Case study 44. Haltwhistle Burn – a total catchment approach to headwater run-off and pollution

Author: Malcolm Newson

Main driver: Ecology, water quality and flood risk management

Project stage: Constructed (March 2015)

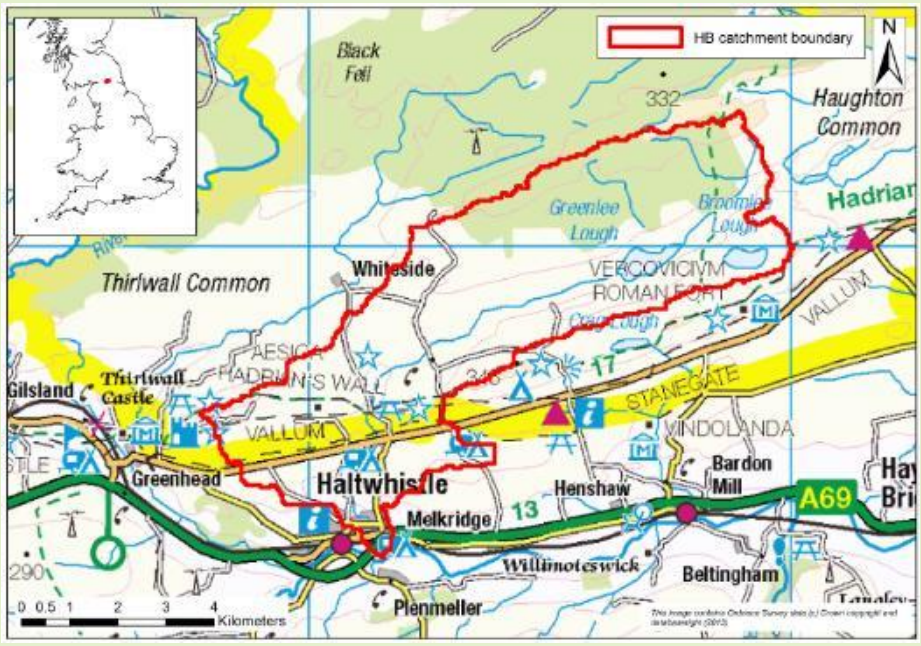
Photo 1: Jimmy the horse carrying construction material to the site for the Natural Flood Management scheme (source: Newcastle University)

Project summary:

Haltwhistle Burn (Map 1), a 'total catchment' approach, was a partnership project led by Tyne Rivers Trust which used the Defra Catchment Restoration Fund (CRF) to improve the whole catchment. This rural catchment is under multiple pressures. The CRF funded project sought to manage a number of catchment-based issues such as controlling diffuse nutrient pollution, erosion and deposition of sediment as well as flood risk. Newcastle University worked closely with Tyne Rivers Trust and all relevant stakeholders to characterise the catchment and collect historical information as well as establishing and installing Natural Flood Management (NFM) features.

Key facts:

This was far from being a simple NFM flood storage project and addressed the entire 'wiring' of run-off (and its quality) for the catchment from moorland/forestry source areas to urban flood risk sites. Accurate quantities (for example , for volume) added to short-term storage are hard to calculate (many of the project sites did not address attenuation directly but via increasing hydraulic roughness, re-routing direct drainage and reducing the dangers of catastrophic conveyance failure by managing sediment sources and riparian trees). The project report (Newson and Gibson 2015) lists 15 separate work sites in the 7 topographical/land use zones of the catchment; 3 more sites were completed after the report. In addition to the comprehensive approach to the run-off process, awareness was raised in the flood-prone community, supported by Newcastle University's installation of flood warning instrumentation.



Map 1: Haltwhistle Burn (source: Newcastle University)

1. Contact details

Contact details	
Names:	Malcolm Newson, Eleanor Starkey, Geoff Parkin and Paul Quinn
Lead organisations:	Tyne Rivers Trust and Newcastle University
Partners:	Defra, Environment Agency, Natural England, Forestry Commission, Natura Environment Research Council (NERC), Haltwhistle Town Council, Northumberland National Park Authority, Northumberland County Council, Newcastle University (Newcastle Institute for Research on Sustainability, NiRES), Hadrian's Wall Heritage Ltd
e-mail address:	Project contacts: https://research.ncl.ac.uk/haltwhistleburn/contact/ m.newson@tyneriverstrust.org

