If we assume that the flow should be higher at the lower flume (as suggested by the catchment area difference and the observed low flows) then we can estimate the impact on Qp. If we assume the first flow peak in storm A should be approximately 20% higher in flow than at the lower flume then the reduction in Qp is about 40%.

Attempts to upscale this work are now taking place in the EA Belford project (see Wilkinson, M., Quinn. P.F. and Welton, P. (2008), 'Belford catchment proactive flood solutions: storing and attenuating runoff on farms.' BHS symposium 2008, Exeter, U.K. http://www.ncl.ac.uk/iq/download/BelfordBHSpaper.pdf

More features at Nafferton Farm

Sediment flow from roads is redirected into ponds

Interception ponds capture fast polluting flow paths before they reach the ditch, the pond then stores flow and strips sediment from the runoff. Ideally ponds should capture runoff from roads and small ditches.

Sediment traps and a sedge wetland for nutrient pollution management

P trap
Sediment trap

Barriers retard flow and induce rapid sedimentation thus reducing phosphorus losses. The wetland can further remove nutrients.

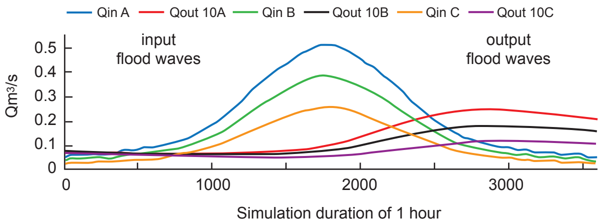
The sedge wetland

The usual V shape of the ditch is altered to be flat and wide (here the ditch is now 3m across).

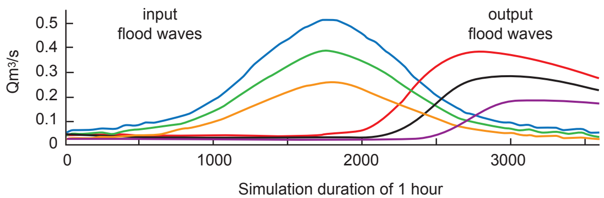
Conclusions

For storms that are of a magnitude of 1 in 1 year or less, we can observe storage and attenuation effects of differing degrees, dependent on the antecedent conditions and the storm magnitude. However, the observed hydrographs suggest that more temporary storage features could have a significant effect.

To upscale the effect of the smaller features to a larger scale – to the whole farm scale, we carried out hydraulic simulations for a range of scenarios using the Noah 1D hydraulic model. A simulation of a 500m ditch, which included a wide area of low gradient land with high roughness (such as a pond or wetland), greatly shifted the pattern of a theoretical flood wave. Equally, a scenario of a widened ditch (3m wide) with high roughness, running for 500m (such as the within ditch willow wetland), then the reduction in Qp could be significantly altered (see below). N.B. the time of travel of the flood wave with no features was determined as 7 minutes. Here we see that the time of travel is also greatly effected when simulated.



*500 m ditch with a 30*50m wetland*



*Widened ditch 3*500m and willow*

www.ncl.ac.uk/iq

www.youtube.com/proactivefarms

Paul Quinn, Sean Burke (EA) Jennine Jonczyk, Caspar Hewitt, Mark Wilkinson, David Rimmer

ESL earth systems laboratories

Newcastle University

CeG Civil Engineering and Geosciences

Flood storage and attenuation on farms

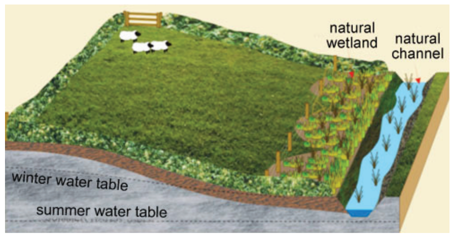
A landscape scale sustainable soft engineering option

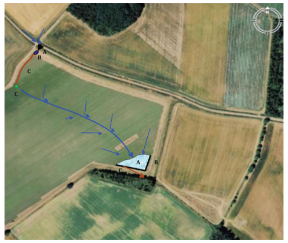
'A scheme that must have clear benefits to farmers and the Environment'

The PROACTIVE approach to farm runoff management is a joint initiative of the Environment Agency and the Newcastle University Earth Systems Laboratory initiative.

firm Plans are based on experience and evidence arising from full scale applications on farms working closely with farmers and farm advisors.

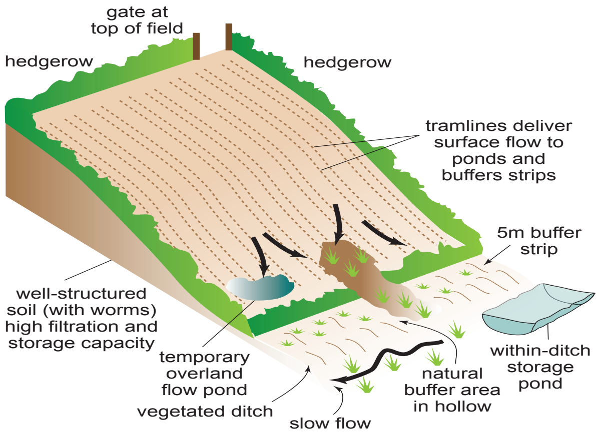
farm integrated runoff management plans





If a typical farm or small catchment can sacrifice 5-10% of the landscape to temporary runoff storage and mitigation features then the magnitude and properties of the runoff regime can be greatly altered.

