WILD TROUT TRUST

wildtrout.org

Advisory Visit
River Leen
“Love Your Leen”, Nottingham

Paul Gaskell (pgaskell@wildtrout.org)

30/01/2026

River	Leen
Waterbody Name	Leen from Source to Day Brook and Leen from Day Brook to Trent
Waterbody ID	**GB104028052880 and GB104028053250**
Management Catchment	Trent and Lower Erewash
River Basin District	Humber
Current Ecological Status	Moderate
U/S Grid Ref inspected	SK5434443849 (52.989207, -1.192108)
D/S Grid Ref inspected	SK5614538427 (52.940337, -1.166053)
Length of river inspected	7.99 km

1 Summary

- *Comprehensive modification of the channel to perform as a floodwater conveyance system has severely degraded the ecological potential of the River Leen between Bulwell and the River Trent*
- *There is limited structural variety available within the channel to provide a wide range of habitat niches for aquatic species which should be a priority when considering regeneration, planning, capital projects and other place-based improvements*
- *The riparian zone often consists of hard engineered surfaces or heavily mown grass bunds, further limiting river corridor biodiversity*
- *Multiple bottlenecks to flood flow exist in the form of low-capacity culverts and bridges, such that the increasing frequency of extreme wet weather events may mean the current channel design may not deliver sufficient flood risk mitigation in the future*
- *In combination with appropriately-detailed flood modelling, it may be possible to create floodwater storage areas that also improve the ecological potential of the river corridor in certain key locations*
- *Geomorphological modelling and design should be used to create meandering channel sections that incorporate a more natural array of substrate features, along with greater connectivity to localised floodplains within floodwater storage areas*
- *Establishing effective Sustainable Urban Drainage systems would also help to mitigate flooding as well as improve water quality and control the supply of fine sediment to the river*
- *Dividing walls that run down the centre of the channel in many places could be dismantled and the arising material used to create more diverse substrate and/or be utilised within rock ramp structures to help tackle barriers to migration*
- *Feasibility of weir removal should be investigated, however in many cases the surrounding infrastructure is likely to mean that rock ramp construction could be the most pragmatic mitigation measure*
- *Local custodians of the River Leen can contribute significantly to the well-being of the river by engaging in pollution monitoring, litter removal and invasive species control*
- *Comprehensive improvements to the overall ecological potential of the river will require extensive effort, a joined-up, catchment-based approach and financial investment*
- *Regeneration opportunities (e.g. previously developed land and future land use changes/planning decisions), urban greening and access improvement projects will be important tools in creating sufficient space for water, flood-management and river corridor habitat restoration to enhance urban biodiversity while delivering simultaneous, improved public space benefits*
- *Public and governmental understanding of the key concepts affecting flood risk and river corridor biodiversity will fundamentally determine the potential for successful improvements to the River Leen*

2 Introduction

The Wild Trout Trust (WTT) was invited to assess habitat quality on a length of the River Leen in Nottinghamshire by the Environment Agency as part of the "Love your Leen" project. Throughout the report, banks are designated as right (RB) and left (LB) while facing downstream. The summary table at the start of this report contains both Decimal Degrees and National Grid Reference formats for mapping locations to enable cross-referencing between reporting systems.

3 Habitat Assessment

The surveyed reach was walked over two days in a downstream direction. Observations were recorded and are reported following that same downstream, sequential progression. Due to the exceptionally consistent nature of channel modifications throughout the visited reach, the main issues encountered will be discussed before giving specific examples. This will limit the amount of repetition needed when addressing the specific examples photographed.

3.1 Issues and Implications Overview

The River Leen in Nottinghamshire has been subjected to extensive modification in response to historic flood risk. Within the 8km of watercourse captured by the survey reported here, this results in a channel that is essentially entirely artificial. The engineering interventions that have shaped this watercourse reflect a design philosophy prioritising rapid conveyance of water away from areas of human occupation and infrastructure. While understandable in the context of flood risk management aspirations, these modifications have fundamentally altered the ecological character of the river and constrained its capacity to support diverse aquatic communities. There is also likely to be a counterintuitive relationship between increased conveyance and statistical flood risk. The presence of multiple bottlenecks in the form of bridges and culverts may actually make the prioritisation of rapid conveyance incompatible with effective flood mitigation. Particular details related to bottlenecks are discussed later in this section. However, it is noted here as being particularly pertinent when considering climatic changes that include more frequent extreme rainfall events.

Extensive straightening has shortened the overall path-length of the channel, effectively increasing the gradient and flow velocity while eliminating the natural sinuosity that would otherwise create varied flow conditions and habitat types. This straightening represents more than a simple geometric change. In natural stream systems, the meandering pattern creates a mosaic of different habitat types as water accelerates around the outside of bends (creating scour pools with coarser substrates) and decelerates on the inside of bends (allowing deposition of finer materials to form point bars). The loss of this natural pattern has homogenised flow conditions and removed the physical template upon which habitat diversity typically develops.

