OUSE BURN

Restoration, flood retention and enhancement opportunities and examples


For

the Environment Agency

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Prepared by

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Document Revisions

No.	Details	Date
1	Draft Report	December 2014
2	Second draft	February 2015
3	Final Report	March 2015

Disclaimer

These notes are compiled on the basis of the River Restoration Centre's (RRC) expertise and a short walkover site visit. RRC seeks to provide advice and suggestions to facilitate river restoration progress, but is careful not to produce detailed design drawings. In this way the Centre limits its liability. Liability for any restoration designs should be with the consultants tasked with the detailed technical feasibility and design work which will be necessary to take forward any options identified in this document.

RRC is a national centre for information and advice and holds a dataset of river restoration and best practice management works. To inform this inventory please let us know of any progress with this project and also other projects which are carried planned in the future. Please send any information to the RRC (rrc@therrc.co.uk).

Cover images: Ouse Burn at Woolsington (left) and Brunton Bridge (right).

Contents

1. Introduction

The Ouse Burn (GB103023075780) is a tributary of the River Tyne. It has its source close to Callerton to the north-west of Newcastle and joins the Tyne in the centre of Newcastle. It is defined as a heavily modified water body, mainly due to previous flood protection measures. The overall status of the waterbody is moderate and identified as ‘at risk’. It has poor fish, macro-invertebrate and phosphate quality elements and a ‘not high’ hydromorphological quality status. The main reason for failing the Water Framework Directive (WFD) is diffuse pollution, followed by physical modification and point source pollution (TRT, unpublished report).

The river would significantly benefit from restorative measures such as sediment management, diffuse pollution mitigation, floodwater attenuation and habitat creation. This report will provide an overview of opportunities identified for seven sites along the Ouse Burn (see Overview map in section 4). These sites were chosen as they had previously been identified by the Environment Agency as degraded areas, but with opportunities for restoration.

The business justification for this scheme is to meet the WFD and to identify restoration opportunities including 10ha of habitat creation as stated in the Flood and Coastal Risk Management programme (Outcome Measure 4a and c - Hectares of water-dependent habitat created or improved; kilometres of river protected under the EU Habitats or Birds Directive).

A number of previous studies have been carried out in the area which will be cited in this report. With the exception of the Atkins and Tyne Rivers Trust (TRT) reports, they can be found at https://research.ncl.ac.uk/proactive/ouseburn/

- Atkins Ltd (2004) Ouseburn pre-feasibility study
- Wilkinson, M.E. and Quinn, F.P. (2008) Making space for water report. Newcastle University
- Ouseburn Catchment Steering Group (2009) Ouseburn Catchment Action Plan Part 1 and 2
- Quinn, P., Wilkinson, M. and Jonczyk, J. (2012) The potential to store flood flow in the rural landscape upstream of Brunton Bridge on the River Ouseburn. Newcastle University, with an ‘Appendix to EA study’
- Rennie, M. (2012) A water quality survey of the River Ouseburn. Newcastle University
- Tyne Rivers Trust (in progress) Ouse burn Waterbody: Current situation and related questions

Newcastle City Council is also currently developing an Integrated Surface Water Management Plan for the Ouse Burn, the aim of this is to pull together all the surface water issues (road, runoff, sewer discharges and new development) to help address water quality issues. Northumbria Water Limited (NWL) is managing the project and it is hoped that a draft report will be available by late March 2015.

In addition to the above, the Blue-Green Cities research consortium has identified that some of its case studies will focus on sections of the Ouse Burn (http://www.bluegreencities.ac.uk). It is therefore recommended that any actions taken forward from the suggestions made within this report are linked with activities planned within both the Tyne Rivers Trust and the Blue-Green Cities project. Both have strong links with catchment stakeholders. The Tyne Rivers Trust has regular discussion groups with stakeholders, whilst the Blue-Green Cities project has set up an action alliance to encourage the key stakeholders (e.g. city council, local environmental groups, Freemen of

Newcastle upon Tyne, Environment Agency, etc) to voice their opinions and to establish people's perceptions, in the context of habitat and natural flood management issues.

Three main issues in the catchment have been identified as:

- **Flooding** – the Ouse Burn is a flashy catchment that often flows out-of-bank in its lower urban sections where the flood risk is high. There are also some newer developments in the mid- and upper-catchment which contribute to large runoffs and more impermeable surfaces.
- **Water quality** – diffuse pollution from agriculture is one of the main reasons for the poor water quality. There are also several misconnections identified within the catchment (TRT, unpublished report) and sewer outfalls which are contributing to poor water quality with faecal contamination levels above regulatory standards recorded in some areas (Rennie 2012).
- **Habitats and river-floodplain connectivity** – the instream habitat quality and diversity are, in many sections, poor and there is very little connection between the river and its floodplain. Physical modification including straightening and over deepening has negatively impacted the hydromorphological status, which is currently failing the WFD requirements.

The *Making Space for Water Report* listed above identifies several land-use changes and new developments that have contributed towards increased runoff and flood peaks within the catchments. Hydrometric analysis in the catchment also concluded that the flow from the Kingston Park Outfall (Section 5 below) could contribute with almost 80% of the total river flow during storm events. Atkins state in their report that storage for another 80,000m^3 (8ha) of water in the upper catchment would be needed to reduce flood risk in the lower urban catchment. In '*the potential to store flood flow'* feasibility study Quinn *et al*. (2012) have identified the agricultural land around Callerton and Woolsington as the most suitable for flood water attenuation.

Poor water quality stems from a combination of diffuse and point-source pollution in the Ouse Burn catchment. The *Water quality survey of the Ouseburn* identified two major point sources of faecal pollution, a malfunctioning storm overflow outflow at Kingston Park (Section 5 on the overview below) and an unidentified source downstream of the A1. Kingston Park discharge is known to be a major contributor to poor water quality. With major development planned upstream, action needs to be taken now to prevent even worse quality issues in the future, potentially costing even more.

Whilst it is recognised that previous reports have indicated that reconfiguring the existing sewer pipe could be extremely costly, it is recommended that alternative options are considered. There could be an opportunity to block the existing pipe and divert the outfall to the storm water overflow area as indicated in the diagram below (Figure 1). This could then act as a treatment pond for the contamination before entering the watercourse. Potentially this would a significant positive impact on the water course.

Figure 1. Diversion of the Kingston Park outfall to the storm water overflow

To improve WFD status on the Ouse Burn would also require restoration of instream and riparian habitat diversity and addressing the causes of the poor hydromorphology.

2. Aims of the report

The River Restoration Centre (RRC) visited the Ouse Burn on the 2nd September 2014. Representatives from the Blue-Green Cities project were invited to ensure that there would be synergy between the options outlined here and the work of the Blue-Green Cities. People present during the site visit were:

Phil Wilson (EA)
Ulrika Åberg (RRC)
Jenny Mant (RRC)
Emily Lawson (Nottingham University and part of the Blue-Green cities project team)
Scott Arthur (Herriot Watt University and part of the Blue-Green cities project team)

The following report aims to review options for river restoration and enhancement along 8km of the Ouse Burn from Callerton to the B1318 road at City of Newcastle Golf Club. This is an evaluation of the current situation with recommendations for where improvements can be made. The report is not a technical feasibility study and will therefore not provide detailed designs. Drawings and sketches included in this report are only indicative. Hydrological modelling and topographical surveys will be needed to support process based restoration and ensure that plan-form, long- and cross-sections are supported by current flow and water levels.

The report provides comments and specific restoration advice at a number of locations identified during the site visit. It also links this advice to previous recommendations provided within other reports. This approach is aimed at ensuring that synergies between recommendations are captured; where RRC has identified additional benefits over and above previous reports these are also stated.

The report has concentrated on a combination of opportunities for natural flood retention in the upstream area, wetland creation (to filter urban, road and agricultural diffuse pollution) and instream and riparian habitat restoration.

3. Reach-scale opportunity maps

During the walkover survey seven reaches were identified where the river would benefit from improvements. These are shown on an overview map of the Ouse Burn (see heading 4 below). Other potential opportunities for restoration were discussed on site, but were not visited during the walkover survey. In particular, there is a reach at Woolsington Park (Grid ref: NZ201700) – between Section 3 and Section 4 on the overview map below – where there is a proposal to create an online pond. In general, creating online ponds is not sustainable. These features often limit longitudinal connectivity and result in sluggish, silty sections with poor habitat qualities. They are also likely to require significant silt management in the future since they act as sediment deposition zones. This would negate the benefits in terms of flood storage.

Other opportunities for natural flood management (NFM) and management of tributaries carrying runoff from the airport may exist around Woolsington Park. It is important that the current development plans in the area (see overview map below and Newcastle Proposals Map drawn by DBC 04/09/2014) take appropriate measures to prevent further deterioration of WFD elements, integrate SuDS and work with natural processes for NFM.

To the east of the City of Newcastle Golf Course, Mott MacDonald is carrying out a flood alleviation scheme which includes realigning the Ouse Burn further west into the golf course. These works are planned to start in March next year (https://www.nwl.co.uk/your-home/your-account/in-your-area/Brunton-park.aspx?). The existing channel will act as a storage channel to receive surface water flows from Brunton Park, however, no detailed design of the new channel profile or instream diversity has been seen – https://www.nwl.co.uk/_assets/documents/aerial_photo_layout.pdf. It is important that the design mimics a natural channel profile, accomodating both high and low flows, and incorporates habitat restoration measures for BAP and other species. RRC would be happy to review this and provide comments.

The upper part of the catchment, especially section 1-4 (but also 7), could play a vital role in attenuation of flood waters (up to 10.5ha of potential retention area identified) and opportunities for WFD and biodiversity. However, a new development is planned in the Callerton area (section 1). It is of outer most importance that the new development is designed with consideration to the environment, NFM and pollution prevention through e.g. Sustainable Drainage Schemes (SuDS) and rainwater harvesting features.

