoured banks (which prevent gravel inputs) and also apparently substantial runoff of sand due to surrounding land-use (leading sand-sized particles to dominate long sections of riverbed)*
- *Weirs noted during the visit will limit riverbed substrate transport (downstream) and the migration of aquatic species that need to travel between different habitats during their lifecycle (both upstream and downstream)*
- *Overall the Doe Lea faces substantial challenges to water and habitat quality. The input of polluting substances has become an established status quo – a situation that must be reversed before ecological recovery becomes possible*

2 Introduction

The Wild Trout Trust (WTT) were invited to visit two separate reaches of the Doe Lea in the Bolsover area by members of the Don Catchment Rivers Trust. Throughout the report, banks are designated as right (RB) and left (LB) while facing downstream. Locations are specified using Decimal Degrees format in the main report text – enabling co-ordinates to be pasted directly into common mapping platforms. The summary table at the start of this report contains both Decimal Degrees and National Grid Reference formats to enable cross-referencing between reporting systems.

3 Habitat Assessment

For this report, the Doe Lea was surveyed in two sections. The first section spanned between a downstream limit at 53.234167, -1.3125000 and an upstream limit at 53.22191, -1.312552. The second section spanned between 53.20005 -1.312421 (downstream) and 53.194444, -1.3150000 (upstream). Observations are recorded sequentially from downstream to upstream across both sections.

3.1 Section 1

A stepped weir and extensively impounded flow upstream (and also low longitudinal gradient downstream) of the structure marked the downstream limit of this visit (Fig.1).

Figure 1: Stepped weir causing both a barrier to migration and inhibition of bed material transport at 53.234167, -1.3125000.

The high proportion of sand-sized particles making up the riverbed was notable and, in the impounded reach, encroachment of emergent macrophytes (aquatic higher plants) were noted (e.g. Fig. 2).

Figure 2: Fine sediment and ponded flows favour extensive ingression of emergent plants in this section of the Doe Lea.

As well as surface runoff from the carriageway of the A632, there are likely to be significant sediment inputs from the surrounding agricultural land (e.g Fig.3).

Figure 3: Looking down on the valley bottom from a vantage point above the RB shows the potential for sediment runoff to enter the Doe Lea – particularly from the LB around the downstream limit of this visit.

Moves towards creating wetted and vegetated areas within the floodplain on the LB were observed along with recent construction of possible "runoff interception" or (somewhat steep-sided) "newt" ponds (Fig. 4).

Figure 4: With the river at the foot of the distant treeline, these plastic-lined ponds and (beyond) floodplain vegetation re-establishment may offer a degree of sediment interception. Note the uniformly steep, smooth sides of the ponds are likely to limit their habitat value.

The reach shown in Figs.1-4 has also, reportedly, been subject to petro-chemical pollution from a nearby industrial source and is likely to suffer from nutrient enrichment from surrounding land-use (as well as sewage outfall inputs). Entering the channel in the area where the A632 crosses the Doe Lea revealed ecological consequences of both soluble and particulate pollution inputs (e.g. Figs.5-7).

Figure 5: Extensive growth of filamentous algae and pond weed within the channel indicate significant nutrient enrichment (indicating a probable increase in biochemical oxygen demand and associated depression of dissolved oxygen levels).

Figure 6: Sand and silk weed choked riverbed – indicating degraded habitat and poor water quality.

Figure 7: Sewage fungus is a colloquial name for the pale, gelatinous bacterial colonies visible (with difficulty) above the weed and sandy substrate here. These colonies thrive in response to excessive elevations in nutrient levels and strip the water of dissolved oxygen.

The channel is both straightened and rock-armoured in this reach – further limiting the potential for diverse habitat structures to arise (Fig.8). In rivers with a higher proportion of natural processes governing their formation, a much wider range of substrate particle sizes are found – along with a greater variation in cross-sectional depth and flow-velocity. That physical complexity provides far more opportunities for a diverse range of species to co-exist (whereas the Doe Lea lacks adequate structural variety).

Figure 8: Although flanked by vegetation in this particular reach - the straight "box-shaped" armoured channel generally provides poor habitat.

A combination of armouring the banks and changing the course of the river will limit the variety of substrate entering the stream. By cutting the straightened channel more deeply into the landscape, the river has been separated from its floodplain over a much greater proportion of its length. As a result, some of the natural capacity of a river to lower its nutrient load (by depositing nutrient-enriched silt on the floodplain during spate events) is also constrained.

