Netherton Burn Runoff Management Works

Elilaw Farm, Netherton, Northumberland

This case study is intended to provide an overview of a Natural Flood Management (NFM) project undertaken using feasibility and capital funding support through Cheviot Futures.

Winner
Northumberland National Park Natural Resources Innovation Award
2013

Background to the project

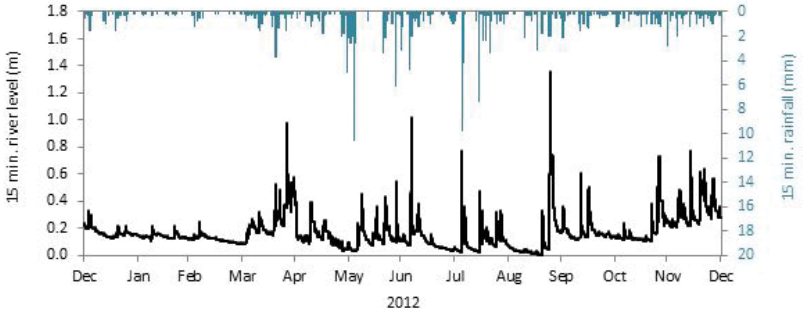
The Netherton Burn project has been developed in partnership with the farm business, Northumberland Community Flooding Partnership, the PROACTIVE team at Newcastle University, and Catchment Sensitive Farming. Initial development centred around exploring potential and feasibility with the landowner, and then developing specifications and suitable features to build on experience gained by project partners on other sites. The information within this case study relates to the practical delivery of four runoff attenuation features, implemented through Cheviot Futures.

The successful completion of works on Elilaw has led to additional funding secured by Northumberland County Council for additional works to complement this project. Further detail is provided in the Cheviot Futures newsletter, issue 4, and on the website.

Catchment monitoring

A key part of the development phase was the installation of monitoring equipment within the Netherton Burn to provide baseline data relating to rainfall and the way the watercourse reacts to extreme weather events.

Telemetered river level and rainfall measuring equipment were installed in the Netherton catchment in November 2011. Data sets are recorded at 15 minute intervals, which are uploaded to a web-based database on a daily basis. The chart below shows that 2012 had a number of intense rainfall events occurring in the summer which resulted in 'flashy' responses in river level. The highest peak river level of 1.4 metres was recorded at 05:00 on 25 September; this was due to 78 millimetres of rainfall measured over a 44 hour period. The flood mitigation features constructed in the catchment are designed to target these high-magnitude events by temporarily storing and attenuating peak flows.



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Overview of Features

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FEATURE 1

Farm Pond with Additional Offline Flood Storage Capacity

Overview of feature

This feature is a multi-benefit approach to additional flood storage. The farm pond is designed to hold water permanently, offering a valuable habitat and biodiversity improvement to the location, while also increasing sporting interest for the farm business. In addition the sediment trap element of the feature – *see below* – assists in reducing nutrient load ahead of water reaching the natural watercourse system.

The pond has been designed in such a way as to offer additional water storage in times of high flow, with a heightened bund allowing 1m freeboard for additional short term holding of flood waters. In times of peak flow, additional water is held in the feature, released slowly back to the system once the main peak within the Netherton Burn channel has passed, allowing release of water from the pond to the Burn. Approximately 1,050m³ of additional water can be held within the feature in this manner.

The pond feature itself is supported by a series of sediment traps on the inflow points. The main fill is supplied by a pre-existing ditch, partially diverted to provide flow to the pond to maintain the regular fill volume. A series of three sediment traps were excavated on this inflow line, in order to intercept both sediments and nutrients from the ditch, which has a watershed including the farm steading and a number of field drains from cultivated and managed pasture land.

In addition, another inflow ditch supplying water to the pond feature also has its own sediment trap to fulfil the same functions, situated at the bottom end of the pond, taking water from pre-existing ditches.

The material excavated from the pond and sediment traps was sorted and stockpiled to allow it to dry sufficiently to be used in the construction of features 2 and 3, further upstream – *see below*. This meant that no material required disposal, nor outside material used on the site.

Schematic diagram showing the design and function of the sediment trap approach – not to scale.