2. Location and catchment description

Catchment summary	
National Grid Reference:	NY7215065921
Town, County, Country:	Haltwhistle, Northumberland, UK
Regional Flood and Coastal Committee (RFCC) region:	Northumbria
Catchment name(s) and size (km^2):	$42km^2$
River name(s) and typology:	Caw Burn and Pont Gallon Burn rise in the north and flow south-west towards their confluence where they form Haltwhistle Burn, a high energy upland watercourse.
Water Framework Directive water body reference:	GB103023075580
Land use, soil type, geology, mean annual rainfall:	Farmland Seasonally wet deep loam, predominantly limestone/sandstone/siltstone/mudstone Mean annual rainfall: 800–1,250mm

3. Background summary of the catchment

Socioeconomic/historic context

The Haltwhistle Burn catchment covers an area of approximately $42km^2$ and is predominantly rural. Caw Burn and Pont Gallon Burn rise in the north and flow south-west towards their confluence, forming Haltwhistle Burn. The Burn then continues south over farmland, past Hadrian's Wall and into a gorge. From here the Burn flows into Haltwhistle, a small town in Northumberland which is a natural and cultural heritage hotspot. The watercourse continues south through the 'Town Foot' area, passes through a culvert (beneath the B6322 road) and out towards its confluence with the River South Tyne. In the past, the power of the stream was used to power corn and woollen mills. The rich rocks of the burn gorge were exploited for building stone, lime, coal and clay (see http://haltwhistleburn.org/). Today, Haltwhistle Burn and its tributaries are a massive asset to the Haltwhistle area, providing benefits to locals, tourists, farmers and wildlife.

Flood risk problem(s)

The Haltwhistle Burn catchment has a history of flooding, with records dating back to at least 1892, affecting the town in numerous locations during 2007, 2012, 2013 and more recently, the April and May 2014 events when local properties were flooded. Due to the elongated shape and steepness of this catchment, it responds rapidly during rainfall events. As a result of these physical characteristics and past flood history, the Haltwhistle Burn catchment is listed on the Environment Agency's rapid response catchment register.

Other environmental problems

Although the catchment itself is failing to achieve a 'good ecological status' under the Water Framework Directive assessment criteria, the catchment suffers from a range of issues including

flood risk, bank erosion, sediment build-up (causing blockages within culverts) and poor water quality.

4. Defining the problem(s) and developing the solution

What evidence is there to define the flood risk problem(s) and solution(s)

The various flood-related problems in the lower Haltwhistle Burn catchment include:

- flooding from the Burn in the Town Foot area
- flooding from the Burn's flashy tributary, Slaty Sike, just north of the town along Willia Road
- flooding from the Hemmel Burn to the west of the town (partly caused by reduced capacity in a culvert)
- surface water flooding from the steep, developed slopes to the north of the town centre
- flooding at the confluence of the Haltwhistle Burn and River South Tyne (mainly notable for its geomorphological impacts)

Although these issues are clustered within the 'impact zone' where the catchment becomes extremely steep and narrow, the majority of the fluvial flood waters originate from first and second order ditches and streams located higher up in the catchment. Valuable local knowledge has confirmed that farmland is also affected by flooding during heavy and/or prolonged rainfall events; this enhances the catchment connectivity effect.

What was the design rationale?

Although flooding was not the central focus of this project at the outset, the experiences and interests of the Burn's human residents showed that run-off at high flows was of great concern. Run-off processes and high flows are also highly relevant to water quality (diffuse pollution, notably siltation) and fisheries issues which are central to the catchment-based approach. The features implemented to improve the Water Framework Directive issue of siltation/diffuse pollution would have the knock on benefits of helping to alleviate flooding, as the land use and land management techniques implemented also capture and slow run-off.

To understand the catchment and develop solutions to its environmental problems, a fluvial audit was conducted. This is a walkover survey during which the sources and sinks of sediment are mapped and quantified. In addition, river habitat surveys were carried out on the Caw Burn above the Military Road and in the gorge section of the Haltwhistle Burn. These surveys were supported by further appraisal work as detailed in the project report (Newson and Gibson 2015).

Project summary	
Area of catchment (km^2) or length of river benefitting from the project:	42km^2 and 1.8km of river benefitting from this project
Types of measures/interventions used (Working with Natural Processes and traditional):	River floodplain restoration Bank/road/footpath erosion protection Fish passage Wetland 10 leaky dams Sediment traps

	Tree planting (500 willow, 500 alder, 200 rowan and 200 hawthorn) Forest/urban drainage interventions Flood monitoring/fixed point photography
Numbers of measures/interventions used (Working with Natural Processes and traditional):	18 direct 'works' interventions backed by community interventions for flood awareness and flood action
Standard of protection for project as a whole:	Not available
Estimated number of properties protected:	Not available

How effective has the project been?

