

# Phosphorus Export from Agricultural Catchments: The Role of Organo-Mineral Suspended Sediment Dynamics

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## River Wensum Demonstration Test Catchment

The Demonstration Test Catchment (DTC) initiative is a joint project between Defra, the Environment Agency, and the Welsh Assembly Government to evaluate the extent to which on-farm mitigation measures can cost-effectively reduce the impacts of diffuse agricultural pollution on river ecology whilst maintaining sustainable food production capacity. DTCs have been established in the Eden (Cumbria), the Avon (Hampshire), and the Wensum (Norfolk). This project will focus on the Blackwater sub-catchment of the River Wensum - an internationally important chalk groundwater fed river with SSSI and European SAC status due to the diversity of its lowland calcareous flora and fauna. However, 99.4% of the stream habitat is in an unfavourable or declining state due to nutrient enrichment from agriculture and sewage effluent.

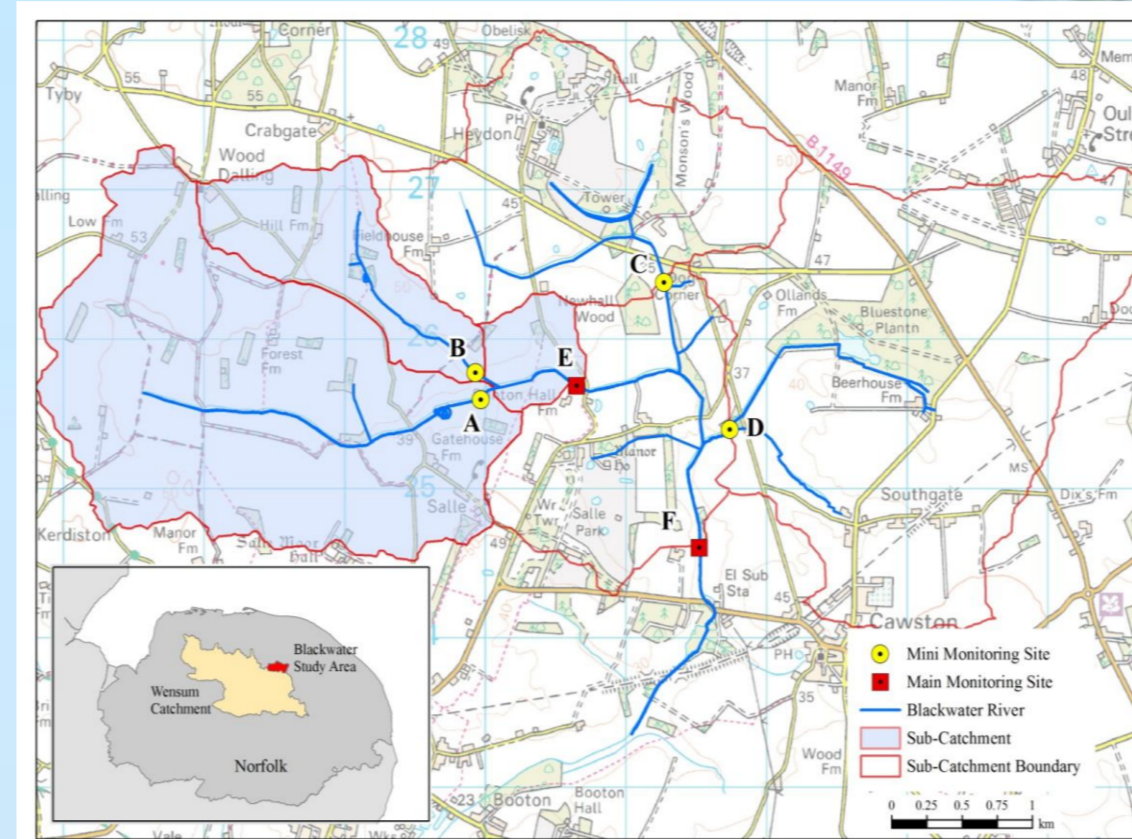


Fig. 1: Mini-catchment monitoring sites A, B, and E within the Blackwater sub-catchment of the River Wensum, Norfolk, where sampling will take place