Despite the multiple, compounding impacts on both habitat and water quality, some examples of valuable habitat were noted (e.g. Fig. 9).

Figure 9: Natural dead-fall of riparian trees creates much-needed structural complexity in river channels.

However, it will not be possible to offset all of the previously mentioned negative impacts by simply allowing (or even deliberately increasing) this type of stable woody material within the channel.

Restoration of diverse habitat is constrained by the extent of previous channel modifications. Through an apparent combination of increased cross-sectional area of the channel and realignment, to create reduced longitudinal gradient, flow velocities are much reduced. The habitat within the channel commonly resembles a linear pond (e.g. Figs.10-12).

Figure 10: Under normal discharge levels, water is almost static in many reaches observed in Section 1 of the Doe Lea considered in this report.

Figure 11: Emergent vegetation dominates the channel in the slowest flowing areas.

Figure 12: Further example of an extensively straightened, incised channel with ponded flow.

A major obstacle to improving the habitat is the land-use that was enabled by realigning the channel. Returning the channel to a more natural, meandering planform through the land won by altering the course of the river is not feasible currently.

It may be possible to achieve a degree of habitat diversification in some locations by raising bed levels with imported cobble and gravel substrate. This would require topographical surveys to determine whether sufficient longitudinal gradient is available at specific locations. Without the gradient (coupled with reducing cross-sectional channel area) to support silt-dispersing flows at normal discharge levels, imported substrate would quickly become blanketed with fine sediment. However, indications that this may be possible were noted adjacent to Carr Vale Nature Reserve (e.g. Figs. 13-15).

Figure 13: Though dominated by sandy substrate, the pinched flow caused by the tree has created some diversity in flow depth and velocity.

Figure 14: A section where, if sufficient gradient is available, bed-raising may create a more diverse riffle/pool sequence. It is worth investigating potential for removing any downstream structures that may be impounding water in this reach.

Figure 15: A plentiful supply of large woody material would help stabilise imported substrate in structurally diverse habitat features.

If sufficient available gradient cannot be confirmed, importing bed material is likely to exacerbate the existing impoundment. Other significant considerations include:

- Hydraulic modelling to ensure sufficient retention of imported substrate over time (i.e. shear velocities vs particle sizes)
- Hydrological modelling to ensure no additional risk of flooding compared to current situation (alongside investigating potential

mitigation measures that may increase the amount of flood protection to infrastructure and property)

- Allowing for future “seeding” of substrate to make up for a lack of natural inputs
- Creating suitable access for delivery and installation of substrate
- Assessing financial and opportunity costs against likely ecological improvement – alongside the need for unpolluted water before significant biodiversity gains can be realised

In an ideal situation, far more natural processes could be reintroduced into the Doe Lea. Under such a scenario, the watercourse would meander naturally through a floodplain of alluvial deposits - with the freedom to gradually change course over time. As a result, fresh inputs of substrate across a range of particle sizes would be periodically introduced. Similarly, the presence of riparian woodland would provide episodic inputs of large woody material as well as subsidies of leaf material and invertebrates to the aquatic food web. Extensive lateral connectivity of the main river channel to surrounding flood plain would provide mitigation for both downstream flood risk and in-stream nutrient enrichment. Longitudinal connectivity would be sufficient to support natural downstream transport of sediment as well as resilient metapopulations of species that move between different habitats and areas to complete their lifecycles. Finally, anthropogenic inputs of pollution would be eliminated or reduced to negligible levels and frequencies.

The constrained nature of the current river course imposed by surrounding land-use makes the above ideal extremely challenging to achieve. Similarly, the tackling of severe water quality degradation is likely to be a long-term and expensive process. In a situation where water quality could be reliably improved, it may be viable to assess the costs and benefits of substrate introduction. However, it would be important for the Don Catchment Rivers Trust to consider that against other opportunities within their geographic area of interest.

3.2 Section 2

Moving upstream to consider the lower limit of section 2 at 53.20005 -1.312421 revealed a narrower channel that was markedly more incised below the bank-top level of the surrounding floodplain (e.g. Fig. 16). Densely vegetated on both sides, the watercourse appears to be of a smaller volumetric discharge – while at the same time supporting higher average velocities at normal flow levels. While the watercourse is, again, apparently highly modified; evidence of a somewhat more geomorphologically active channel was noted. For instance, the scour pool and cobble bar (Fig.17) observed a short distance up from the lower limit.