Tyne Rivers Trust does not regard the project as complete. One of the successes of the Project Board was to make relevant institutions add ongoing engagement to forward budgets and the community awareness that was developed will keep the pressure on for this 'legacy' to occur. Just as there were few formal design procedures (except where consents were necessary), numerical tests of effectiveness are not appropriate. All structures built remain intact (some minor damage to fish passage wooden baulks will be repaired).The Haltwhistle community, represented by the Town Council and Flood Action Group, are satisfied that there are tangible improvements and a severe pragmatic test, posed by the 'named storms' of winter 2015 to 2016, was passed. Ongoing technical appraisal of the project via the Newcastle University monitoring programme will allow some more formal assessments of effectiveness in future.

5. Project construction

How were individual measures constructed?

Three different groups of measures were constructed throughout the catchment.

Green engineering

This project has used green engineering techniques (Photo 2) at several of its work sites to create habitat and ‘slow the flow’, allowing silt and sediment to drop out onto the floodplain, protect river banks from erosion and create access to the Haltwhistle Burn from the River South Tyne. Using living material from the immediate surroundings reduces transport costs and avoids introducing non-native provenance. Live material often ‘gives’ more in high flow conditions and is less likely to fail catastrophically. At the ‘new’ downstream mouth of the Haltwhistle Burn, locally cut wood was used to hold back silt and gravels keeping the channel open to allow fish passage up.

Photo 2: Haltwhistle Burn mouth before (left) and after (right) simple green engineered interventions (source: Newson and Gibson 2015)

Further up the burn in the 'gorge' section, trees have grown overly tall in search of sunlight. Some are ideally positioned, if laid like a hedge, to protect the watercourse from land slippage of contaminated sediment (Photo 3).


Photo 3: Left: A living tree is laid to reduce river bank collapse at old quarry/mine site. An additional trunk is secured on the river bed to direct flow away from eroding bank. Right: One season of growth demonstrates how well the bank is repairing. This is a fixed point photography site (from marked post on footbridge) (source Newson and Gibson 2015)

Wetland creation

In the head waters, simple timber sluices and secured brash bundles take the power out of the water in storm conditions, pushing sediment onto the floodplain. These forms of interventions are easily installed and maintained by trained volunteers (Photo 4).


Photo 3: Volunteers working as a team (left) to produce brash bundles to add to the timber sluice constructions (right). Brash material was acquired from Environment Agency tree maintenance work further down the catchment and transported to site by a project partner (source: Newson and Gibson 2015)

The Haltwhistle catchment area is wet. Lower parts of the catchment have an average annual rainfall of 850mm, but in the headwaters, double this may occur, with wetter months experiencing 'a foot of rain' (300mm). Two activities were identified as mutually beneficially to the farm business and the protection of the Site of Scientific Interest (SSSI) areas and watercourses. Guttering, water tanks and troughs allow the collection of rainwater from farmyard buildings to be harvested and used to water stock, reducing the volume of water that exacerbates run-off of farmyard material into the SSSI areas and water courses. The hard standing area of the farmyard was extended slightly and laid to direct all run-off flow to one corner where a wetland area was created to connect via this point. The wetland area collects run-off water in a settlement pond to allow all nutrients and material to settle out. An overspill creates capacity for 'cloud burst' conditions by feeding into a winding channel to allow

further settlement before reaching the final holding pond, which includes a last silt trap and allows reconnection with field drains.

Tree planting

Leaky dams were used to create some backing up of water at each of the structures; these drain quickly once a rainfall event has passed. This reduces the erosive force during storm flow as well as letting sediment settle out; material builds up quickly in the leaky dam stilling zone – possibly a future management challenge. Good practice for this type of work suggests that it is better to have a large number of small structures rather than a small number of big ones. Therefore, 10 leaky dams were installed to offer a more effective and comprehensive solution.

Tree planting has been carried out along the Haughtongreen Burn (covering an area of 2.8ha) to create dappled shade ('keeping rivers cool'), increasing invertebrate life and a supply of woody debris in the future. The selection of trees used were approved by the Northumberland National Park Authority and consisted of 500 willow, 500 alder, 200 rowan and 200 hawthorn.

The Forestry Commission Design Plan includes planting of broadleaf scheduled for 50 years' time. The CRF project has brought this forward by supplying the trees in partnership with the Woodland Trust and providing a workforce of Tyne Rivers Trust contractors and volunteers. This planting will take place along the Greenlee and Haughtongreen Burns within the Forestry Commission boundary and, as with that agreed with the Northumberland National Park Authority for the Haughtongreen Burn, includes a good mix of alder, rowan, willow and hawthorn. It is intended that planting on this scale will help regulate the temperature of the streams as well as binding the banks, while providing further habitat for terrestrial invertebrates and shelter for fish.