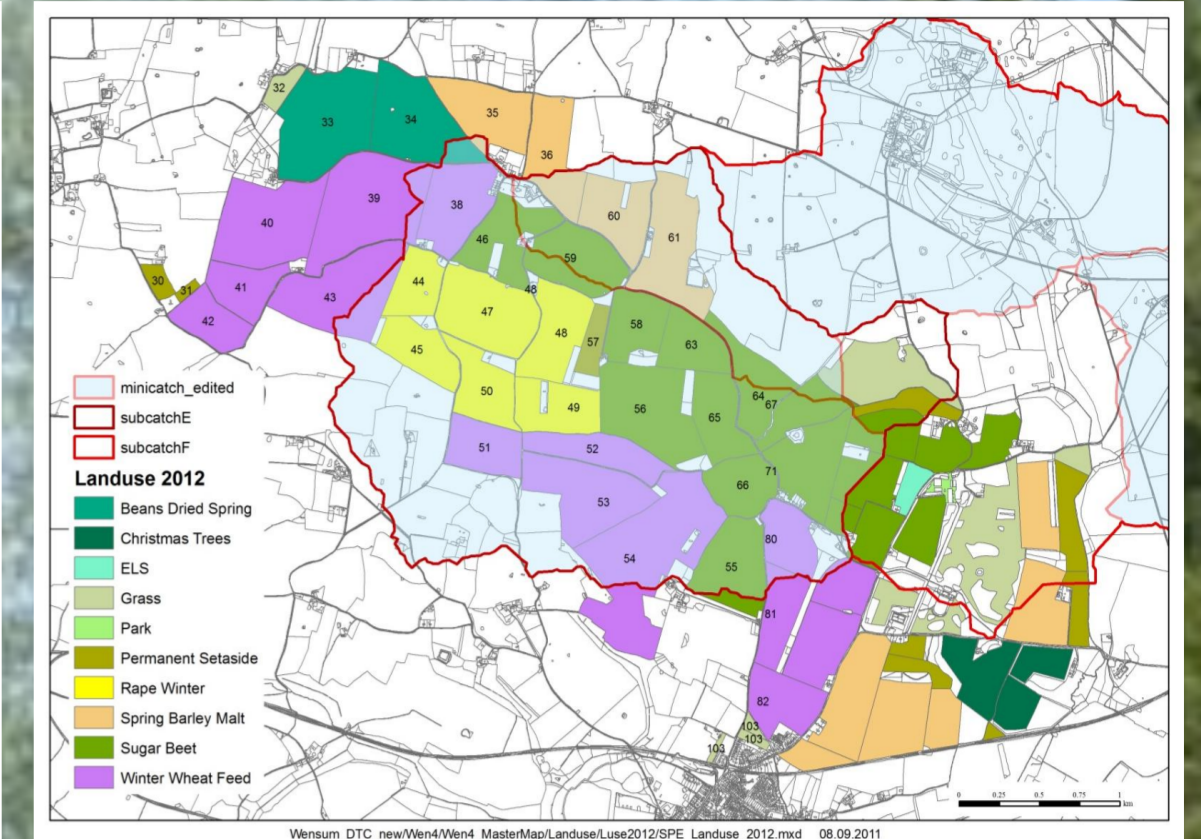


Fig. 2: 2012 field crop cover types for mini-catchments A, B, and E in the Blackwater sub-catchment

## Aims & Objectives

- To determine how the organo-mineral composition of suspended sediments controls in-stream phosphorus export, principally concerning concentrations of Fe and Al oxyhydroxides, organic matter, and cerium.
- To determine the spatial and temporal dynamics of phosphorus transport within and between storm events of differing magnitude.
- To assess the importance of field drain outflows in exporting phosphorus from beneath different crop types. Road runoff contribution will also be assessed.
- To monitor the impact of on-farm mitigation measures on suspended sediment chemistry, primarily the effectiveness of winter cover crops and reduced tillage.