By locking the channel in place through hard engineering, the supply of natural bed substrate that normally arises from bank erosion is cut off. In unmodified streams, lateral migration of the channel progressively erodes one bank while accumulating material on the inside of bends (and in mid-channel riffles). This process continuously introduces fresh substrate material into the channel, providing a renewable source of gravel, cobble and other bed materials that are essential for many aquatic species.

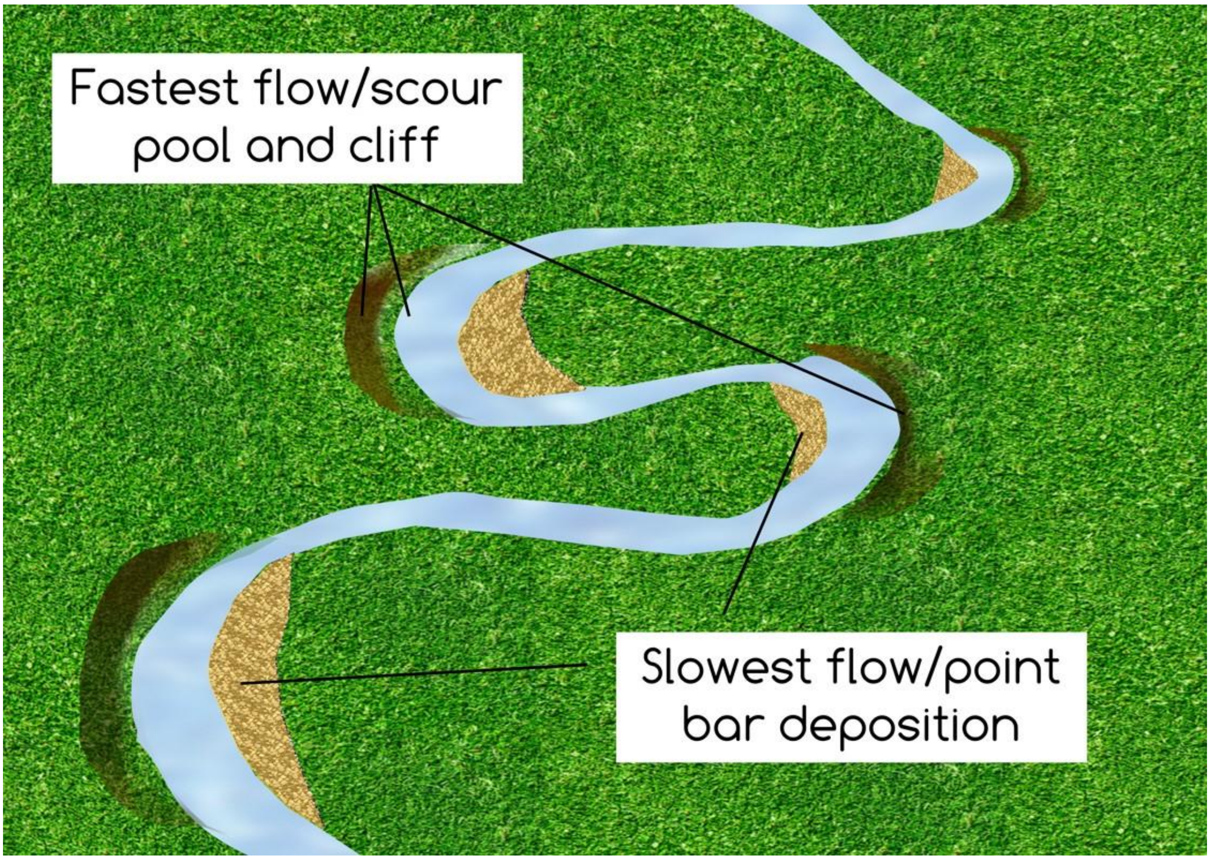

Figure 1: Erosion from the fastest-flowing areas towards the outside of bends provides a supply of substrate that forms both point bar and also mid-channel riffle depositional features.

The artificial banks of the River Leen prevent this natural substrate supply mechanism, creating a system that relies entirely on upstream sediment delivery without the replenishment that bank erosion would normally provide. It should be noted that excessive bank erosion can also be problematic in other contexts and such excess is not being advocated here. The ideal scenario would be, wherever possible, to create an appropriate balance between bank resistance and erosion along with sufficient space for the watercourse to adjust its course within a floodplain. One relatively recent example of removing stone revetments and deliberately reinstating appropriate levels of natural channel material turnover can be found at the

University of Staffordshire site incorporated into the SUNRISE project: https://youtu.be/_qCtgpFltf8?si=GMBilcIkBkfUkZAe.