In the lower catchment (especially sections 5 and 6) it is essential to address pollution and water quality issues. If the water quality problems are not solved, there is little chance for any improvements in biodiversity or WFD status. One of the most urgent water quality issues that needs to be addressed is the polluted discharge from the large Kingston Park outfall (see previous section).

For each opportunity identified an assessment has been made about its WFD (biology, hydromorphology, water quality) and other (NFM and societal) benefits, as well as indicative costs. Both elements are based on expert judgement and drawn from information held at the RRC. The cost element has taken into account where e.g. flood modelling or detailed pre-project assessment will be necessary. Identifying benefits and indicative costs also help to inform the priorities for each measure listed in the table under heading 5. The codes used for these benefits and cost indications are shown below.

3.1 Potential WFD and other benefits

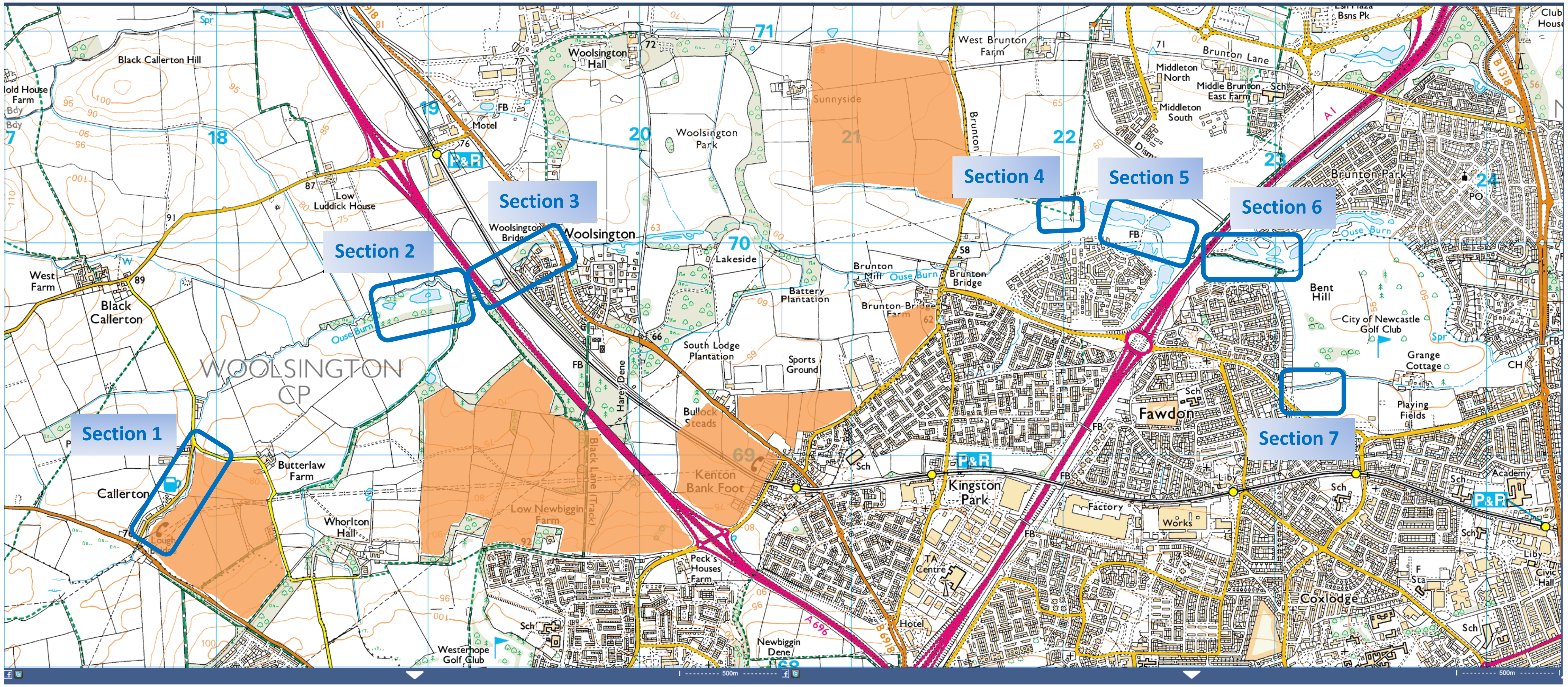
Bio = Biological quality elements
HM = Hydromorphology
WQ = Water quality elements
NFM = Natural Flood Management
SAE = Social/ Amenity/ Education

3.2 Indicative cost category

H = High >50,000
M = Medium 10,000-50,000
L = Low 5,000-10,000
S = Small <5,000

4. Ouse Burn overview map

Overview map showing location of each reach discussed in this report (blue rectangles) and allocations for new potential residential development (orange fields)



4.1 Callerton village (Section 1) - NGR: NZ176685 – NZ179690

Issues

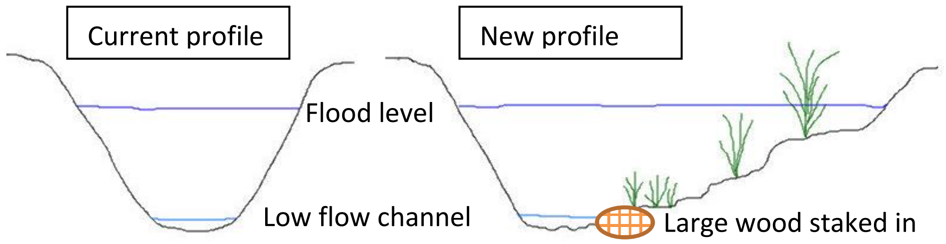
- On the Newcastle Proposals Map (drawn by DBC 04/09/2014, provided by the EA), the area shaded in orange on the aerial, is marked as 'Residential Development Allocation'.
- Channel incised and narrow with steep banks covered by rank vegetation (photos A and B). Insertion in photo A shows the same location in winter when vegetation has died back (from Appendix to EA study). Runoff from the surrounding agricultural fields is likely to cause the excessive growth of rank vegetation on the banks.
- Little instream habitat variability.
- No connectivity with the floodplain (photo C).

Opportunities

The proposal for the new development requires early discussons with the landowner, planning authority and developer to advice on WFD requirements and ensure that a large enough buffer zone is left around the river to provide space for multiple opportunities (red outline). Runoff from the planned housing development needs to drain into SuDS to prevent deterioration in water quality. Due to more impermeable surfaces discharge might increase during storm events, so rainwater harvesting features and natural retention areas need to be considered. This advice also needs to be linked to Newcastle City Council's Integrated Surface Water Management Plan (in progress).

The 'Appendix to EA study' (Number 2) suggests to install a series of debris dams backing up flood water that can then spill over into a storage feature in the field (location 1 on the aerial view). The RRC also identified a second location for a possible storage/wetland feature (location 2 on aerial view).

To improve habitat diversity for BAP and other species the river bed and banks also need to be re-profiled to resemble a more natural channel cross-section (see example in Appendix A). The new channel profile should accommodate both high and low flows with a high- and low-flow channels, as indicated in the figure below.

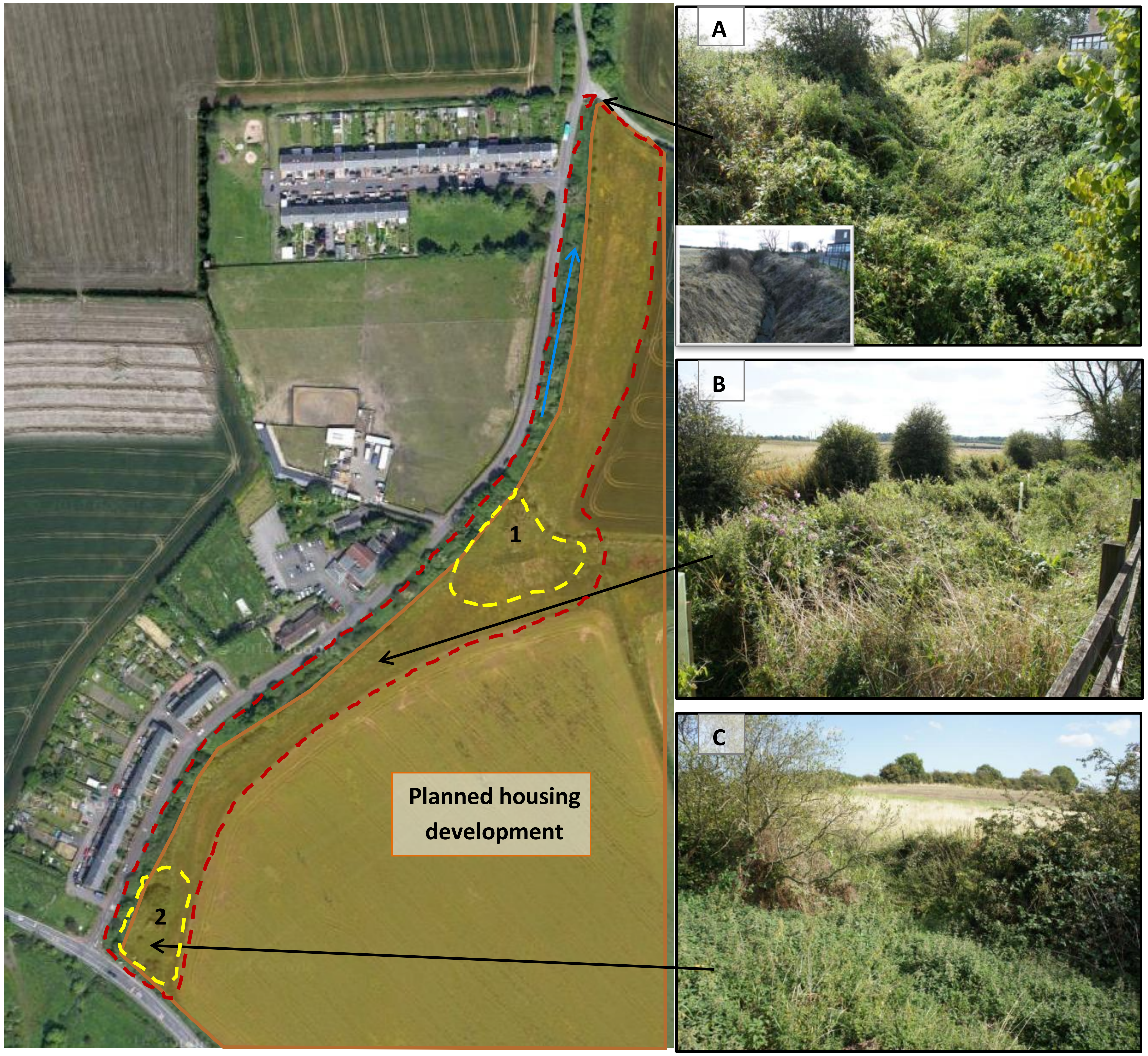


Trees along the bank, together with an extended buffer zone towards the agricultural fields/development, will reduce growth of rank vegetation. The instream design should have a slightly meandering shape with a variety of instream habitats (see example in Appendix B). It is also important to engage the local community in this work.