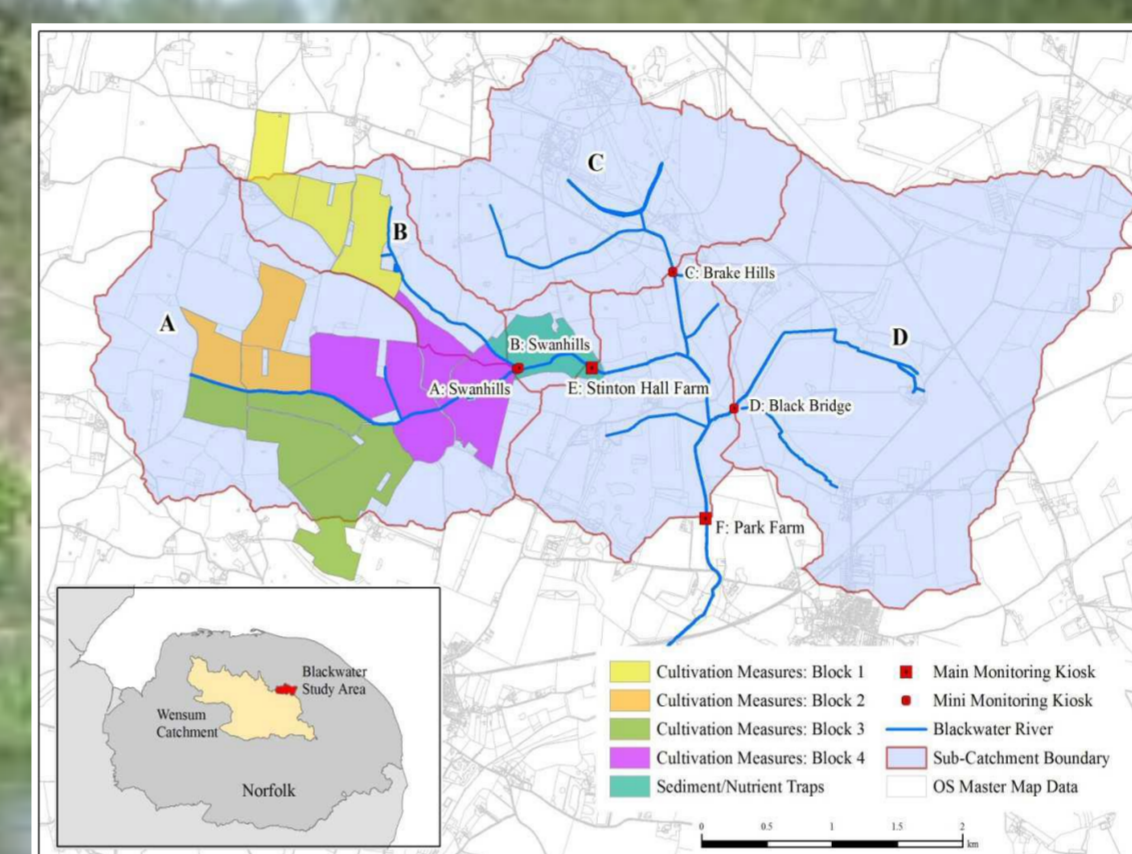


Fig. 3: Proposed areas for reduced tillage, cover crops, and a rural suitable drainage system (RSuDS). Measures commencing Autumn 2012