To compound the reduction in structurally-varied substrate supply, there appears to be poor retention of gravel in most areas. However, constrained supply makes retention difficult to accurately characterise by visual inspection alone. The combination of increased gradient from channel straightening and the uniform cross-sectional profile means that flows with sufficient energy to move bed materials often tend to transport gravel and cobble downstream. Within confined, steep, straight channels, the hydraulic conditions necessary for deposition and retention are often absent. Opportunities for gravel and cobble to accumulate are confined to a subset of isolated locations, such as in the area around the confluence with the Day Brook. At tributary confluences, the interaction of flows from different sources can create localised areas of reduced velocity or flow convergence that allow heavier particles to settle. In areas without deposited gravel, the uniform, artificial (rock-lined) stream bed tends to predominate. That artificial bed may be buried with silt or sand in slower-flowing areas where finer materials can settle. Multiple impounding structures, particularly weirs, contribute a number of example sites where rocky substrate is buried under a layer of fine sediment.

The weirs create barriers to upstream and downstream migration of fish and these also restrict the natural redistribution of substrate that could, otherwise, help to diversify habitat structure. Weirs function as steps in the longitudinal profile of the channel, creating discontinuities in the natural gradient. Upstream of each weir, flow velocities decrease as water backs up against the structure, leading to deposition of sediment belonging to all particle-size fractions from fine silt up to chunks of stonework. This clearly impedes the natural downstream movement of substrate during high flows. In the absence of weirs, substrate would be redistributed to areas of more dynamic flow conditions. That continual redistribution tends to create much more varied habitat features that consist of a wider variety of particle-sizes. Such physical diversity provides the basis for greater biological diversity through the provision of a wider range of available ecological niches.

Due to the vertical offset created by impoundments, flows accelerate over weirs and may scour the bed to create a plunge pool downstream of the structure. While this might seem to create habitat diversity, the abrupt nature of these transitions and the barrier effect they impose on fish movement severely constrains the ecological functionality of the system. There can also be a limit to the depth of such scour pools where the bed is artificially armoured.

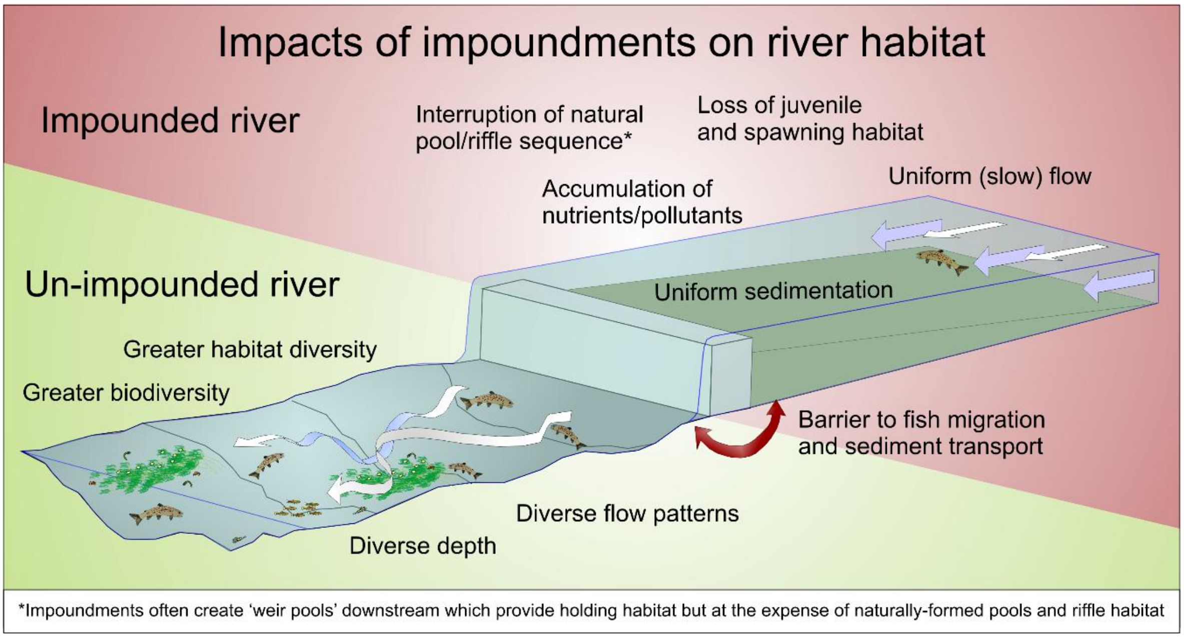

Figure 2: A graphical summary of some impacts of weirs on rivers. The depth of any weir-pool will be limited to the level at which the bed is armoured (unless that armouring surface eventually breaks down).

Furthermore, fish attempting to migrate upstream for spawning or to access different habitat types must navigate these artificial obstacles, and many species (particularly smaller individuals or those with limited jumping ability) may be unable to pass. The barriers also prevent the free downstream movement of fish which is equally important for juvenile and adult fish seeking the different habitat required to complete their lifecycles.

Overall, retaining and redistributing structurally-varied substrate appears to be constrained on the Leen by the uniformity in channel width, lack of meanders and an apparent complete lack of in-channel large woody material. The situation is, of course, compounded by the lack of supply of naturally-arising substrate resulting from armoured banks. Additionally, the supply of sand and silt is likely to be elevated due to urban, hard-surface runoff routed to the river by the drainage system.