WFD and other benefits (cost)

- Opportunities integrated with development (cost subject to type and extent)
- Flood storage feature/SuDS – Bio, WQ, NFM (L/M)
- Channel re-profiling – NFM, Bio, HM (M)
- Buffer zone and vegetation management – Bio, SAE (S)

Section 1 – Callerton. Google ((Imagery ©2014 Bluesky, Digital Globe, Getmapping plc, Infoterrs Ltd & Bluesky, The GeoInformation Group, Landsat, Map data ©2014 Google)



4.2 Callerton fish ponds (Section 2) - NGR: NZ189697

Issues

- The drain from the agricultural fields seems to be carrying large amounts of fine sediments that contribute towards silting up the river (photo D).
- The river does not seem to be well connected with the floodplain and existing pond features (photo E).
- The small tributary is featureless with poor instream habitat quality (photo F). Might be carrying more runoff if the large area to the south is developed.

Opportunities

Utilising these ponds more effectively for flood water attenuation and adding a bund around is proposed in the 'Appendix to EA study' document (Number 3). We agree that the pond features can be better utilised to retain floodwater, but any plans will need to take account of Newcastle Airport. Instead of open water habitat, create a mosaic of small wetland areas and wet woodland that can get inundated during flood events and provide OM4 habitats for BAP species (see example in Appendix C).

- Within the marked red area create a natural floodplain storage area rather than a pond. To achieve this, the bank between the river and the pond needs to be lowered (see example in Appendix A). This design would be more natural than the one suggested in the 'Appendix to EA study' and does not require any in- or outlet pipes.
- If necessary, spoil from the banks can be used to create a bund around the outside edge of the floodplain area to protect the surrounding agricultural land.

Flow modelling and topographical survey needed to ensure an effective design.

To decrease siltation in the river, set back the outfall (photo D) and create a reedbed at the drain exit and extend buffer zone north of the river.

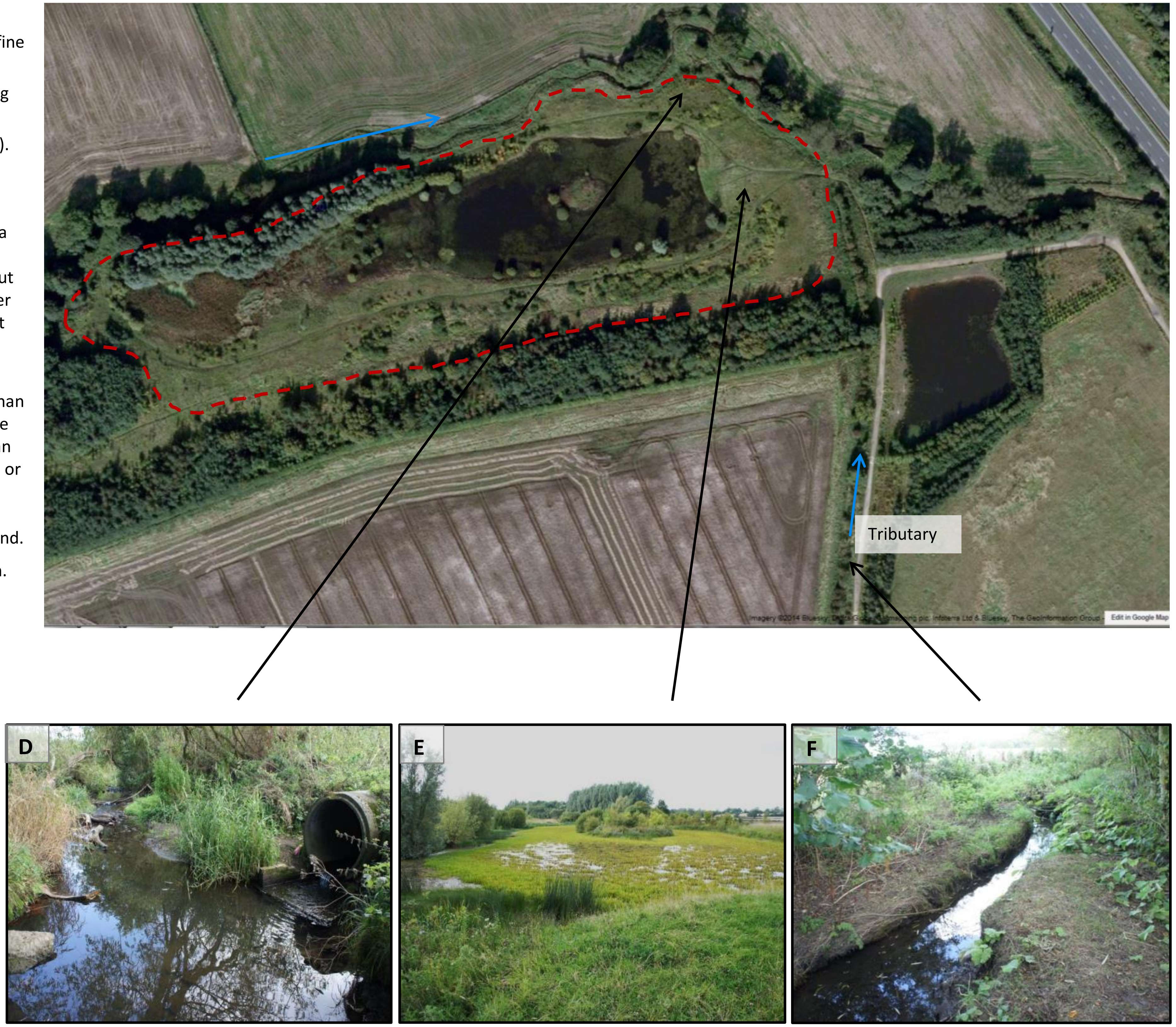
Expand the buffer zone along the tributary to make space for restoration and protect against runoff from the field (photo F). The tributary can be re-profiled to remove the vertical banks, a slightly meandering plan form created with some large wood could be installed (and firmly pinned down) to encourage flow diversity. This design could also help to slow the flow and decrease flood peaks in the main river. Slowing the flow will also be increasingly important if the large housing development upstream along the tributary proceeds. Discussions with planning authorities and developers will be essential to prevent further deterioration.

These projects should preferably be carried out in collaboration with the local community and/or the angling club that use these ponds for fishing. In conjunction with these works the eastern pond could be improved as a fishing resource.

WFD and other benefits (cost)

- Reconnecting to floodplain – Bio, HM, NFM (H)
- Reedbed at outfall – HM, WQ, Bio (S)
- Tributary – Bio, HM, NFM (L)
- Improve eastern fishing pond – SAE (L)

Section 2 – Callerton ponds west of A696. Google (Imagery ©2014 Bluesky, Digital Globe, Getmapping plc, Infoterrs Ltd & Bluesky, The GeoInformation Group, Landsat, Map data ©2014 Google)



4.3 Woolsington (Section 3) - NGR: NZ194699

Issues

- Water quality issues, suspected runoff from road (A696) entering the river.
- Outfall in Woolsington seems to be carrying silt and possibly pollutants (photo G).
- River silty with poor instream habitat quality. In low flow conditions the river is very shallow.

Opportunities

Any work carried out between the road (A696) and the rail line will require hydraulic modelling. The area could not be viewed during the walkover survey, but the road and railway bridges might form bottlenecks for flow capacity. Recommendations:

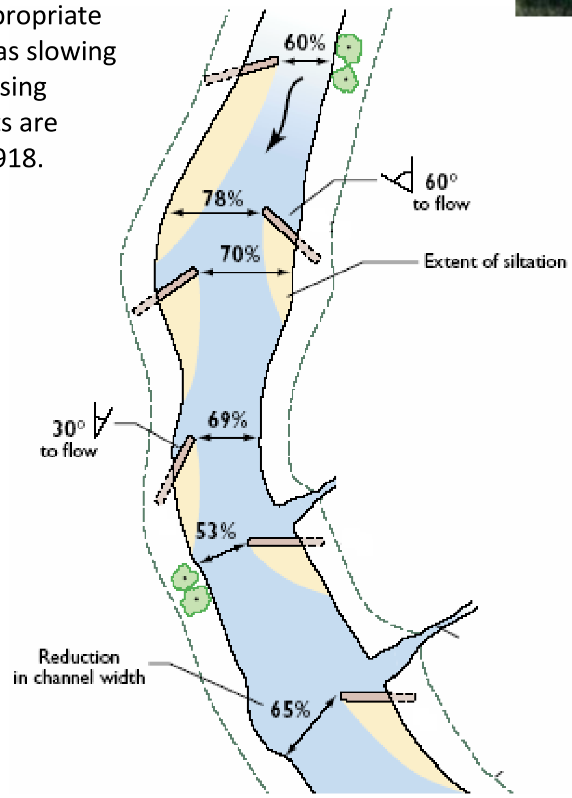
- Investigate runoff from A696 and the rail line. Possibility to drain runoff into SuDS connected with the pond feature between the road and the rail line.
- Investigate possibility to enlarge the pond between road and rail line to contribute towards increasing the total flood water storage capacity in the catchment.