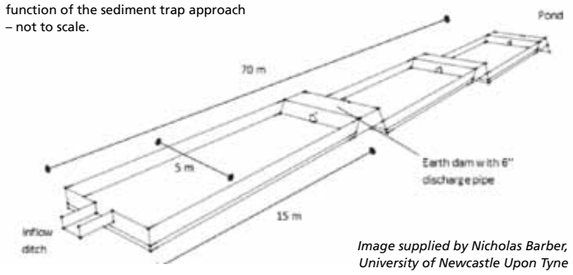


Image supplied by Nicholas Barber, University of Newcastle Upon Tyne

Practical considerations and permissions required

Implementation of features such as this may require additional consideration and/or prior approval or consents:

- Ecological survey to determine flora or fauna interest that may impact on implementation of works or siting of the feature
- Land drainage consent – available from the Environment Agency for main river sites or local authorities for ordinary watercourse sites
- Planning permission may be required in some circumstances
- If site locations lie adjacent to or within a designated site such as a SSSI, consent is likely to be required from Natural England

Work begins on the farm pond feature, January 2012.

The completed works, January 2012 – inflow sediment traps and main pond feature.

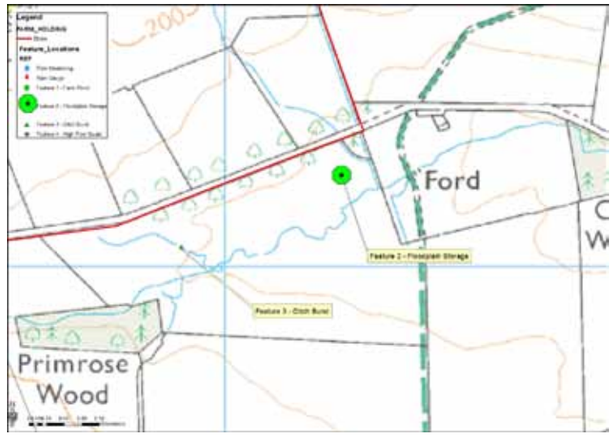
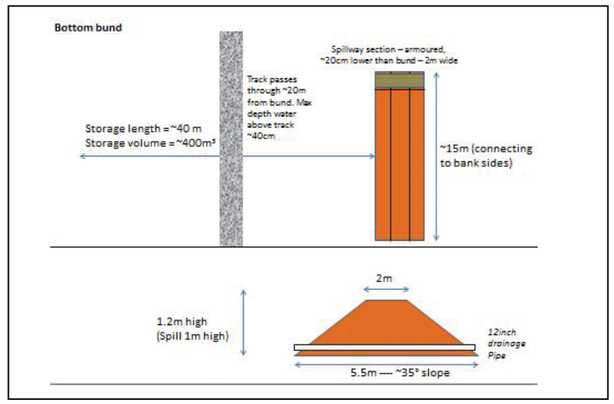


Diagram showing the indicative storage potential of the two bunds. Taken from the proposals document 'multiple track bund features'



Schematic diagram showing the design and specification of the feature two bunds. Taken from the proposals document 'Multiple track bund features'

The floodplain bunds upon completion, March 2012.

The bottom bund feature, March 2012.

The bottom bund feature showing revegetation, November 2013.

FEATURE 2

Enhancement of Floodplain Offline Storage Capacity

This feature makes use of the old river channel to store flood flows. It will be final storage point for the flood waters which were spilt over 800m upstream *(via features 3 and 4 below)*. The flood waters slowly take a torturous route over the flood plain and this storage feature will act as excellent flood attenuation features not only storing the flood peak but slowing it down.

The feature was created by constructing two earth bunds using material from the farm pond *(feature 1 above)*, which act as a temporary barrier to overland flow, backing up water in the storage area before releasing it slowly back to the natural system over a longer period of time, attenuating peak flows.

The diagrams below show how the bund features work, taken from project development documents prepared by the University of Newcastle Upon Tyne as part of the Netherton Burn Runoff Management Plan.

Practical considerations and permissions required

- Implementation of work of this nature on other sites is unlikely to require additional consents or approval, unless immediately adjacent to a watercourse and/or within a designated site such as a SSSI.

FEATURE 3

Ditch Bund

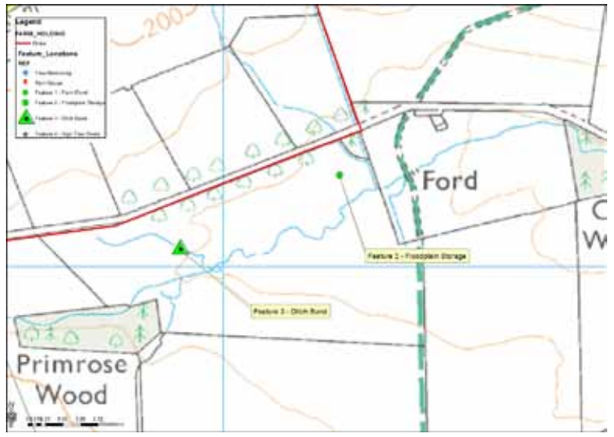
The smallest of the 4 features completed at Elilaw, but perhaps the most vital, this ditch bund comprises a soil bund constructed using material from the farm pond *(feature 1, above)* with an integrated pipe to allow normal flows to pass through. In times of high flow, excess water is backed up, with the assistance of a sluice drop-board, spilling into the relic channel landform of the floodplain and directed towards the floodplain storage area *(feature 2, above)*.