The size, location, materials and vegetation used in the proposed features are the key to the practical, economical implementation and maintenance of the measures suggested by **firm plans**.



Options to reduce pollution and flood risk:

- Small temporary storage features in most fields, to slow and store flow and to capture sediment and phosphorus
- Features within small ditches to slow flow
- Wetlands and sediment traps in ditches, to radically alter the stream flow resistance
- Buffer strips that are put to effective work

Changes to planning/policy needed for effective **firm plans**:

- Temporary storage ponds, barriers, sediment traps and buffers to be made part of the stewardship regime on farms
- Construction, maintenance, and waste recovery (sediment and phosphorus) need to be funded activities.
- Agri-environment, flood risk management, carbon and renewable energy initiatives should be integrated together to create an incentive/payment scheme for farmers

A willow hurdle

Leaky barriers' of wood and recycled plastic

Willow planted in the ditch and a sediment trap during a storm

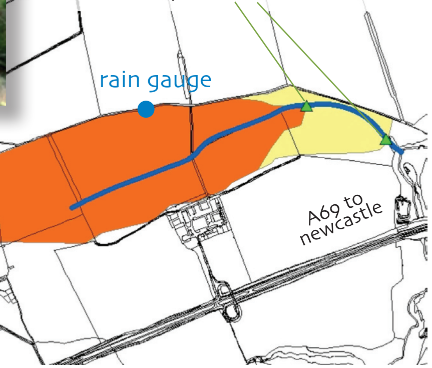
Numerous features have been trialled at Nafferton Farm

The channel is widened and flattened. Willow hurdles are constructed and willow is planted into the ditch bed. During storms flow is retarded and temporary ponds build up behind the features.

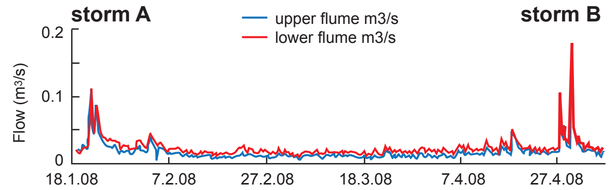
Barriers must be firmly embedded into the banks and the ditch bed. Overflow and energy dissipation must be made part of the design.

At Nafferton Farm, The Making Space for Water Initiative commissioned an experiment to test the attenuation effects of several features on flow propagation. Within a 400m stretch of ditch a series of attenuation features were present: the sediment trap; the vertical plastic barrier; the sedge wetland (25m long); the willow wetland (30m long) and three wooden leaky barriers. Thus the net impact of all the features on a flood wave magnitude could be made, i.e. Qp.

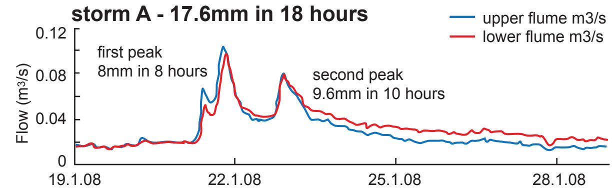
Two identical flumes were installed upstream and downstream of the 400m ditch experiment.



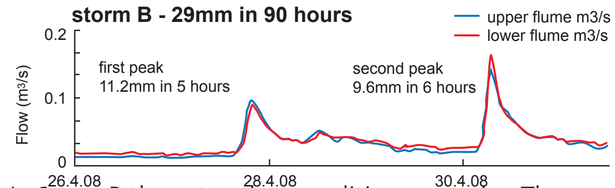
During 2008 both flumes recorded a series of storms for the 400m long within-ditch experiment



N.B. From the FEH software package – a 1 in 1 year storm event is estimated to be 12 mm in 5 hours or 26 mm in 1 day. During low flow periods the flow at the lower flume is consistently higher than at the upstream flume



In Storm A the first peak that passes through is much lower in flow at the lower flume than at the upper flume. The second flood wave is equal in flow to the upstream flume. We can postulate that the first flood wave is being affected by the physical storage volume provided by the features. In the second wave much of this physical storage maybe in use but the flow is still being attenuated but to a lesser degree.



In Storm B the antecedent conditions were dry. The first peak to pass is reduced in flow at the lower flume. The second, larger flood peak, has a higher flow at the downstream flume, and has less attenuation. This second peak is the largest event recorded to date and is close to a 1 in 1 year storm event which has fallen on a wet catchment.

N.B the time of travel for the flood wave is 20-25 minutes for 400m of travel (see later)