Figure 16: Steeply incised but well vegetated banks. Note also the ochre (iron oxide) precipitation commonly associated with coal measures

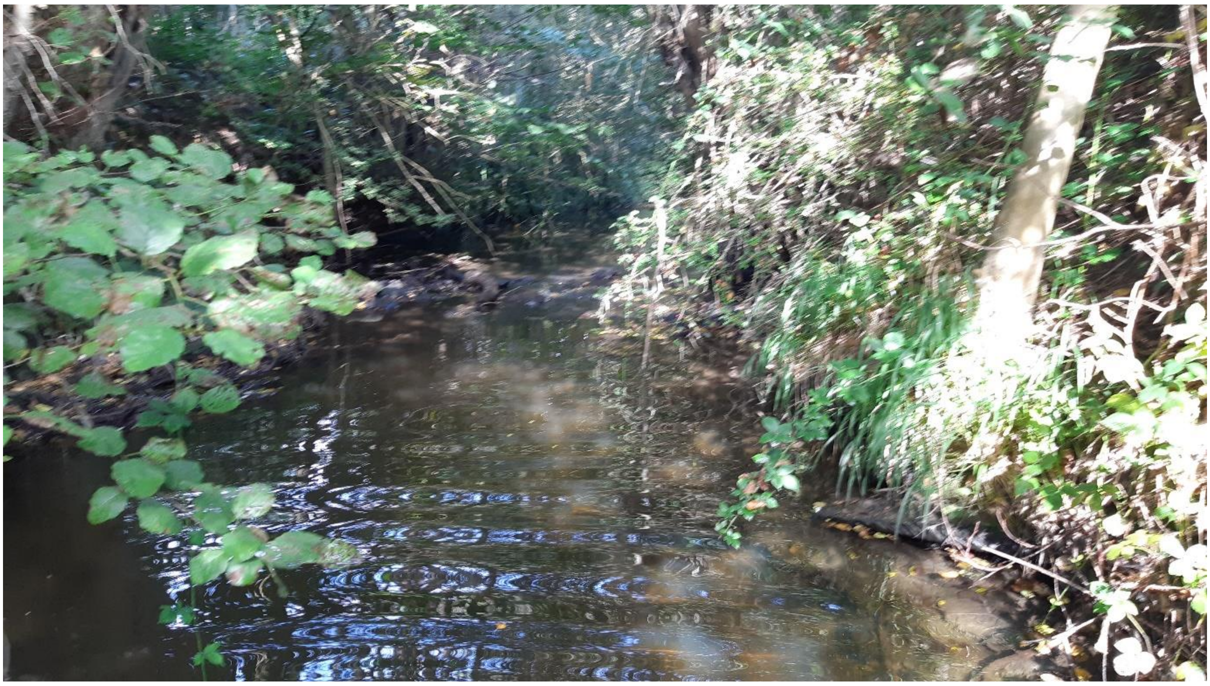

Figure 17: A scour pool approximately a meter deep under normal flow conditions was associated with a cobble and boulder feature formed from deposited material arising from scoured substrate.

Although relatively sparse, some deposits of gravel-sized particles were noted within Section 2 (Fig.18). These consisted of shale/coal measure strata material and provide a contrast to the substrate observed in Section 1 - which was dominated by sand and fine silt laying over a largely artificial bed. However, it is important to recognise that this section of channel is also likely to have been significantly straightened and revetted in the past.

Figure 18: Gravel sized shale deposits - along with ochreous discharge and eroded brickwork.

Further upstream, towards the A617, a low weir was noted which seemed to have been consolidated with slag or similar industrial by-product material. It was not simple to distinguish its construction from a natural shelf in the bedrock. Consequently, it is possible that some artificial construction had been added to an existing bedrock feature (Fig.19).

Figure 19: Low weir (foreground) and small bounder-sized substrate (background) which may have originated from engineered channel structures.

Just upstream of this weir a significant accumulation of woody debris had formed (Fig. 20). However, the conveyance capacity of the channel doesn't seem to be restricted below the hydraulic limit already set by the A617 culverting at 53.194444, -1.3150000 (Fig.21).