These prospects might also link with opportunities for water quality issues addressed in Newcastle City Council's Integrated Surface Water Management Plan (in progress).

Set back the outfall (photo G) to the tree line and create a reedbed at the exit to mitigate against siltation and possibly pollution from surface runoff /misconnections. Any existing misconnections must also be corrected. See example in Appendix D and photo from Oregon, USA. Engage the local community with this work.

Adding wood or deflectors will increase flow and habitat diversity (see example in Appendix B). With appropriate design these features will add diversity as well as slowing the flow in high flow conditions without decreasing channel capacity. These instream improvements are suitable along the river on both sides of the B6918.

Using small low level deflectors or similar can help to trap silt and may provide area for in-channel marginal vegetation, whilst narrowing the channel in places. The figure on the right shows an example of using deflectors to trap silt and increase instream diversity. The wood is staked in at different angles to create a more natural look. Ideally gnarled wood should be used rather than straight deflectors to provide for a more aesthetic outcome. (Note: not to scale, for illustration purposes only).



WFD and other benefits (cost)

- Pond/SuDS – WQ, Bio, NFM (L/M)
- Outfall – SAE, WQ, Bio, HM (L/M)

Section 3 – Woolsington, east of A696. Google (Imagery ©2014 Bluesky, Digital Globe, Getmapping plc, Infoterrs Ltd & Bluesky, The GeoInformation Group, Landsat, Map data ©2014 Google)

4.4 Old wildlife reserve (Section 4) - NGR: NZ219701

Issues

- River disconnected from its floodplain
- Open grass area provides little habitat diversity (photo I)
- Moderate to poor instream habitat quality (photo H)
- Upstream the tributary flows along a new planned housing development and minght carry more runoff if development goes ahead

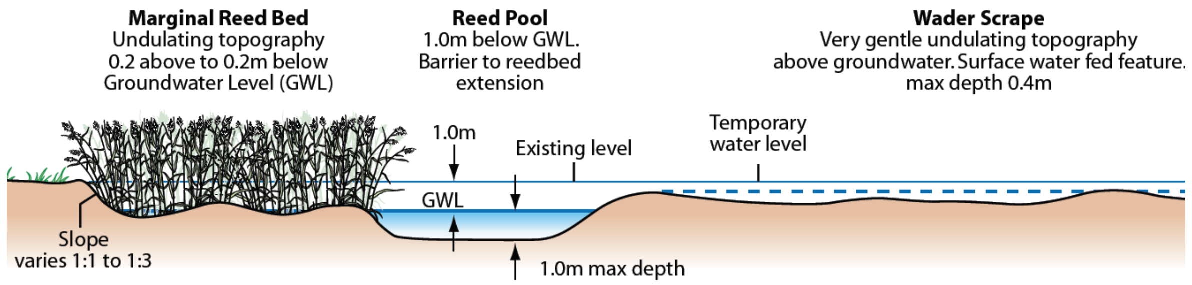
Opportunities

The green space north of Ouse Burn (red outline on the aerial view) is a de-notified nature reserve. This area provides good opportunities to re-connect the river and floodplain, create various wetland features (indicative yellow outlines) and increase flood water storage capacity in the catchment. The small tributary could also be re-meandered and designed to hold back silty runoff while concurrently provide new habitats (see example in Appendix E).

A mosaic of ponds, scrapes and other wetland features will increase diversity in the area and provide OM4 habitats for BAP species (see example in Appendix C). Scrapes and ponds should be created in naturally occurring depressions on the floodplain. To be successful and provide ecological value they are dependent on a reasonably reliable source of ground- or surface-water. The figure below gives some examples of wetland features, but a more detailed analysis of what is appropriate for the area is needed. (Note: yellow marks on the aerial view are only indicative).

To re-connect the river with its floodplain the left bank needs to be re-profiled and lowered (see example in Appendix A). Instream features could also be added, such as staked-in large wood or berms, to increase flow and habitat diversity (see example in Appendix B).

Flow and surface level modelling would be required to ensure that the floodplain reconnection and functioning will be effective.

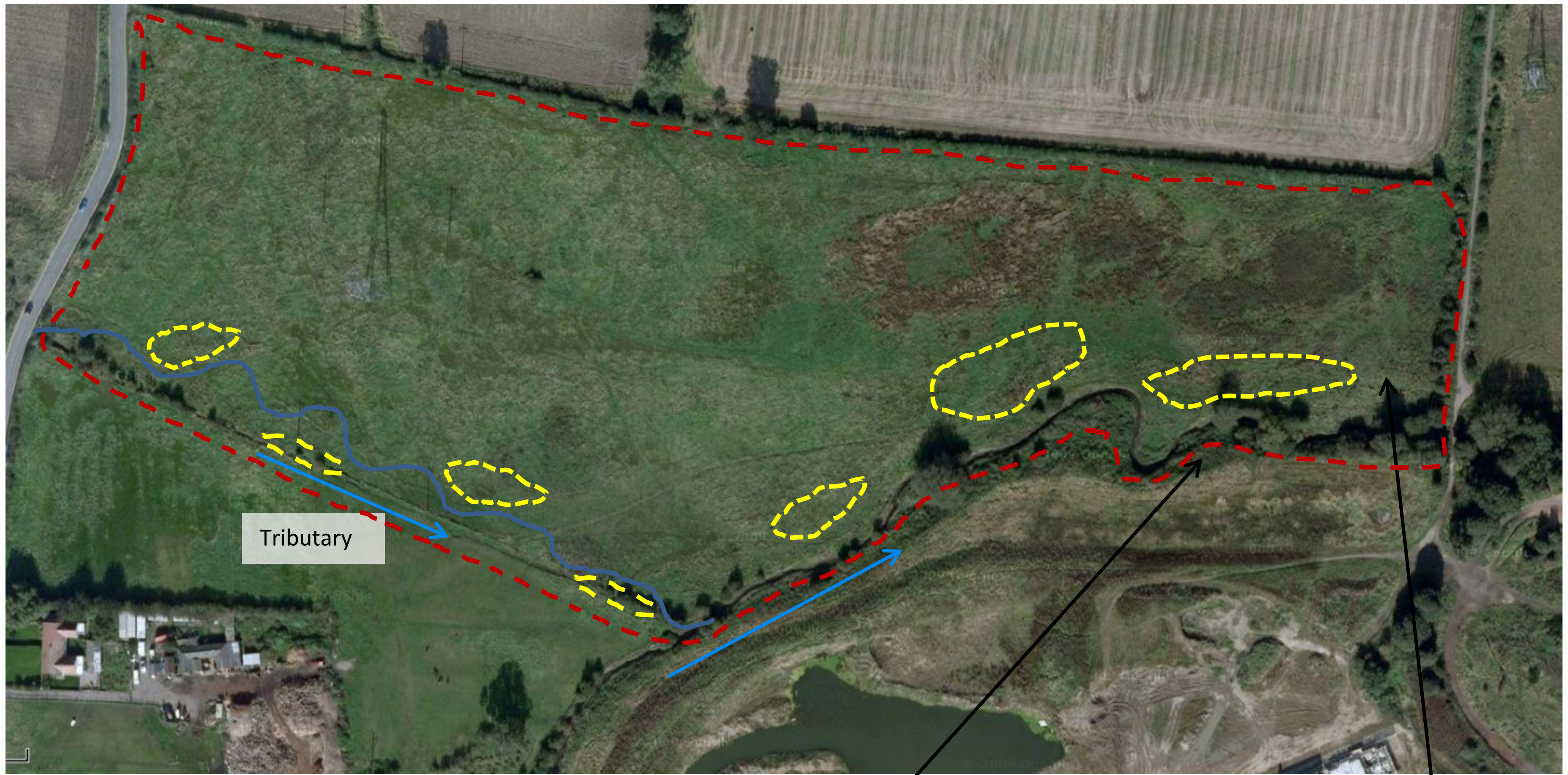


To improve habitat diversity and mitigate against potential increase in runoff from development upstream, the tributary could be remeandered across the field (along the lowest line)

WFD and other benefits (cost)

- Floodplain features – NFM, Bio, WQ (M/H)
- Instream habitat enhancement – Bio (L)

Section 4 – Old wildlife reserve (de-notified). Google (Imagery ©2014 Bluesky, Digital Globe, Getmapping plc, Infoterrs Ltd & Bluesky, The GeoInformation Group, Landsat, Map data ©2014 Google)



4.5 Kingston Park (Section 5) -

NGR: NZ220701 – NZ226699

Issues

- Evidence from other reports points out the Kingston Park Outfall (photo J) as a major contributor both to faecal pollution (Rennie 2012) and increased flood peaks (Wilkinson & Quinn 2008).
- The river in this section is very straight with steep banks and poor instream habitat quality (photo K).
- There has been a long investigation regarding the performance of the SuDS in this area (photo L). Newcastle University has concluded that they do work in accordance with the original design (Ouseburn Catchment Steering Group 2009). In 2015 the Blue-Green Cities will make a detailed study of the operational success and sustainability of these.

Opportunities

An MSC student at Newcastle University (Rennie 2012) identified that repairing the malfunctioning storm overflow at Kingston Park would be expensive, disruptive and still not fully effective as there is another major pollution source further downstream. Pollution from both is likely to be resulting from misconnections. Rennie also question the cost-benefit of mitigating against the issue by designing a large SuDS reedbed. Instead he suggests adding a finer screen to the outfall, keeping the steep banks to avoid human contact with the water and potentially put up a fence.

This approach is not ideal as it neither address the faecal pollution issue nor the excess discharge during storm events. It will also hinder improvements in WFD status. The pollution from this outfall is a major constraint to improvements in biodiversity, ecosystem services and increasing the WFD status and needs to be rectified before any other restorative measures are implemented, otherwise they will have limited benefit. This needs further investigations including dealing with misconnections and evaluating options for reconstruction; see also the suggested plan (Figure 1) in the introduction. Further impacts on the river may be identified through the Blue-Green Cities investigations and Newcastle City Council's Integrated Surface Water Management Plan.

