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# Monitoring the effects of Natural Flood Management on water quality in the Evenlode Catchment

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## Project Context:

Lowland catchments in the UK face multiple threats, particularly in terms of water quality degradation resulting from pressures including intensive farming, land-use and climate change. In an attempt to mitigate the impacts of these changes, integrated catchment management approaches such as 'Working with Natural Processes' (WWNP) and 'Natural Flood Management' (NFM) are currently being trialled. The Littlestock Brook NFM scheme in the Evenlode Catchment (Figures 1-2) is one of these trials, in which a variety of instream and land-based NFM interventions have been implemented across the rural landscape (Figure 3). In order to assess the potential water quality benefits and dis-benefits of these NFM features, local-scale hydrological and fluvial processes are being monitored.

Water quality can be determined by various chemical, physical, and biological characteristics (Figure 3). It is important to understand how their dynamics operate under intense storm conditions as well as baseflow conditions, and in the long-term.

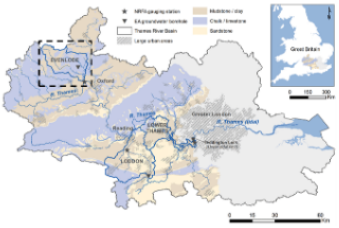


**Figure 1:** Thames Basin and Evenlode Catchment[5].


**Figure 3:** Key constituents of water quality.

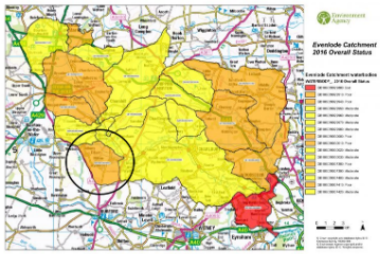


**Figure 2:** Evenlode Catchment WFD waterbody statuses for 2016 (Littlestock Brook circled)[6].

## Monitoring Network:

The NFM scheme and the wider Littlestock Brook waterbody are closely monitored by a network of hydrological sensors and equipment, using a range of technologies providing data at varying temporal resolutions (Figure 5).

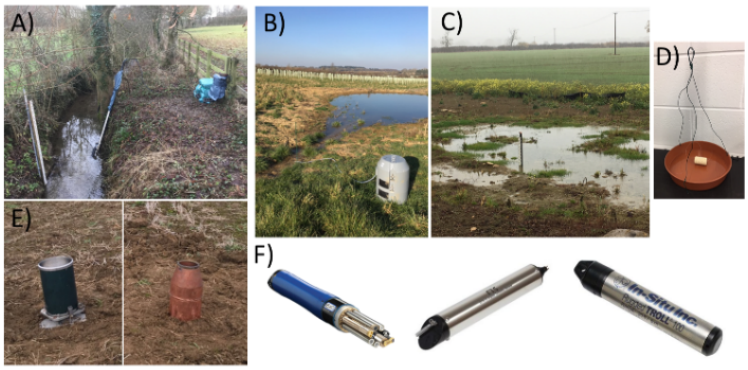


**Figure 5:** A) One of three long-term monitoring sites recording water level and turbidity at 5-minute intervals. B) An automatic water sampler next to the inlet of an online pond. C) Stage board and pressure sensor to measure water levels contained by a field corner bund. D) DIY sediment trap for quantifying sediment/nutrient deposition in ponds. E) Tipping bucket rain gauge (left) and storage gauge (right). F) High-resolution instruments for water quality, turbidity, and water level monitoring.

## References:

[5] Neumann *et al. J. Hydrometeorol.* **2018**, *19*, 1062.
[6] Environment Agency. *Evenlode Water Bodies Summary*. **2016**.
[7] Environment Agency. *Working with Natural Processes - Evidence Directory*. **2018**.
[8] Lloyd *et al. Sci. Total Environ*. **2016**, 543, 388–404.

## The Littlestock Brook NFM Scheme:

This scheme is the first NFM trial in the Thames Basin and was developed by the Environment Agency as a 5-year project (2016-2021) to address both WFD objectives and the national call for evidence on NFM effectiveness[7]. The scheme is being facilitated by the Evenlode Catchment Partnership (ECP) hosted by Wild Oxfordshire with the involvement of a wide range of partner organisations and stakeholders.

So far, the first phases of the scheme have seen a variety of NFM measures implemented across the 16.3 km$^2$ sub-catchment (Figure 4). Further implementation is ongoing, including the creation of riparian and floodplain woodland, field corner bunds, online sediment interception ponds, and wetland areas.




**Figure 4:** A) Drone imagery of field corner bunds storing water after a storm event in May 2018. B) One of the many 'leaky barriers' (woody dams) installed instream of the Littlestock Brook. C) Drone imagery of three on-line interception/storage ponds in the agricultural headwaters of the Littlestock Brook.

## Project Plans:

In addition to the current monitoring, several sampling/monitoring regimes will be put in place to build a conceptual model of water quality in the Littlestock Brook sub-catchment:

- Baseflow water sampling will be conducted regularly to characterise nutrient dynamics throughout the year.
- Data for storm events will be captured using automatic-samplers and sediment traps alongside manual sampling to evaluate the functioning of NFM features (Figure 6).
- Water quality sondes will be deployed to measure seasonal changes in dissolved oxygen, conductivity, and algal biomass.
- Flow measurements will be taken to create a rating curve, ultimately allowing sediment/nutrient fluxes to be calculated.

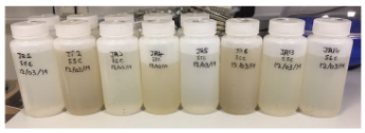

**Figure 6:** Water samples from a storm event prior to analysis for suspended sediment concentration.

## Data:

High-resolution data from storm events allows for detailed analysis of water quality dynamics and can be used to infer controls on sediment and nutrient transfers[8]. Turbidity is a good proxy for suspended sediment during these events and often matches peaks in water level (Figure 7). Hysteresis analysis can be used to characterise storm event behaviour and see the response of sediment mobilised in the catchment (Figure 8).

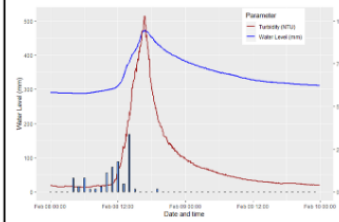


**Figure 7:** Hydrograph from a storm event in the Littlestock Brook, February 2019. Blue bars represent hourly rainfall (maximum rainfall of 4.2mm at 14:00 on 8th Feb).

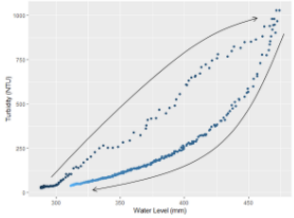


**Figure 8:** Clockwise hysteresis loop showing the relationship between water level and turbidity during a storm event in the Littlestock Brook, February 2019.

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