As part of the design of the flood-protection scheme, the river is cut off from its floodplain and is deliberately constructed to function more as a drainage conduit than a stream ecosystem. Natural floodplains serve multiple ecological functions, providing lateral habitat connectivity, allowing nutrient and organic matter exchange between the channel and adjacent wetland areas, and creating refugia for aquatic organisms during high flow events. The disconnection of the River Leen from its floodplain eliminates these functions and reinforces the character of the system as a conveyance channel rather than a living ecosystem. This reframing presents an excellent opportunity challenge the way people look at the Leen, in ways that allow us to think differently about land use and to seek solutions through:

- Better integration of the river within existing green spaces, green ways and areas where there is larger channel capacity;
- Forward planning and integration of the river within regeneration sites e.g. areas of previously developed land
- Re-thinking existing hard engineered spaces like car parks alongside plans for urban greening and improving non-car access

In areas where flood walls are set back from the wetted perimeter of the channel, a mowing regime currently excludes most vegetation apart from closely-cropped grass. This is reported to maintain predictable conveyance within these sections by preventing the establishment of vegetation that might increase hydraulic roughness and reduce flow capacity.

However, the enlarged conveyance capacity found in these areas is typically constrained by the presence of bridges that impose a much lower hydraulic limit than that implied by the available channel created by grassed areas, flood walls and a channel that is notably incised below the height of the bank at the edge of its wetted perimeter. This represents something of a paradox in the design. If bridges already constrain conveyance capacity to a level below that provided by the vegetated sections between them, then the maintenance of those vegetated sections in a closely-mowed state may be providing less flood risk benefit than assumed. There may, therefore, be opportunities to allow more diverse vegetation to develop in some sections without materially increasing flood risk. Similarly, localised increases in sinuosity and channel width (combined with stable large woody material introductions) could further enhance the potential for diverse riverine habitat to develop. A range of woody material introductions were incorporated into channel interventions across two urban sites carried out under the SUNRISE project in Stoke on Trent (e.g. https://www.wildtrout.org/wttblog/river-trent-stoke-on-trent-sunrise). Some wood introductions were used for erosion-control revetment functions that also offered greater habitat diversity compared to gabion baskets or stonework (root-plates). Other large woody material was introduced into the Trent purely for habitat structural diversification (felled tree material). Other longer-standing urban examples of large wood introductions include the River Douglas running through a small patch of woodland opposite the main hospital in Wigan (Wigan Infirmary): https://www.wildtrout.org/wttblog/wigan-trout-town-river-habitat-works-last. While any such changes would probably need careful hydraulic modelling to verify that conveyance capacity remains adequate, the targeted hydraulic roughening and better connection with the floodplain where there is space for lateral connectivity could be highly effective in relieving the flooding pressure from those numerous hydraulic bottlenecks.

For a relevant precedent, hydraulic and flood modelling of the Porter Brook in Sheffield identified culverts presenting increased flood risk. In line with these findings, the creation of Matilda Street "Pocket Park" on a deculverted section of the Porter Brook (Figs. 3 and 4) provided increased flood resilience on two fronts. Firstly, the removal of a problematic culvert "bottleneck" (Fig.3) and secondly, the creation of increased flood-water storage capacity within the stepped "amphitheatre" design of the park itself (Fig.4).

Figure 3: Culverted section of the Porter Brook at Matilda Street, Sheffield. Photographed facing downstream from road bridge. After deculverting, a portion of the car park to the left of the frame was converted into a pocket park which also provided additional floodwater storage.

Figure 4: Facing upstream from within the previously-culverted channel and the pocket park. The black gantry attached to the white brick wall on the left (background) is visible in Fig.3 as the red gantry to the right of the frame in that image. In spate conditions, the river now spills over into the stepped amphitheatre.

It is also typical that, at each bridge or culvert on the River Leen, there is a central, vertical wall running lengthways along the channel (e.g. Fig. 5). Its purpose appears to be to allow one side or other of the channel to be shut off by dropping boards into vertical slots. This would enable repairs and maintenance to be carried out on both sides of the channel by blocking off the water from each side in turn.

Figure 5: Central dividing wall for channel maintenance on the River Leen.

While this design feature has clear operational benefits for asset management, it creates an additional barrier within the channel and further fragments habitat. These central walls effectively create two parallel channels at each bridge or culvert location, consolidating the uniform, "box-like" channel characteristics in both. The Environment Agency have confirmed that these central walls are redundant structures and are not currently used for maintenance.

Environment Agency fishery surveys indicate the presence of trout within the system, though in relatively low numbers. The persistence of trout in what are clearly challenging habitat conditions suggests some potential for ecological recovery. With that said, the low trout numbers indicate that current conditions are far from optimal for supporting healthy populations. Trout require clean, well-oxygenated gravel beds for spawning and a diversity of flow and depth conditions to support different life stages. The limitations in substrate quality and diversity, combined with barriers to migration and the general homogenisation of habitat, probably explain the depressed population levels. In turn, this indicates a lack of habitat diversity and connectivity that is likely to impact a wide range of aquatic species.