If the faulty outflow is rectified, the banks can be re-profiled, connected to floodplain in the downstream reach and instream chanel features added to increase flow and habitat diversity (see examples in Appendix A and B).

WFD and other benefits (cost)

- Rectifying faulty outfall – WQ, FRM, Bio, HM, SAE (H*)
- Bank and instream channel works – Bio, HM, SAE (L)

*This might be very costly

Section 5 – Kingston Park. Bing Maps

4.6 East side of A1 (Section 6) - NGR: NZ226699

Issues

- Runoff from the A1 and/or housing discharge straight into the river via an outfall east of the road (photo M). The water quality is poor with high values of faecal coliforms (Rennie 2012).
- The deculverted storm water drain and constructed SuDS/wetland feature (photo N) along the A1 had a low water level and did not seem to fulfill its purpose as a habitat or filtering feature.
- Instream habitats and flow are uniform and not of good quality (photo O). There is also little river-floodplain connectivity.

Opportunities

The outfall in photo M probably drains both the development to the south and the A1. To mitigate against pollution and fine-sediment runoff the outfall should be set back and drain into a set of new SuDS (e.g. reedbeds) where the water will be filtered before discharging into the river (see example in Appendix D). Any misconnections draining into the outfall also need to be rectified.

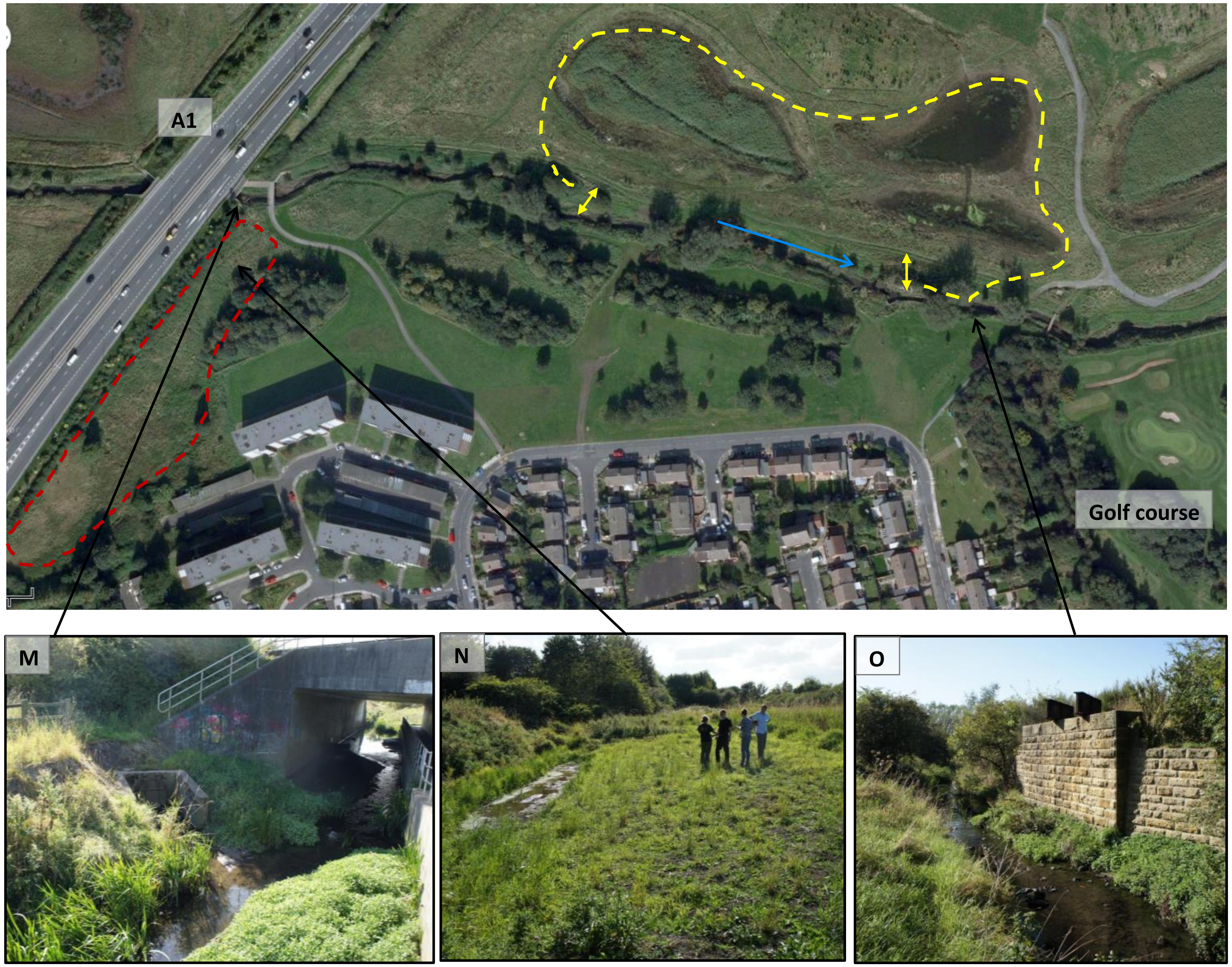
Northumberland Wildlife Trust has recently (July 2014) completed a reed shelf where a storm water drain has been deculverted. The reedbed deals with some of the runoff from the A1 (photo N). A total of 690m^2 habitat was created, but when visited in September 2014 the water level was very low and its performance may need to be monitored. Along the A1 (area marked in red) there is potential for creating a larger retention area. Temporary ponds could be achieved by lowering the area and water levels could be increased by re-directing the runoff from the development/A1 outfall. The area should be designed with wildlife and people in mind and could provide some OM4 habitats for BAP species.

Between the A1 and the golf course space seems to be available north of the river (depending on landuse and ownership) to re-connect the river with its floodplain (yellow line and arrows, for indication only) and improve instream, riparian and floodplain habitat diversity for BAP and other species (see examples in Appendix A, B and C). This stretch of river was not visited during the survey and needs to be assessed further.

WFD and other benefits (cost)

- Setting back outfall – WQ, FRM, Bio, HM, SAE (H)
- New/improved SuDS – WQ, FRM, Bio (M)
- Instream/riparian improvements – Bio, HM, SAE (M)

Section 6 – East side of A1. Google (Imagery ©2014 Bluesky, Digital Globe, Getmapping plc, Infoterrs Ltd & Bluesky, The GeoInformation Group, Landsat, Map data ©2014 Google)



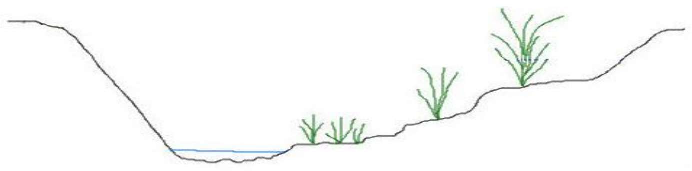
4.7 Playing field (Section 7) - NGR: NZ232693

Issues

- Parts of the playing field close to the drain get very wet in high fow conditions with standing water.
- Poor water quality and flashy flow conditions.

Opportunities

It is not clear where the source of this watercourse is, but it drains the Fawdon estate to the west and meets the Ouse Burn south-east of the City of Newcastle Golf Course. Depending on the annual flow the watercourse could be re-profiled to create more naturally sloping banks with a low flow channel as indicated in the figure below (see also example in Appendix A). Any mis-connections draining into the watercourse should be recitfied.



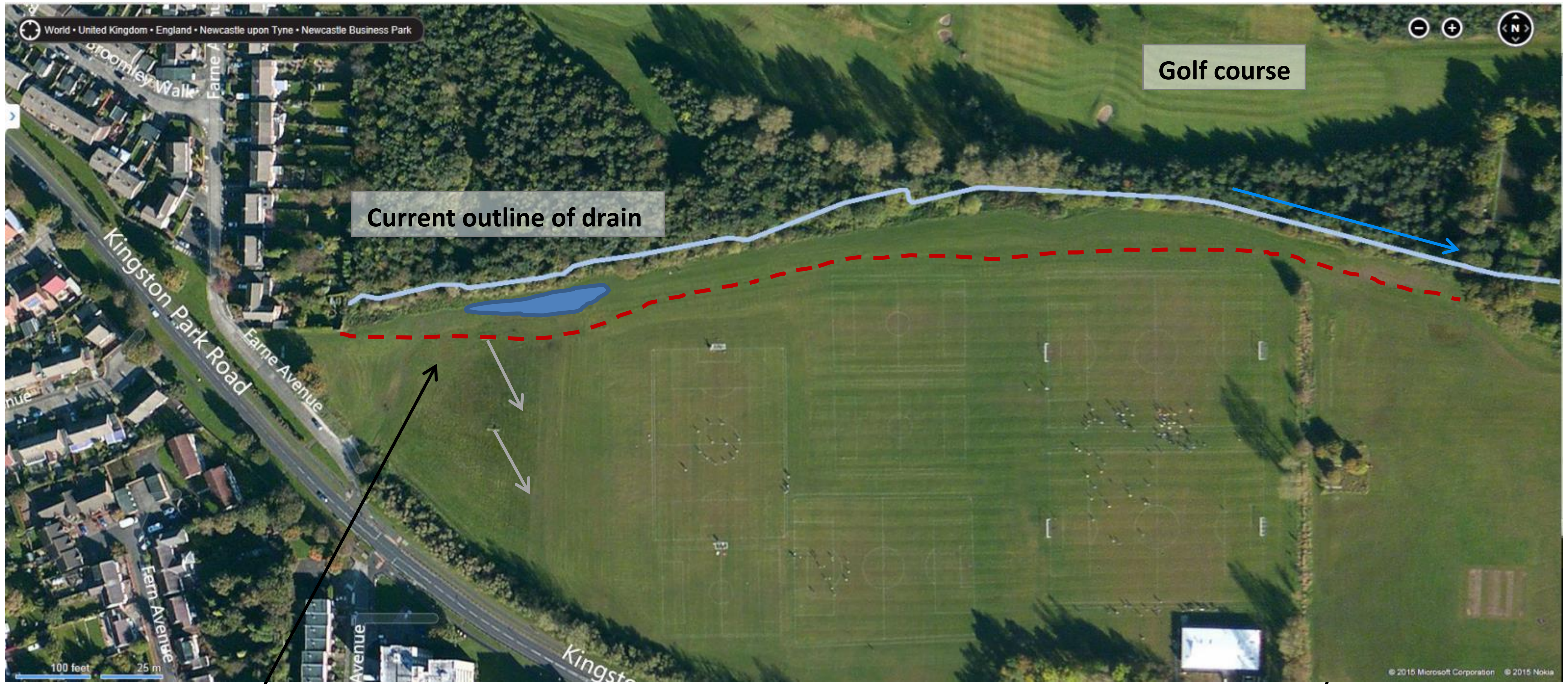
Moving the pitches away from the river and wetter area to the adjacent higher ground would provide space to widen the riparian corridor and create scrapes in the lowest lying area and a succession of reedbeds along the channel (see example in Appendix C). This would improve habitat diversity, benefit water quality and contribute towards increased flood water storage in the catchment whilst retaining an important local amenity. However, any wetland features are dependent on a reasonably reliable source of ground- or surface-water.