How long were measures designed to last?

Extensive use of natural materials means that design lifetime cannot be compared with engineering standards. Urban flood protection normally attracts '1-in-100 year' standards but large woody debris may rot in 20 years.

Were there any landowner or legal requirements which needed consideration?

- Respect for SSI status of upper catchment
- Geological protection for gorge section of Haltwhistle Burn
- Historical and amenity value of the Mossy Bank waterfalls and trackways up the Burn
- Transparent, fair dealings with all landowners with patient explanation of aims and objectives, plus engagement with the practical works

Tyne Rivers Trust emerged as a non-controversial broker for improvements which landowners had refused to negotiate with statutory bodies.

6. Funding

Funding summary for Working with Natural Processes (WWNP)/Natural Flood Management (measures	
Year project was undertaken/completed:	2015
How was the project funded:	Defra Catchment Restoration Fund Natural England through Higher Level Stewardship Community Chest through small grant Forestry Commission, Northumbrian Water Ltd and Environment Agency through partnership working in kind

	Newcastle University and NERC via PhD stipend River Watch Group through grants applied for and coffee morning nd-raising event
Total cash cost of project (£):	£363,000
Overall cost and cost breakdown for WWNP/NFM measures (£):	Construction features and management of construction: £322,000 Community engagement: £33,000. Monitoring: £8,000
WWNP/NFM costs as a % of overall project costs:	~90% total costs spent on constructing individual NFM measures
Unit breakdown of costs for WWNP/NFM measures:	Wetland: £9.05m2 Silt trap: £34.73m Leaky dams: £104.84 per structure Willow spilling: £50 per metre Stone river crossings: £100 per metre Sleeper river crossings: £60 per metre Stone revetment: £150–350 Timber revetment: £25 per metre Brash bundles: £25 per metre Trees (1/2 metre): £0.30 Woodland Trust or £4 commercial price Willow whips: £5.44–£6.40 Laying trees: £10 per metre For full details see Newson and Gibson (2015)
Cost–benefit ratio (and timescale in years over which it has been estimated)	Not available

7. Wider benefits

What wider benefits has the project achieved?

As well as slowing and storing flood waters this project also:

- improved water quality
- created habitat for fish, white-clawed crayfish and other aquatic and riparian species
- benefitted Greenlee Lough SSSI
- benefitted local residents who became engaged in the citizen science
- helped crate change resilience/adaptation benefits along the riparian zone where tree planting has occurred

How much habitat has been created, improved or restored?

The main driver for the project was the Water Framework Directive rather than the Habitats Directive or Birds Directive. However, the extensive involvement of Natural England and the Northumberland National Park Authority (and their brokering of agri-environment grants) has meant that at least 60% of the project interventions have been to extend, improve or sustain woodland, wetland and lake/river habitats. Most of the sites to benefit are less than one hectare but the source-to-mouth approach

means that the entire stream network has benefitted and Greenlee Lough now has further restoration plans under Countryside Stewardship.

8. Maintenance, monitoring and adaptive management

Are maintenance activities planned?

Maintenance funding was not part of the CRF, but a significant project legacy was planned from the outset and this was achieved by choosing influential public bodies as part of the Project Board and by activating community interest/education/engagement. Tyne Rivers Trust can use more recent funding (for example, for fish passage) but there is confidence that recent initiatives (for example, by the Town Council and Northumberland National Park Authority) will ensure the desirable project legacy in terms of both extending the scope and maintaining the existing project assets.

Is the project being monitored?

This project has found that monitoring techniques such as regular consumer specification time-lapse cameras, photographs, videos and 'kite-cams' (Photo 5) are suitable for long-term and low-cost monitoring of a variety of NFM features. More details of the monitoring approach are given in the project report (Newson and Gibson 2015).

These techniques have been compared with traditional hydrometric monitoring equipment. It is clear that traditional techniques are expensive and require specialist skills and that their outputs are complicated to the untrained eye. The alternative methods tested are visually more meaningful, can be interpreted by all stakeholders, and techniques can be easily utilised by citizen scientists, landowners or flood groups. Such techniques therefore offer a before, during and after NFM monitoring solution which can be more realistically and readily implemented, supports engagement and subsequent uptake, and maintenance of NFM features on a local level. For more details see the project web site (https://research.ncl.ac.uk/haltwhistleburn/newsevents/).