Any efforts to improve the ecological status of the River Leen will depend heavily on funding availability, as the scale of modification and the urban context create substantial practical and financial challenges. Surrounding development as well as transport and industrial infrastructure commonly constrain the potential to re-meander the river and create better lateral connectivity. The river flows through a built-up landscape where space is at a premium and where multiple competing land uses must be accommodated. Where opportunities to pursue more ambitious restoration interventions exist, those opportunities should be pursued as a priority. Even if wholesale re-meandering is not feasible throughout the system, there may be specific locations where land availability, ownership patterns and hydraulic considerations align to allow meaningful habitat improvements.

Depending on access for heavy plant machinery and local considerations of structural stability, weirs could be removed, notched or rely on a rock-ramp installation to help ease passage of fish in both upstream and downstream directions. Complete weir removal represents the most ecologically beneficial option as it promotes bed-slope regrading and allows unimpeded movement of both organisms and sediment. However, removal may not always be feasible due to concerns about downstream erosion, impacts on adjacent infrastructure or the need to maintain specific water levels for other purposes. Notching weirs (creating a lower section that allows fish passage while maintaining most of the structure) represents a compromise solution that can improve connectivity while addressing some of these concerns. Rock-ramp fish passes, which replace vertical drops with sloped sections of large, stable rocks, can provide better passage conditions by creating a gradient that fish can navigate more easily while also introducing substrate diversity and flow variation that benefits other aquatic species.

The mid-channel maintenance walls are sufficiently redundant as to be removed, assuming that alternative arrangements for future maintenance access can be agreed. Material arising from those removals could be broken up and used to diversify substrate particle size and character, turning a problematic asset into a resource for habitat improvement. The concrete or masonry from these walls, once broken into appropriately sized pieces, could provide stable substrate in areas where gravel retention is currently poor. This approach would also have the benefit of contributing to solutions for in-channel barriers while addressing substrate limitations without the need to import material from outside the catchment.

In sections where sufficient space around the channel exists, creating a meandering channel would be beneficial as long as a nature-like variation in cross-sectional profile (incorporating features such as point bars, riffles and scour pools) could be incorporated into the design and delivery. Simply creating a sinuous planform without attention to the detailed morphology of the channel bed and banks would provide limited ecological benefit. The value of meandering lies not just in the increased path length but in the way that water interacts with the curved alignment to create the varied flow and substrate conditions that support diverse communities. In naturally-forming meandering channels, the cross-sectional profile of the stream bed varies as you travel along the channel through bends, riffles, pools and glides. Any re-meandering work should therefore seek to replicate the natural processes that create this variation rather than simply imposing a snake-like pattern on an otherwise uniform channel. Creating a meandering channel with a trapezoidal cross-section adds little to no ecological value. Furthermore, the reduced supply of cobble and gravel imposed by locking artificial banks in place may need to be offset by seeding the channel with an appropriate range of substrate particle-sizes, assuming conditions for retention of that substrate can be created. Measures to locally increase hydraulic roughness and channel cross-section would, consequently, be required to realise the benefits of substrate seeding.

Throughout the surveyed reach, the same artificial channel design has been applied with remarkable consistency. One result of such uniformity is that much of the advice that applies to one area can simply be adapted and applied to all other, similar examples. While this creates opportunities for developing standardised approaches to habitat improvement, it also highlights the scale of the challenge. The river has been transformed into a fundamentally artificial system over most or all of its length within the surveyed area, meaning that significant ecological recovery will require interventions at a similarly comprehensive scale. Isolated improvements, while valuable, may be limited in their effectiveness if the overall character of the system remains unchanged. A strategic approach that identifies priority areas for intervention while working towards a long-term vision of more systemic restoration would therefore be advisable, recognising that financial and practical constraints will probably necessitate a phased approach to improvement rather than wholesale transformation in a single project.

3.2 Photographed Examples & Observations

The following photographs and notes give specific examples of challenges and potential solutions identified. To assist orientation, a map showing the distribution of numbered image figures is attached to this report (Appendix 1). For this report, the upstream limit coincides with the downstream limit of previous advice given for the Bulwell Bogs section of the River Leen (WTT, River Leen Advisory Visit, 2022: https://www.wildtrout.org/av/river-leen-nottingham-ventura-drive-to-mill-street-recreation-grounds).

Figure 6: Upstream limit of the visit at SK54316 43872 (near Highbury Vale tram stop) straightened channel, small, submerged degrading weir.

Comments for this section, constrained on the RB by footpath, are highlighted in the original report. The removal or notching of the weir is one such intervention. Around the bend (just below the bridge used to take the image shown in Fig.4), it was suggested to explore some potential berm creation. However, during the most recent visit, the previous path of the watercourse was reported to be a series of meanders crossing what are now recreational grounds at Highbury Vale/Basford area. The old route of the river can be traced via an existing greenway path traversing from Mill Street Recreation Ground through to Mill Street/David Lane. Large willow trees are still present along this route marking the river's historic route. The meandering channel can be seen between the Highbury Vale Workhouse and Basford on the one-inch 1877 Ordnance Survey Map, sheet 126 hosted by the National Library of Scotland: https://maps.nls.uk/view/239763862.