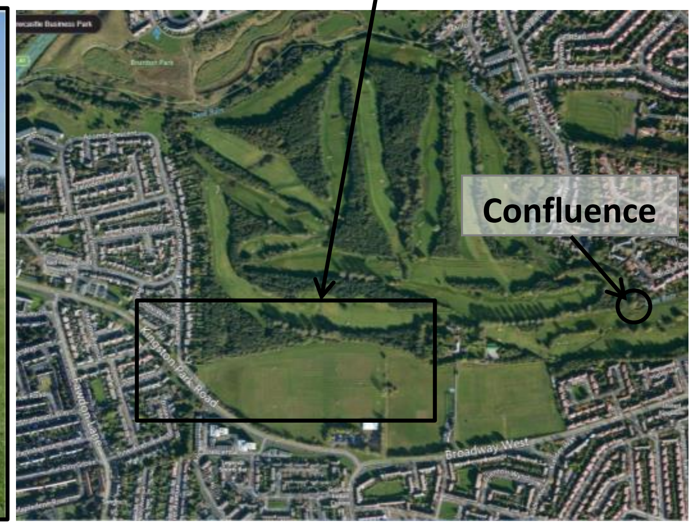
Engaging the local community in this work is essential and negotiations with land owner and tenant needs to be a priority. Incentives should include moving/raising pitch area that floods to provide space for the channel works and installing better drainage to pitches to create an improved space for both people and wildlife.

WFD and other benefits (cost)

- Expanding the watercourse corridor, re-profiling and adding instream diversity – FRM, Bio, SAE (M)
- Moving pitches and engaging with local community – SAE (S)

Section 7 – Tributary along playing field. Google (Imagery ©2014 Bluesky, Digital Globe, Getmapping plc, Infoterrs Ltd & Bluesky, The GeoInformation Group, Landsat, Map data ©2014 Google)





5. Summary of options and prioritisation

Habitat improvement and channel enhancement are important measures to increase hydromorphological and biological WFD status and improve the catchment for BAP species. However, observations from the walkover survey and reviewing of other reports indicate that there are some serious water quality issues. If the water quality problems are not dealt with first (or in combination with) any habitat restoration measures, these will have very little effect on increasing biological quality elements.

Prioritisation

The three main reasons for the Ouse Burn failing the WFD are diffuse pollution, physical modification and point source pollution. Although addressing the polluted discharge from the Kingston Park outfall might be costly, this needs to be urgently addressed as it also undermines any habitat and biodiversity works undertaken downstream of this point. Further investigations into how to best rectify the faulty outfall are needed and these need to link with the Blue-Green Cities investigations and Newcastle City Council's Integrated Surface Water Management Plan. The other top three priority sections to focus on are listed below:

1. Callerton housing development (Section 1) – this development is planned very close to the course of the river at Callerton. To prevent any deterioration of the river environment it is very important to start early discussion with regulators, developers and local stakeholders to secure a substantial buffer zone along the river that can accommodate multiple benefits such as restoration measures (bank re-profiling, habitat features) and SuDS features.
2. Floodplain restoration at fish pond (Section 2) – This area will have very positive benefits increasing retention areas for NFM and decreasing diffuse agricultural pollution. Contact need to be made with landowner, tenant farmers and local angling club to discuss possibilities for restoring the floodplain for habitat and NFM and possibly improve the western pond for fishing purposes. Topographical surveys and flow modelling are needed to ensure best performance and use of the area available.
3. Denotified nature reserve (Section 4) – Restoring this nature reserve will have multiple positive effects on biodiversity, NFM, water quality, amenity and recreation. A holistic design including re-profiling of Ouse Burn, instream habitat improvements, river-floodplain reconnection, mosaic of floodplain features and re-meandering of the tributary needs to be designed including topographical surveys and flow modelling.

Summary of options

This table summarises the key opportunities, indicative costs and identifies a priority level (High/ Medium/Low) for the proposed measures. The priority level is based on an expertise judgement of the cost-benefit of the proposed actions.

Section	Opportunities	Benefits	Indicative cost	Priority (H/M/L)	Wetland area (Ha)	Risks and limitations
1	If the proposed housing development is going ahead we suggest that the channel is re-profiled and instream habitat diversity improved by adding large wood and/or coir rolls.	NFM, Bio, HM	M	H		Impact and extension of housing development will involve compromises to restore natural processes and habitats. Early discussions with authorities, landowners, tenants, local community and developers are essential to secure the space needed to safeguard habitats, care for water quality and improve retention. Proximity to road restricts re-profiling of left bank.
1	Vegetation management is needed to manage the excessive growth of rank vegetation. Engage the local community.	Bio, SAE	S	M		
1	Flood water storage features (needs revision to include SuDS if development goes ahead).	Bio, WQ, NFM	M (H)	M	0.5	
2	Reconnection with floodplain; expansion and re-design of the current pond into a more naturally functioning floodplain.	Bio, HM, NFM	H	H	4.5	Vicinity to Newcastle airport restricts the size of open water features. Contact need to be made with landowner and tenant farmers to discuss options for restoring floodplain and possibly improving smaller pond for fishing purposes. Flow modelling and topographical survey needed to ensure an effective design.
2	Set back outfall and create reedbed.	WQ, HM	S	M		
2	Improve habitat quality in tributary by re-profiling and installing instream features. These measures should also engage the local community and angling club.	Bio, HM, NFM	L	M		
3	Improve pond/SuDS between A696 and railway to take runoff from the road and increase retention area for natural flood management.	NFM, WQ, Bio	L/M	L	1	Access to area between A696 and rail is currently limited and more investigations needed to conclude whether the road or railway bridges would create bottlenecks at high flows. When setting back the outfall any issues with misconnections needs to be addressed (highlighted in the TRT report as a common issue in the catchment).
3	Set back outfall and create reedbed. Engage the local community.	SAE, WQ, Bio, HM	L/M	M		
4	Re-connect river and floodplain and recreate a mosaic of floodplain features.	NFM, Bio, WQ, SAE	M/H	H	4	When restoring the area the plans need to avoid impacting on the Public Right of Way. Space mainly available along the left bank.
4	Bank lowering and instream enhancement.	Bio, SAE	L	H		
5	Rectifying faulty outfall (reconstruction or set back with creation of SuDS). Inspections of	WQ, FRM, Bio, HM,	H*	H		Cost is potentially a significant limitation to rectifying the outfall. This work will require

	misconnections and other measures might also be needed to solve this issue.	SAE				linkages with the Blue-Green Cities investigations and Newcastle City Council's Integrated Surface Water Management Plan. The outflow currently carries high values of faecal coliforms with potential risks to both humans and wildlife.
5	Bank and instream river restoration works. However, physical improvement of habitat quality will only be successful once the water quality has been improved.	Bio, HM, SAE	L	H	0.5	
6	Set back outfall and create reedbed.	SAE, WQ, Bio, HM, NFM	H	M**		The outfall downstream might also carry flow from misconnections negatively impacting water quality and wildlife. The main issue at this location may be existing utility infrastructure. Contact need to be made with Northumberland Wildlife Trust to discuss what work was undertaken by them.
6	New/improved SuDS design and expansion of wetland retention area.	WQ, FRM, Bio	M	M	0.5	
6	Instream and riparian improvements - links needed to Mott MacDonald's re-alignment plans.	Bio, HM, SAE	M	L		
7	Expanding the river corridor and create scrape. Engage the local community.	FRM, Bio, SAE	L	M	0.5	Very low flows at times could negatively affect any wetland features. Any possible misconnections also need to be addressed.
					11.5	

*This might be very costly depending on what measures need to be taken

* *Priority will depend on the pollution levels from the outfall (might be High if quality is very bad)

Potential WFD and other benefits:

Bio= Biological quality elements
HM = Hydromorphology
WQ = Water quality elements
NFM = Natural Flood Management
SAE = Social/ Amenity/ Education

Indicative cost categories:

H = High >50,000
M = Medium 10,000-50,000
L = Low 5,000-10,000
S = Small <5,000

6. Appendix of technical examples

Appendix A – Bank re-profiling, case study: River Rhee at Wendy

Along the Ouseburn opportunities have been identified where the banks could be re-profiled to improve channel diversity, channel capacity and/or re-connect the river with its floodplain.

The Rhee (Upper Cam) had been historically dredged at this site until the channel was very deep, wide and had little in stream variation. Banks were uneven, having a high left bank where years of dredgings/weed cuttings had raised levels.

The combination of dredgings and deepening had formed a steep high slope on the left bank, over 1m higher than the right bank. The nutrient input to the topsoil from the dredgings, and lack of tree cover on this bank had resulted in a nettle covered slope, with very little native vegetation on the bank or river margin.

Before, May 2001

Steep angle of the bank before re-profiling carried out.

Nettle banks with dredgings levee.