The bund feature diverts flow from the pre-existing ditch and also water spilled from the Netherton Burn itself further upstream – *see feature 4, below*. A small sediment trap excavated ahead of the bund works in the same way as those serving the main farm pond, intercepting sediment and nutrient loads from the ditch, improving water quality ahead of reaching the main Netherton Burn watercourse.

Practical considerations and permissions required

- Implementation of features such as this on other sites will require land drainage consent. For this site the land drainage consent was determined by Northumberland County Council as an ordinary watercourse site.

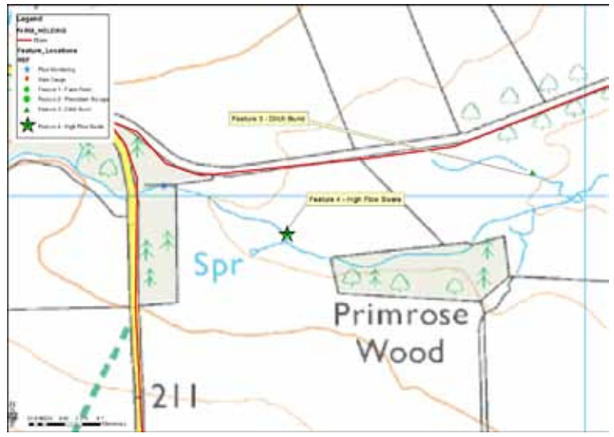
The ditch bund feature, viewed from below, March 2012.

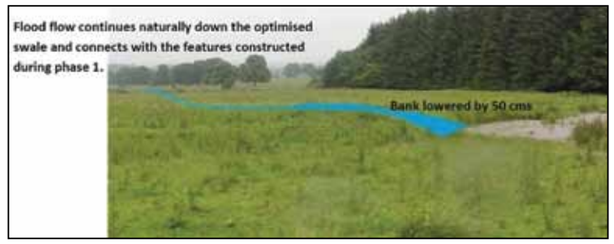


Schematic showing the ditch bund proposal, taken from the Netherton Burn Runoff Management Plan

The feature beginning to take effect in a high flow event, April 2012.

The sediment trap, bund and sluice drop board making up feature 3, November 2013.





Indicative sketch of the feature ahead of construction.
Taken from the Netherton Burn Runoff Management plan (phase 2).

Work underway on the creation of the swale following detailed levels surveys, October 2012.

The swale following re-seeding and vegetation growth, November 2013.

The armouring and hardwood sill on the entry to the swale feature, November 2013.

FEATURE 4

Grassed Swale Diversion Channel

This was the final feature to be constructed as part of the works on Elilaw, but is the first element in the diversion of high flow waters from the Netherton Burn.

The feature comprises an armoured spillway and hardwood sill to divert excess water from the Netherton Burn as it reaches bank full capacity, at the point when water would naturally begin to spill onto the floodplain. A grassed swale was created, connecting this spill point to the low points on the floodplain, ultimately diverting flow to the floodplain storage area *(feature 2, above)*.

The swale connects to the Burn on the outside of an existing meander, and is designed to be functional only in extreme high flow scenarios. Water levels need to rise in the main channel in excess of 45cm above normal levels, thereby removing and storing the peak of the hydrograph.

The hardwood sill integrated to the swale entrance allows for future adjustment of the point at which the swale becomes active. For example if the landowner feels that the feature is taking water in lower level flood events and/ or too regularly, the sill can be heightened by dropping an extra layer in, meaning the water level in the Netherton Burn needs to rise further before entering the swale. Alternatively if larger flood events are occurring without the feature becoming active, the sill can be lowered to allow water in at a lower level.

Practical considerations and permissions required

- Implementation of this feature required land drainage consent, obtained from Northumberland County Council as it relates to an Ordinary watercourse (main river consents remain with the EA) due to the connecting nature of the inflow to the Netherton Burn. This site lies outside of a SSSI or other designation, but in these instances permission would also be required from Natural England.