A citizen science approach to catchment monitoring means this project has been able to co-produce a large number of observations in and around the Haltwhistle Burn catchment. Data have been combined, creating lengthy datasets for 2014. A community hub was created to enable the local community to contribute to the monitoring scheme (https://research.ncl.ac.uk/haltwhistleburn/communityhub/).

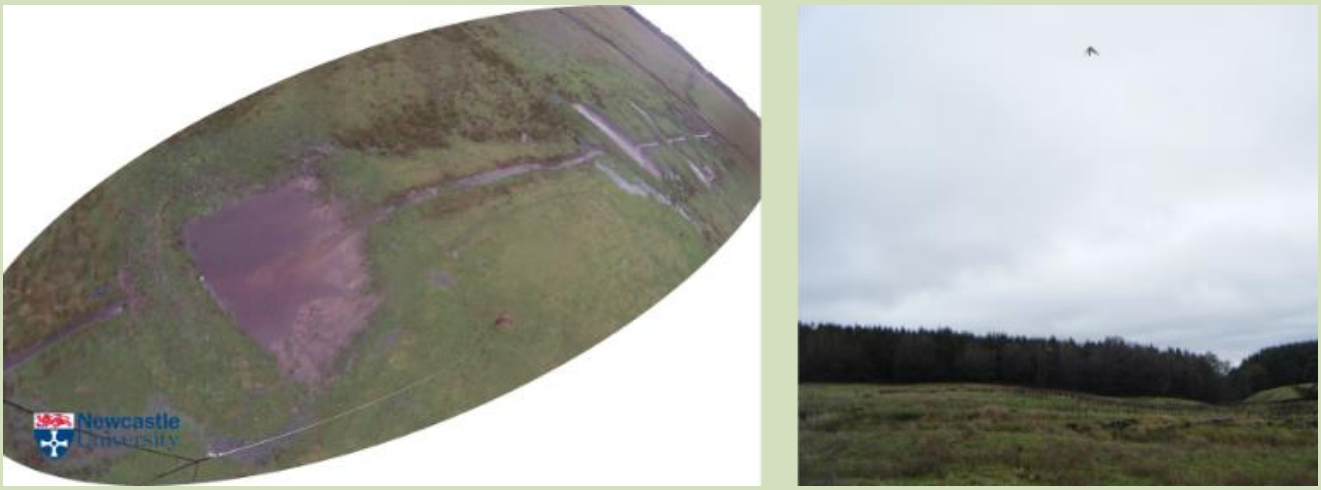


Photo 5: 'Kite-cam' (old camera attached to a cheap kite using elastic bands) being used to assess an NFM pond's performance (source: Newcastle University)

Has adaptive management been needed?

During the project, Tyne Rivers Trust used adaptive management in the sense of a community 'learning by doing' philosophy, with flexibility all times within the broad technical and evidence-based plans. Tyne Rivers Trust tolerated and appreciated the shift in the project emphasis from purely water quality to an holistic impact derived mainly from NFM.

Lessons learnt to date (mainly following Storm Desmond) are that bed sediment transport continues to create conveyance problems at 'pinch points' in the system. A simple technical example of adaptive management is the use of 'portable' wooden baulks for effective fish passage improvements – allowing a 'suck-it-and-see' approach to effectiveness at different flows.

9. Lessons learnt

What was learnt and how could it be applied elsewhere?

It is impossible to achievement multiple benefits in a holistic approach project without the support and commitment of partners, local landowners and local residents. This was only achieved by dedicating time to bringing the right people together and explaining clearly the aims and overlapping benefits. Only then can effective work on the ground begin.

It is vital to consider the legacy and exit strategy right from the beginning. Working at the subcatchment scale cannot be considered in the short term. Management and maintenance of interventions must be planned for and bought into within the community.

10. Bibliography

Haltwhistle Burn research webpages, https://research.ncl.ac.uk/haltwhistleburn/ [Accessed 24 March 2017].

NEWSON, M. AND GIBSON, C. (eds.), 2015. *Haltwhistle Burn – a comprehensive catchment approach to headwater runoff and pollution. Technical report of the 2012 to 2015 Defra Catchment Restoration Fund project*. Corbridge, Northumberland: Tyne Rivers Trust.

Restoring Europe's Rivers, 2016. *Case study: Haltwhistle Burn; a total catchment approach* [online]. EU Restore Project Case Study. Available from: https://restorerivers.eu/wiki/index.php?title=Case_study%3AHaltwhistle_burn;_a_total_catchment_approach [Accessed 24 March 2017].

Project background

This case study relates to project SC150005 'Working with Natural Flood Management: Evidence Directory'. It was commissioned by Defra and the Environment Agency's Joint Flood and Coastal Erosion Risk Management Research and Development Programme.