The reasoning for this was to route the channel around housing development as part of the flood risk reduction scheme. It may be possible to explore the potential to reinstate a more meandering channel by converting some of the recreational grounds to riverside parkland. Exploring current usage and community value of the existing scenario would be helpful in gauging the relative ecological and societal value to an alternative use. Under that alternate scenario the river should be afforded far more room and with much greater (localised) connection to its floodplain and riparian woodland vegetation established within that floodplain. Potential opportunities to convert surrounding land-use and reinstate a more natural form to the river channel, closer to its former route, are rare throughout the River Leen. The constraint of railway infrastructure is shown in Fig. 7.

Figure 7: Section downstream of Mill Street Recreation Grounds constrained by railway infrastructure on the LB, there may be potential to re-route the footpath and create additional meanders with a lowered floodplain on the RB as part of a re-meandering scheme.

Figure 8: Hydraulic limit for the upstream reach imposed by the culvert beneath the rail infrastructure at SK54963 43420. Located near Vernon Road, upstream of Vernon Park.

Figure 9: Sheet piling constraining channel at SK55114 43402 between factory and lake in a small park (Vernon Park) that currently suffers from antisocial drug use.

Figure 10: Constrained channel downstream of Southwark Street and feeding into the section shown in Fig. 9.

Figure 11: Typical example of central, channel-maintenance wall, plus access ladder, between factory and Vernon Park. Section between Vernon Road and Southwark Street, Basford.

Figure 12: Vernon Park lake. The outfall from this lake is likely to contribute significant nutrient enrichment to the River Leen (including via waterfowl feeding and faecal matter). There is also likely to be an impounding structure used to divert flow through the lake from the river. There may be benefits to exploring the establishment of reedbed water treatment at the outflowing end of the lake and the associated return flow to the river. Investigating the ability to maintain lake water levels without impeding fish passage in the river would also be beneficial.

Figure 13: Illustration of straightened channel, constrained by tram/rail infrastructure along the LB at SK55237 43033. Note the slight widening of the channel, visible just above the street lighting fixture. Section part of Lincoln Street Open Space, looking upstream from Nottingham Road near Basford Tram Stop.

Figure 14: Lincoln Street Open Space. Widened area visible from Fig. 13, the confluence with the Day Brook enters under the tram lines from the LB. While care would be needed to avoid breaching the Sustainable Urban Drainage System (SUDS) ponds several metres outside the right hand edge of the frame, there may be opportunities to increase the degree of channel sinuosity and variation in width by altering and regrading the RB in this reach.

Figure 15: Lincoln Street Open Space. Indication of potential to selectively widen and re-meander the channel by cutting into and regrading the RB in the region of the confluence with the Day Brook. Additional floodwater storage could be created through such interventions.

Figure 16: Lincoln Street Open Space. Photograph of the reach close to the Day Brook confluence supplied by EA in summer conditions. This shows retention of a slightly more diverse range of substrate particles and associated submerged macrophyte growth. However, the sand-sized fraction is still very prominent here and has a tendency to smother gravel and cobble particles. Significant investment in SUDS systems to tackle fine particulate matter in surface water runoff (alongside seeding of a mix of cobble and gravel substrate) would be required to create a more ecologically-valuable substrate composition.

Figure 17: Another example of sheet piling on both RB and LB with a central maintenance channel divider at SK55342 42810. Section near St Leodegarius Church, Basford downstream of Church Street.

Figure 18: Reach following a greenway corridor downstream of bridge at Western Blvd. adjacent to railway lines at SK5533742620 where some potential for re-meandering and large woody material introduction along with reduced riparian mowing at the water’s edge would be beneficial.

Figure 19: The hydraulic capacity of this bridge near the Wilkinson Street Tram interchange at SK55390 41999 is close to that of the bank-full height of the incised channel here. Being surrounded on all sides by transport and industrial infrastructure leaves little room for alterations to the channel form.

Figure 20: Weir at SK5543041796 downstream of Wilkinson Street could, as a minimum, benefit from hydraulic roughening of the smooth apron so as to create a rock-ramp style fish passage easement and improved habitat. Upstream walls are already collapsing close to the Wilkinson Road bridge, so any head-cut erosion from weir removal would need to be incorporated into the preferred option of full weir removal.

Figure 21: Facing upstream from the weir shown in Fig.20. The wall on the LB (right of frame) is beginning to collapse. Potentially the repair and mitigation of that situation could be used to argue for a weir removal along with appropriate mitigation for head-cut erosion risks to surrounding infrastructure.

Figure 22: Detail of bank collapse upstream of weir shown in Fig.20.

Figure 23: Sharp bend that angles the River Leen around derelict site of the former Cussons soap-manufacturing plant at SK5529741640. Getting the "Love your Leen" project involved early in any discussions over regeneration of this plot of land is strongly advised. This would greatly increase the chances of being able to divert and re-meander the channel through this parcel of land. As well as ecological benefits, the inclusion of more natural features and better floodplain connectivity would also deliver floodwater storage needed to cope with climate change.