During, August 2002

Re-profiling results in a shallower bank angle and top of bank set back.

Nutrient rich dredgings and topsoil removed and piled behind track waiting to be spread. Ledge formed by pushing toe forward – vegetation and roots intact.

After, June 2003

Bank grass seeding established.

The river suffered from low flows in summer as there was little water over a wide bed area. Marginal growth was severely restricted by the management and lack of suitable substrate, exacerbating the over-wide situation.

The project sought to narrow the low flow channel and create a damp/wet ledge for marginal plant colonisation. This was done by 'pushing' the toe of the clay bank (complete with vegetation) forward and downward (Figure 1). The project also removed the topsoil and nettle roots allowing seeding of native grasses. The banks were re-profiled to provide extra capacity and to let in more light to aid colonisation of the wet ledge.

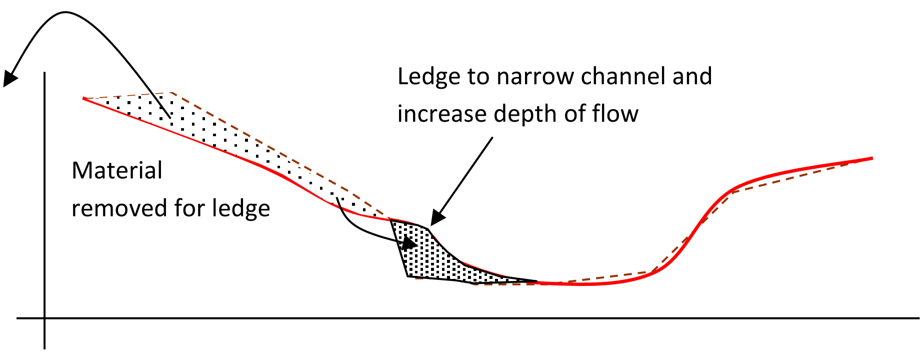


Figure 1. Cross sectional area of material moved, showing graphically the excess of cut over fill.

The added benefit of increased capacity would offset the ledge creation and should reduce flood levels.

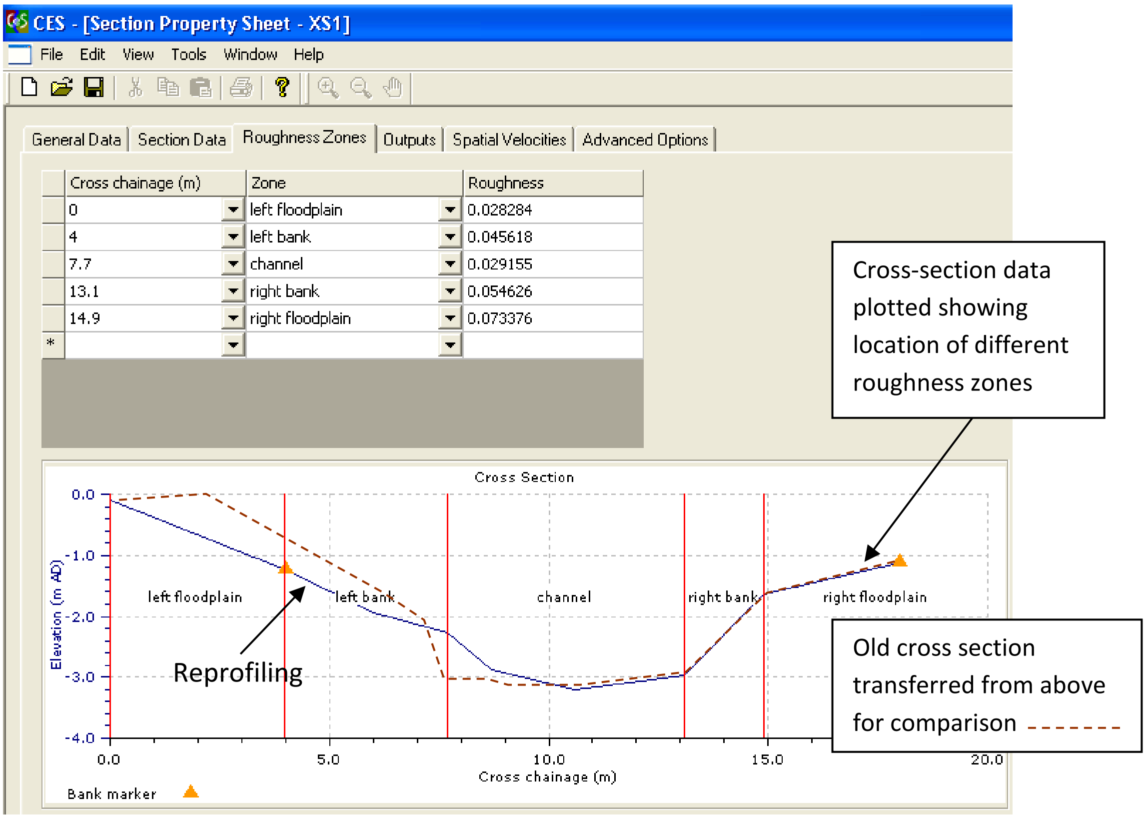


Figure 2. River Rhee cross section 1, pre and post works.

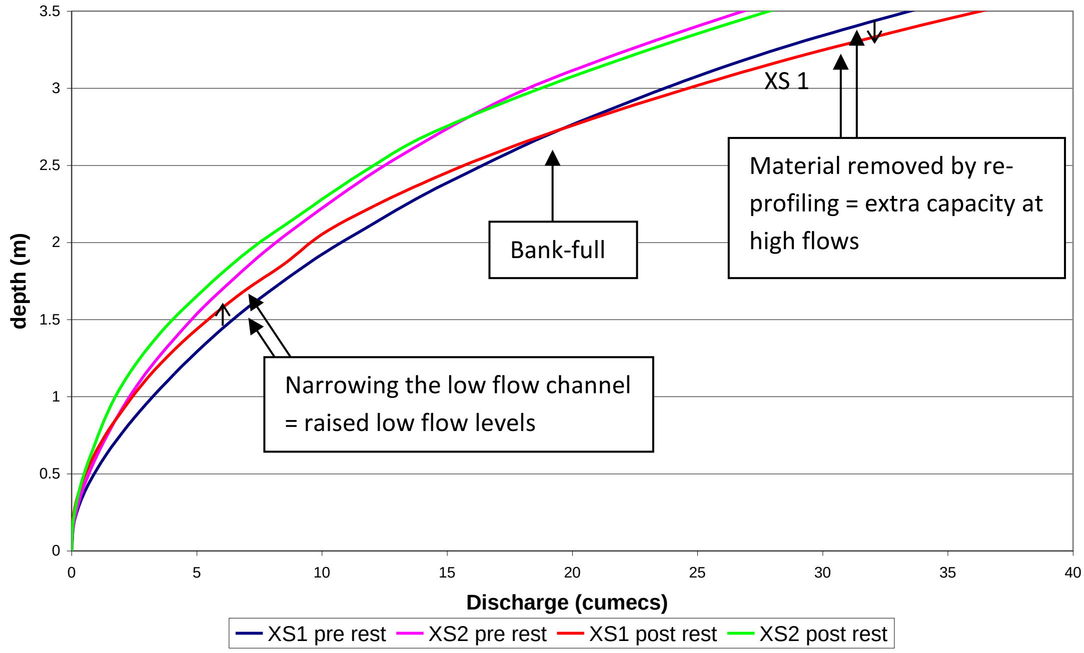


Figure 3. Stage discharge curve for the River Rhee cross sections.

Figure 3 shows that up to the bank-full level, the post restoration channel has a greater depth for the same discharge which is to be expected as the section is being narrowed.

As the water level approaches bank-full level this changes and the post restoration depth is lower, at both sections, for the same discharge. This is due to the increased capacity of the channel where the bank has been re-profiled. In this way the re-profiling works has a direct beneficial effect on the capacity of the channel at flood flows, as well as the recognised enhancement benefits stated above.

Diversity in the channel width can be created by pushing the toe forward to form a ledge (as described above). Another example of creating variation in channel width is to create berms along the channel margin. This video shows how such berms can be formed. Although the example is from a larger river, the principle is the same.

https://www.youtube.com/watch?v=aej4PTzf_0U&feature=youtu.be

Appendix B – Using wood and defectors in rivers

The use of wood in rivers can be an effective way of creating some in-channel habitat, morphological and hydrological variability. Along the Ouseburn wood would need to be tied and staked into the bed with untreated chestnut stakes or similar. This is most effectively achieved by digging a slot trench, hammering in two stakes, one either side of the log and then securing the log by attaching wire across the two stakes (as shown in the photos below). If such an option is considered, the wood must be designed in at a low level so that only the top of it is showing during low flow levels. Designing in conjunction with re-profiling of the banks would ensure that flow capacity is maintained (in areas where this is a necessary function of the watercourse).

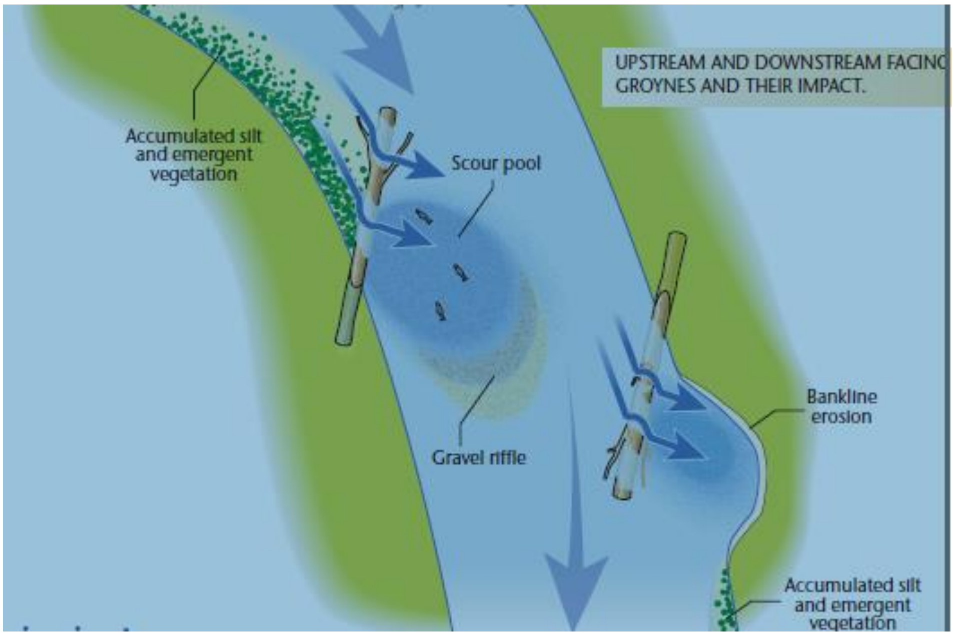
NOTE: As shown in diagram below think carefully about whether deflectors are facing up or downstream.