Sediment Trapping – Research Findings

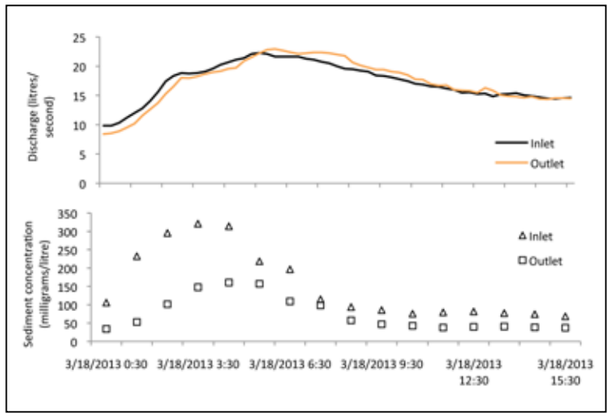
The series of sediment traps integral to the farm pond feature at Elilaw have been the focus of PhD research undertaken by Nicholas Barber, University of Newcastle Upon Tyne.

The following information summarises key findings from this research, and has been provided by Nick.

Sediment traps were constructed directly upstream of the flood storage pond to offer multiple benefits; to improve water quality by retaining sediment and nutrients, and to slow the sedimentation rate in the main pond. A terraced, three-cell sediment trap was constructed in a ditch that contributes approximately 90% of the flow to the site. A multi-cell design was used to maximise sedimentation potential by increasing the residence time in the feature, and to simplify maintenance by allowing easier removal of sediment. The sediment trap was monitored at the inlet and outlet to determine how much sediment and nutrients were removed from runoff during storms, as this is when the majority of pollutants are transported.

On average, over a period of one year (during storm events), the three-cell sediment trap reduced sediment load by 57%, total phosphorus by 45% and nitrate by 27%. The total volume of captured (wet) sediment was 22 m³, which equates to approximately 22 tonnes (dry). This is a trapping rate of 0.3 tonnes per hectare. It is estimated that if the 22 m³ of sediment were to reach the main pond at this rate it would reduce its water storage capacity by approximately 1% per annum. Extending the lifespan of the pond is important as it would be very arduous and expensive to dredge due to its surface area and depth. The phosphorus content of the retained sediment was found to be relatively high due to enrichment in fine particles, meaning it has potential value as a fertiliser/soil conditioner.

The sediment traps on the main farm pond inflow, viewed from the pond looking upstream. Photo August 2012.



Graphs showing simultaneous discharge and sediment concentrations at the inlet and outlet of the three-cell sediment trap during a storm event in March 2013.

Project Costs

NB Costs given here are net value and are intended as an indication only. Implementation of similar works at alternative locations will require site specific alterations to specifications and may incur VAT at the prevailing rate.

Feature reference	Work Element	Cost of Implementation
Feature 1 – Farm pond with offline storage capacity	Exploratory work to determine substrate and suitability of pond site	**£144**
	Excavation of farm pond feature and ancillary sediment trapping facilities, including sorting, relocation and storage of material for features 2 & 3	**£13,053**
	Initial maintenance, including clearing of sediment trap features	**£850**
Feature 2 – Floodplain offline storage area **Feature 3 – Ditch bund to divert high flows**	Building of two earth bunds using material from feature 1 with piped drainage Earth bund with piped drainage capability, creation of sediment trap area and installation of sluice drop-board equipment	**£8,754**
Feature 4 – Grassed swale to divert high flows from the Netherton Burn to the floodplain	Excavation of the swale feature, installation of drop board control and inlet reinforcement Temporary fencing to exclude livestock access to new swale	**£6,210**
	Re-seeding works to aid establishment of native grassland vegetation	**£1,255**
	Total Capital Costs:	**£24,677.00**

Multi-benefit Approach

The works on the land at Elilaw were developed with the intention of providing flood storage capacity upstream of Netherton, in a bid to reduce peak flood flows reaching the village and overwhelming local infrastructure, posing a flood risk to domestic properties and the community.

However, the works have offered a range of benefits:

- ✔ Attenuation of flood water – storage capacity and slowed flow rates
- ✔ Habitat creation and improved biodiversity.
- ✔ Improved water quality through sediment capture and nutrient removal
- ✔ Community involvement and engagement
- ✔ Acted as a catalyst for further works development in the catchment
- ✔ Increased climate change resilience for the farm holding and the wider community

References and Further Information

- Netherton Burn Runoff Management Plan – v4; October 2011; Mark Wilkinson and Paul Quinn, University of Newcastle Upon Tyne
- Feature 2a – multiple track bund features proposal
- Netherton Burn Runoff Management Plan phase 2 – feature 4 specifications

Further detail and information relating to flood and runoff attenuation features can be found via the following:

- http://research.ncl.ac.uk/proactive/
- Runoff Attenuation Features Handbook; Newcastle University & Environment Agency; April 2011

Department for Environment Food & Rural Affairs
The Scottish Government