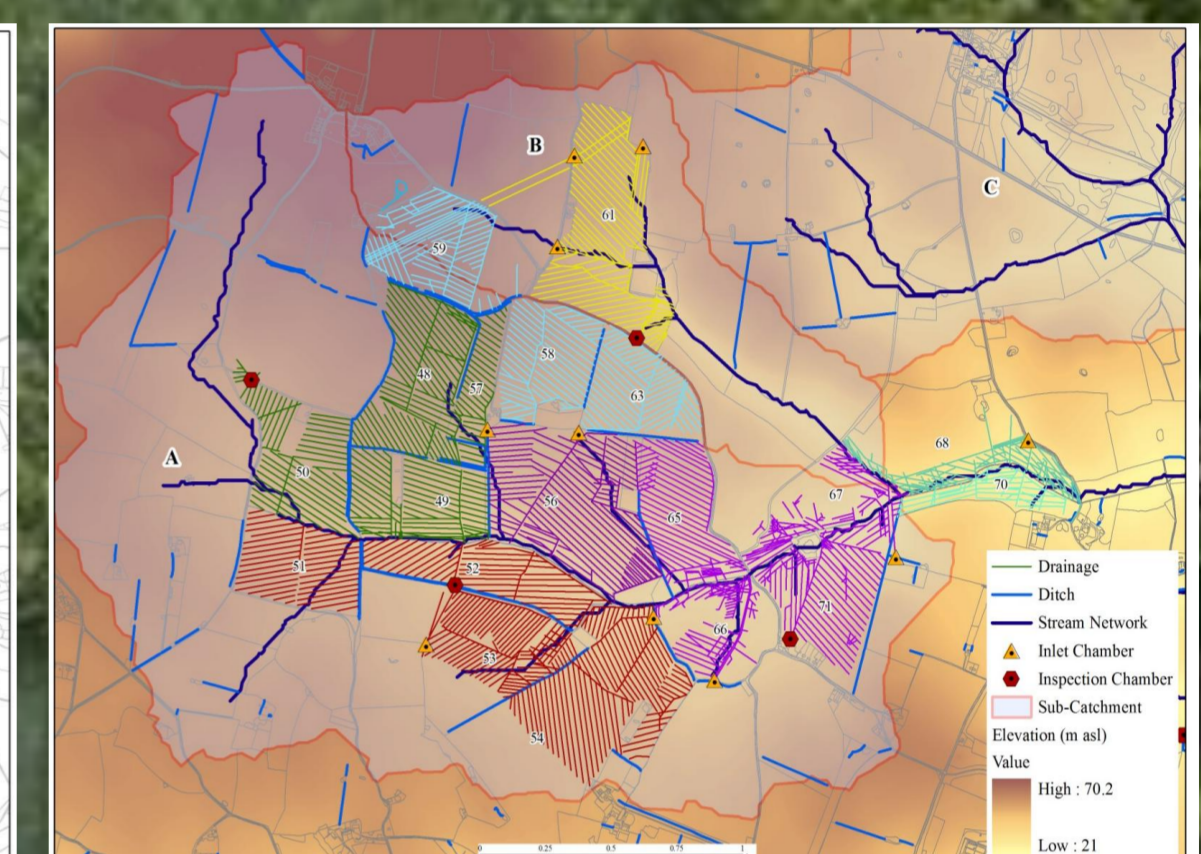
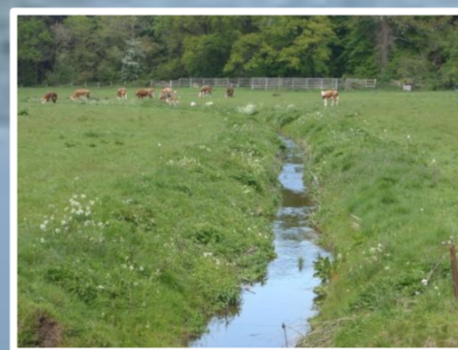
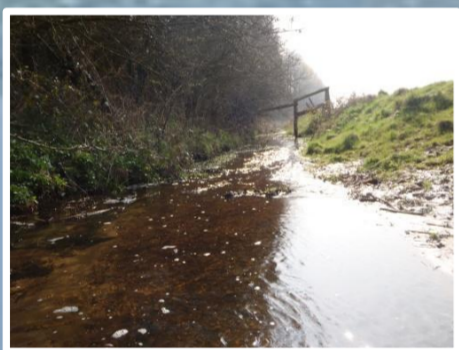


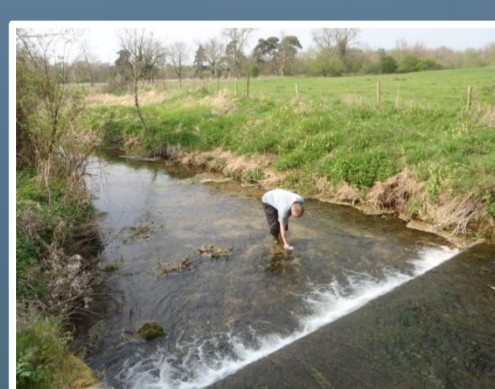
Fig. 4: Mini-catchment sub-surface field drainage network. The organo-mineral composition of sediments discharging from drains under different crop types will be analysed



## Storm Event and Baseline Sampling



ISCO automatic samplers in bankside monitoring stations are remotely triggered to capture 1 Litre samples every 30-60 minutes during a storm, capturing the entire event in high-resolution. Road runoff will also be grab sampled during storm events.



Weekly grab sampling under base flow conditions at sites A, B, and E will be conducted to analyse low flow suspended sediment chemistry and dynamics.



Field drain outflows under different crop types will be sampled at fortnightly intervals using sediment traps to help understand the importance of sub-surface drainage to catchment-wide phosphorus export.



All water samples will be vacuum filtered through quartz fibre filter papers to extract the suspended sediments in preparation for spectroscopic analysis.