Example of the use of woody debris – note dimensions and level would need to be adapted for the specific site

Example 1 of staking in wood

Example 2 of staking in wood

Staked-in wood showing impact on bed morphology locally and flow characteristics



Benefits of wood in rivers to create in-channel variability in habitat and morphology (from WTT chalk stream manual). Upstream deflectors will generally create scour downstream and silt accumulation upstream.

For further reading about the benefits of wood in rivers go to:

http://www.staffs-wildlife.org.uk/sites/default/files/files/Managing%20Woody%20Debris.pdf

Appendix C – Wetlands, ponds and scrapes, case study: River Quaggy in London

Along the Ouseburn opportunities have been identified where a mixture of ponds and scrapes could be included as design features in the floodplain. Creating ponds and scrapes at different depths provide for a range of habitats (both permanent and semi-permanent) as well as being able to store water on the floodplain. The River Quaggy at Sutfcliffe Park and Chinbrook Meadows, near Lewisham, London, provide good examples of what can be achieved as part of a river restoration scheme. Both projects provide additional flood storage areas whilst also creating attractive open spaces for the public. As well as lowering and reshaping the floodplain areas to store flood waters, a range of habitat features were created that included more traditional ponds through to small scrapes. Networks of boardwalks, pathways and viewing points were included in the designs.

Appendix D – Outfall set back and reedbeds

Current research along the Ouseburn has indicated that there is a significant pollution problem within the water course. The RRC reports provides suggestion about how these may be remediated via changes in the current direct drainage network into the river. However, there are clearly a lot of outfalls that discharge directly into the watercourse. Research (see poster below) has indicated that setting back outfalls can have a benefit to water quality. Small redbeed features at outfalls can also have a benefit in terms of improving water quality, but will still need to be set back to enable space for such an approach.

Where there is space, reedbed features such as that indicated in the case study on the river Cole could be incorporated into an option to re-profile the bank to create a linear reedbed feature: see http://www.therrc.co.uk/MOT/Final_Versions_(Secure)/9.2_Cole.pdf

Outfall setback with vegetation, gravel and staked in wood for habitat

Outfall setback with reeds growing at downstream end near watercourse

HS2.3.5-11751: Evaluating the effect of river restoration techniques on reducing the impacts of outfall on water quality

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Introduction

Urban developments release of a variety of heavy metal pollutants which enter rivers through outfall discharge. This results in local nutrient enrichment with adverse effects on the surrounding river ecosystem. Set-back outfalls indirectly discharge into rivers, aiming to reduce pollutant levels by dissipating energy before reaching the main channel. Riparian vegetation reduces sediment generation by decreasing flow velocities, acting as a sediment trap and buffering delivery. It is expected that the ability of the river to remov[...]e with increased modification to the channel and surrounding land-use.

This study aimed to investigate the following:

- Identify the influence of un-natural channel conditions and channel modification on the ability of a river to deal with outfall pollutants.
- Assess the impact of outfalls on the concentration of pollutants
- Analyse the differing impact of direct or set-back outfalls.

Figure 1: Set-back and direct outfalls within the study catchment.

Methods

28 stormwater outfalls (18 direct, 10 set-back) in Johnson Creek, Portland Oregon were analysed (see Figure 2). Sediment samples were taken adjacent to, upstream and downstream of the outfall pipe. At set-back outfalls an additional sample was taken at the junction of set-back and main channel.

Sediment samples were sieved and material <2mm was analysed for 14 pollutants; Pb, Zn, Ma, Cu, Ni, Cr, Ca, Mg, Sn, Ba, Na, K, Cd and P.

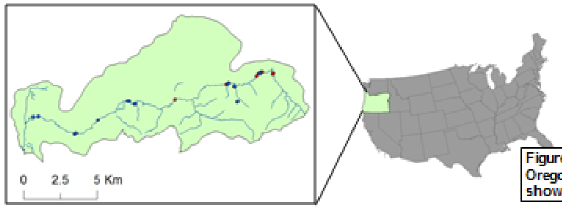

Figure 2: Johnsons Creek, Portland, Oregon USA. Direct outfall sample points shown in blue, Set-back red.

Habitat Quality Assessment (HQA) and Modification scores were calculated at each site (see Raven et al, 1998). An un-natural score, encompassing factors from both HQA and Modification scores and further land-use data was calculated. Percentage change in pollutant levels between upstream and outfalls was calculated. Change between outfall and downstream, as a function of change between upstream and outfall, was also calculated.

Results

- All pollutants observed showed an average increase in concentration at outfalls compared to upstream locations, ranging from 3-275%
- 11 (of 14) pollutants showed higher average percentage increase at direct outfalls than set-back. Paired-sample t-test indicates a statistically significant difference at the 95% level (t=2.253, p=0.042).
- Variability of pollutant concentration change is greater at direct outfalls for all pollutants (see Figure 3).

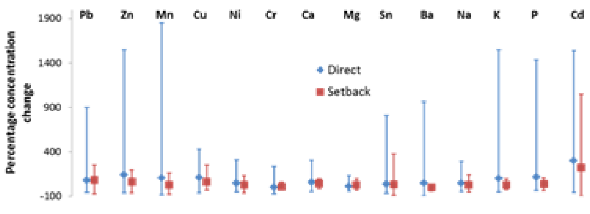

Figure 3: Percentage pollutant concentration change between upstream and outfall. Points show averages, error bars indicate the range of observed values.

- K showed statistically significant negative correlations with un-natural and modification scores at 99% and 95% levels respectively and a positive correlation with HQA
- Mn and Mg showed similar trends
- Zn was the only element to show the opposite of the hypothesised change; positive correlation with HQA, however un-natural and modification scores showed no correlation

Table 1: Significant correlations from pollutant analysis. Orange and yellow squares indicate 99% and 95% confidence levels respectively.

	K	Mn	Mg	Zn
Un-natural	-0.491	-0.361	-0.351	0.082
Modification	-0.404	-0.441	-0.128	0.238
HQA	0.310	0.410	0.175	-0.394

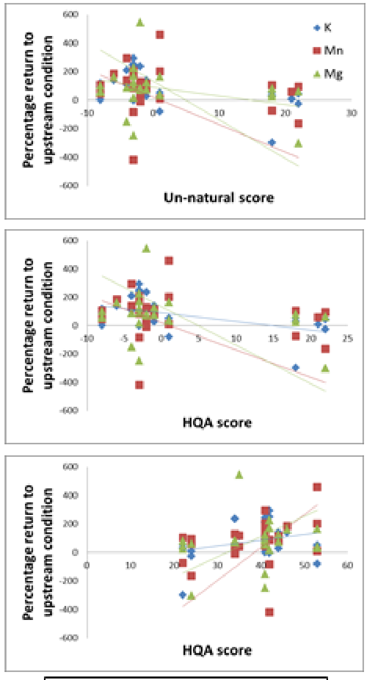

Figure 4: Scatterplots of K, Mn and Mg against Un-natural score, Modification score, and HQA score.

Conclusions

- The results highlight the impact of outfalls on water quality.
- Set-back outfalls appear to ameliorate pollutant concentrations.
- Pollutant concentrations downstream of outfalls relative to upstream significantly increase with the level of modification of the river from its natural state.
- Restored reaches have an increased capacity to remove/store pollutants.
- The results provide a preliminary insight into the benefit of channel restoration for pollutant management.

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References

Raven, P J et al, (1998). River Habitat Quality. Environment Agency, Bristol.

Appendix C – Re-meandering, case study: Bear Brook

Within the old de-notified wildlife reserve (section 4.4) an opportunity was identified to re-meander a current drainage ditch which is currently carrying excessive runoff and silt to the Ouse Burn. With the planned development further upstream along the tributary, there is a risk of increased runoff and pollutants being discharged to the Ouse Burn via this tributary. Re-meandering and planting of marginal vegetation could trap silt while at the same time provide new improved stream habitats to one again have a thriving wildlife reserve in this area.

The case study site on the Bear Book has a flashy clay catchment with a gradient of c 1:650. The brook had previously been straightened, deepened and realigned.

As part of a flood alleviation scheme in 1993 a section of Bear brook was re-meandered for 1km with low berms constructed and banks re-profiled to slope gently to water's edge. Bed depth was reduced by cutting new channel at a higher level.

The re-meandered channel was smaller than the previous water course. In-channel vegetation in low gradient rivers brings with it a potential maintenance issue especially as newly designed channels appear to becoming choked with weed. Under these circumstances any maintenance needs to be sensitively carried out to ensure the natural narrowing effect remains intact.

Re-visiting the site in 2006, the brook had narrowed by over a metre in places and this has exposed/maintained a clear bed. Where vegetation has not extended out into the channel, silt deposition is still evident, but there is a distinct delineation between clear bed and silt covered bed.

Aerial view of the Brook and flood storage/overspill area

Four years on and vegetation is shaping the low flow channel, establishing in the deposited silty margins

Twelve years on. Marginal plant growth is trapping silt and narrowing the channel to form more flow diversity with clear sediments in the open channel. Very shallow slopes allow greater adjustment and development of different habitat and vegetation types.