Figure 24: Apparent penstock/flow control and level gauge on outfall on the RB at SK55173 41656 as well as a submerged, low-level weir crest. Exploring the potential to remove or notch this weir is advised. The river then runs downstream through a very straight section adjacent to Bobbers Mill. The channel features grassed flood embankments on both sides and is tightly constrained by surrounding infrastructure (Figs. 25 and 26).

Figure 25: Facing upstream from Meadow Brown road (with steep-sided pond on LB; right of frame).

Figure 26: Facing downstream from Meadow Brown Road. Note the flood embankments and proximity to housing and business premises. In-channel large woody material, substrate-seeding and allowing riparian vegetation to grow would improve ecological potential here.

Figure 27: The channel adjacent to Poulter Close at SK5499641212 follows the typical design of straightened, artificial channel, flanked by grassed flood embankments (see also Figs 28 - 30).

Figure 28: More extensive vegetation growth on the LB (left of frame) is providing ecological benefits to the channel. Again, substrate-seeding, in-channel woody material and greater sinuosity in the path of the river would further improve prospects for biodiversity.

Figure 29: Far bank (LB) showing a rare example on the River Leen of riparian woodland and understory vegetation species. The low, trailing marginal vegetation will provide much-needed cover from predation and a degree of shelter from spate flows.

Figure 30: Contrasting vegetation-management between LB and RB, along with extreme proximity of the wetted channel to housing and road.

Figure 31: Constraints become even tighter in the Student Quarter of Nottingham around SK55056 40428.

Figure 32: The degree of urban development lining the edges of the channel in these reaches presents huge challenges to river habitat improvement here. Sensitivities over flood risk do need to be balanced with a realistic assessment of the impact of allowing more structurally-diverse riparian vegetation to develop.

Figure 33: Weir at SK55038 40069 downstream of Wollaton Road with a smooth surface and laminar flow that creates a significant barrier to fish migration as well as substrate transport. Roughening the surface so as to promote accumulation of substrate would offer some improvement to habitat and connectivity.

Figure 34: Central wall example at SK54933 40025 in a short, above-ground section of the Leen between Daisy Park student halls and railway line.

Figure 35: View of channel adjacent to Daisy Park student halls just as it passes over a small weir and into a culvert.

Figure 36: Elevated SuDS pond belonging to the Ingenuity Centre building (left), part of the University of Nottingham Innovation Park, adjacent to the River Leen at SK55085 39573.

Figure 37: Culverted section emerging into completely straight concrete-walled channel with central concrete dividing wall at Triumph Road, SK55025 39327.

Figure 38: Section flowing from culvert under Triumph Road to emerge in front of Triumph House.

Figure 39: Standing on entrance to culvert facing upstream towards weir at adjacent to centre for aerospace manufacturing, University of Nottingham Jubilee Campus, SK54933 39242.

Figure 40: Very short, open section at SK54927 39200 with a weir and entering a further culvert (parallel to Hill Side). Structures photographed facing downstream while standing on the downstream end of the culvert cited for Fig. 39. Note the presence of a further, similar weir at the downstream exit of this culvert below the A6200/Derby Road at SK54932 39153.

Figure 41: Emerging into area with a concrete flood wall at SK54935 39087 (LB, left of frame) that is beginning to twist and deform. Ideally, any remedial actions for the wall should include ecological improvements to the river corridor. Note the fence on the RB which creates a sense of physical segregation from river; therefore, people aren't able to enjoy and interact positively with the river. The river follows an adjacent cycle path at Hill Side. This section connects with the QMC hospital site (see section in Figure 42). This section is being considered within the River Leen Strategy with options for de-culverting and setting back the existing flood wall to create more space for river restoration, flood capacity and amenity/access improvements.

Figure 42: Just upstream of the next bridge downstream of Fig. 41 at SK55149 38644, opposite the Nottingham NHS Treatment Centre. Note a small amount of erosion on the opposite bank on the outside of the bend. The adjacent car park and degraded river corridor currently restricts the amenity value of the riverside to hospital patients and staff. Compare with Sheffield's pocket park creation at Matilda street for flood risk, public amenity and habitat improvement: https://www.wildtrout.org/wttblog/reducing-flooding-creating-urban-oasis-and-home-wild-trout

Figure 43: Emerging from Leen siphon (a structure with its own, implied flood-risk concerns) crossing under the Nottingham Beeston canal at SK55382 38600 with some slightly more structurally-diverse vegetation on the opposite bank.

Figure 44: Left bank facing upstream just above the Willow Road bridge, Lenton area at SK55468 38520.

Figure 45: Below Willow Road Bridge at SK55488 38488 photographed from the LB within a formal flood defence channel. Any flooding resulting from the canal-crossing siphon appears likely to bypass these defences.

Figure 46: Weir downstream of Lenton Lane at SK55724 38374. Note hydraulic limit imposed by bridge.