Figure 20: Woody debris – mixed with bins, bike and plastic debris. In spite of the size of this structure, multiple flow paths through and beneath the lodged material are present and it is not expected to pose a flood risk to surrounding land.

Figure 21: Twin pipe culvert running beneath the A617 at the top of Section 2 and setting the hydraulic limit for the downstream reach.

In comparison to Section 1, the structural diversity of Section 2 was perhaps slightly greater. There were fewer signs of nutrient enrichment in the Section 2 reach. However, more rigorous investigations of water quality would be needed to make a valid comparison. The presence of ochre indicates that there may be impacts from groundwater upwelling from coal measures. Historic straightening, along with the associated marked incision of the channel well below the level of the floodplain, negatively impact both habitat quality and lateral connectivity.

The greatest potential for ecological improvement in Section 2 appears to lie in the creation of a nature-like meandering channel. Reprofiling the banks to promote better connectivity with the surrounding floodplain would be important to maximise the benefits of any scheme. In an ideal scenario, the watercourse could be put back into its paleochannel and have a woodland buffer created around it. However, this would depend on the potential to locate and re-establish that previous channel – which may well be unfeasible.

For either a constructed nature-like channel or paleo-channel re-establishment there are obvious challenges to overcome. These include accommodating the adjacent footpath, existing land-use and appropriate flood and hydraulic modelling.

3.3 Notes on invasive plant species

In both Sections 1 and 2 visited for this report there appeared to be a relatively low density of invasive plant species such as Himalayan balsam. Maintaining a similarly low level of such species, alone, has the potential to provide significant ecological benefits to river corridors. Along with monitoring water quality (e.g. via invertebrate sampling using the Riverfly Partnership methodology), efforts to control invasive plant species may be the most cost effective "first tier" options to protect and improve the Doe Lea.

4 Recommendations

It is important to note the scale of the challenges facing any efforts to create meaningful ecological improvements at both of the sections considered in this report. Tackling water quality alone would be both a big challenge and a huge improvement. The likely expense and difficulty of creating improved habitat which reintroduces a wider array of ecological and geomorphological processes should not be underestimated. Consequently, it is important to consider any proposed measures against alternative opportunities within the Don and Rother Catchment.

Options to assess in a cost/benefit fashion could include:

- Establish invertebrate monitoring stations in an effort to characterize the scale and extent of water quality impacts
    - If possible, identify priority issues and sites for water quality problems

    - Campaign for improvements and solutions to ongoing water quality issues
- Monitor and control stands of invasive plant species such as Himalayan balsam, Giant hogweed and Japanese knotweed

In the instance where water quality has realistic prospects for improvement (or already lacks significant impacts), *it may be appropriate to assess the costs and benefits of*:

- Topographical surveys, removal of impounding structures and associated hydraulic designs for raising the riverbed in **Section 1** in the region of **Carr Vale Nature Reserve** to create riffle/pool sequences, augmented by stable, large woody material installations (subject to specific design proposals and flood risk modelling)
    - Logistical assessment for importing materials and installation of features using heavy plant machinery
    - Flood risk modelling to confirm either a net positive or neutral impact on current flood risk for any proposed design
- Assess feasibility of weir removal in **Sections 1 and 2**
- Seek to establish paleochannel location for **Section 2** – along with feasibility study for returning the Doe Lea to a portion of that channel
- In the absence of paleochannel data or feasibility – seek appropriate hydraulic design of a nature-like, meandering channel with improved floodplain connectivity in **Section 2**
    - Again, establishing either a net benefit or net neutral impact on current flood risk would be essential

Legal permissions must be sought before commencing work on site. These are not limited to landowner permissions but will also involve regulatory authorities such as the local council as well as relevant departments within the Environment Agency – and any other relevant bodies or stakeholders. Alongside permissions, risk assessment and adhering to health and safety legislation and guidance is also an essential component of any interventions or activities in and around rivers.

5 Acknowledgements

Wild Trout Trust would like to thank the Environment Agency for supporting the work in this report. The advice and recommendations in this report are based solely on the expert and impartial view of WTT's conservation team.

6 Disclaimer

This report is produced for guidance; no liability or responsibility for any loss or damage can be accepted by the Wild Trout Trust as a result of any other person, company or organisation acting, or refraining from acting upon guidance made in this report.