Figure 47: Facing downstream approximately 120m below Lenton Lane towards culvert. Note the significant additional floodwater capacity between the bridge upstream and culvert downstream. There is potential for re-meandering, more natural riverbed substrate introduction and in-channel large woody material here.

Figure 48: Facing downstream where the culvert cited in Fig. 47 ends at SK56001 38418. The Leen then enters another culvert 530m downstream of this point before its confluence with The River Trent at SK56647 38073, approximately an additional 270m downstream. This is the last open section of the Leen before it meets the River Trent.

4 Recommendations

It is possible that a range of interventions could help to improve habitat in and around the River Leen assessed during this Advisory Visit. Significant constraints exist and the maximal ecological and sustainable floodwater management improvements will only be possible with extensive financial and ideological buy-in from, as a minimum:

- Local council
- Regulatory body
- Community-members
- University interests
- Business stakeholders

Within any strategy to improve the River Leen, it will be important to consider wider benefits beyond biodiversity protection and enhancement. The cross-cutting effects of urban greening and regeneration that confer multiple societal as well as ecological benefits must be acknowledged and incorporated.

Recommended actions include:

- Commission or obtain existing, up-to-date flood modelling for the full extent of the River Leen

    - Identify problematic bottlenecks as well as opportunities for floodwater storage areas to mitigate the flood risk resulting from such bottlenecks
    - Confirm areas with greater floodwater capacity around the existing channel and/or with the potential for the river to be redirected into such areas – especially where such areas have existing hydraulic limits imposed by culvert or bridge structures
        - Explore feasibility of re-routing the channel through the area currently used as recreational grounds adjacent to the channel shown in Fig. 5; https://maps.app.goo.gl/Qj7AVAphFWntejEb8
        - Explore feasibility of re-routing channel through the site of the previous soap factory and the associated parcel of land behind the sheet pilings shown in Fig. 21; https://maps.app.goo.gl/Qk52eZZVvCWt78rU8
    - Significant example areas identified during this walkover with the potential for channel meandering and floodplain connection include Figs. 5, 12/13, 16, 21, 24, 39, 43, 45, 46 as well as the grassed area just downstream of the Ingenuity Centre building pond (https://maps.app.goo.gl/o2yJd5C1pi2Pu7r19)
    - Increase channel sinuosity and localised flood-plain connectivity in such areas by fundamentally re-shaping the channel and re-grading surrounding floodplain
    - Use fluvial geomorphological modelling to design channels capable of retaining a range of substrate particle-sizes from gravel to large cobbles
    - Introduce locally-appropriate substrate within re-shaped areas
    - Install large woody material in the remodelled channel sections
    - Promote the development of diverse riparian vegetation incorporating herbaceous understory species as well as larger woody species as part of pocket-park creation
- Establish a large-scale initiative to install sustainable urban drainage systems to mitigate pollution, reduce flash flooding risk and intercept fine particulate inputs including runoff originating from:
    - surrounding transport infrastructure (road and rail)
    - rooftops
    - hard-surface urban/university/residential and industrial developments
- Explore opportunities for deculverting of buried sections of the channel – and feed deculverted sections into the strategy for pocket park creation with re-meandering/channel naturalisation
- Tackle barriers to migration and degraded habitat caused by weirs by

    - First exploring if removal is compatible with maintaining surrounding infrastructure in the face of geomorphological reactions within the channel
    - Where infrastructure constraints are infeasibly expensive to mitigate, focus on construction of stable, low-gradient rock ramp structures. Rock ramps should mimic a natural stream bed and retain a wide range of substrate particle diameters from small cobbles and gravel through to large boulders
- Break up and redistribute within the channel (or utilise in rock ramps) central concrete channel dividers
    - A range of particle sizes from larger boulder-sized chunks down to coarse cobble could be created as appropriate to local need
- Wherever possible (even while awaiting future channel-reshaping project elements at a particular location) establish an unmown vegetated buffer strip adjacent to the channel
- Install local interpretation boards (and online interpretative material accessed via QR code) to explain the limitations of the existing flood scheme in both ecological and flood-risk mitigation terms
    - Include benefits of proposed (or already installed) interventions
- Support local custodians such as the Love your Leen group to carry out:
    - Regular litter removal
    - Himalayan Balsam control in unmown buffer strips
    - Outfall Safari monitoring of pollution https://catchmentbasedapproach.org/learn/outfall-safari-guide/
    - Riverfly invertebrate monitoring https://www.riverflies.org/
    - Simple UV fluorescence monitoring for optical brighteners derived from fabric detergents in sewage and drainage misconnections https://www.scci.org.uk/news/glow-in-the-dark-tampons-identify-sewage-pollution-in-rivers/
- Engaging and educating key stakeholders and decision-makers in the fundamental principles of river corridor structure and function with respect to flood risk and biodiversity is critical to achieving any of the objectives given above
    - The Love your Leen group can contribute significantly to such engagement and education

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.

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.

Appendix 1: Geographic distribution of numbered image figures taken during walkover survey