## Filter Analysis: XRF and DRIFT

Wavelength dispersive X-ray Fluorescence spectroscopy (WDXRF) will be used to estimate elemental concentrations of P, Al, Fe, and Ce in suspended sediments trapped on filter papers. A calibration model is initially developed from reference standards with known elemental composition.

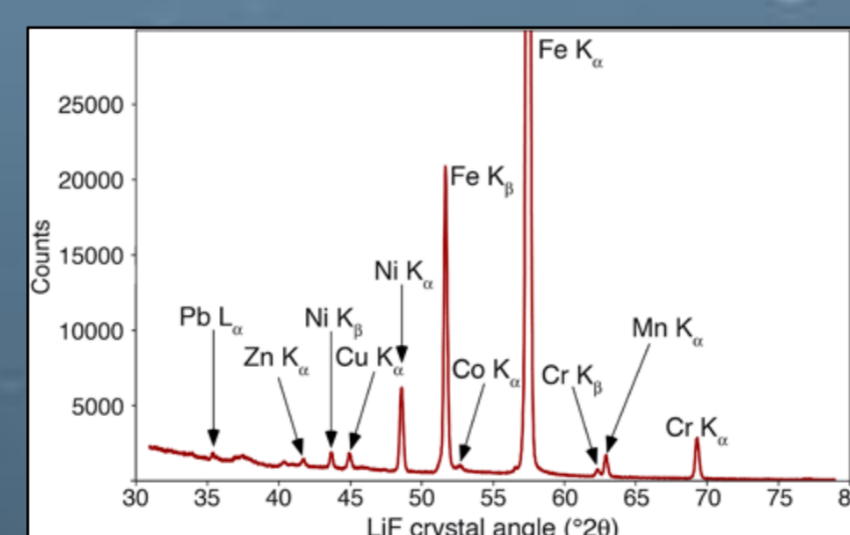


Fig. 5: Example sequential WDXRF spectra. Counts for each element are related to X-ray intensity and elemental concentrations

Filter papers will then be ground into a fine powder and scanned in a diffuse reflectance mid-infrared Fourier Transform (DRIFT) spectrometer. A PLSR model is calibrated from the spectra of reference sediments and used to estimate concentrations of organic matter and Fe/Al oxyhydroxides.

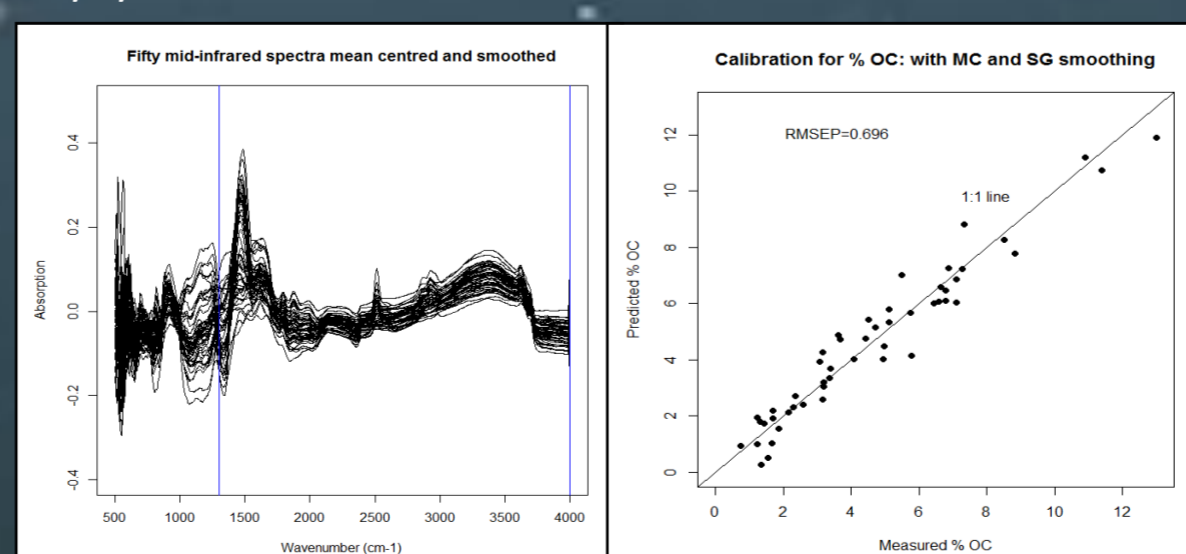


Fig. 6: Infrared spectra for 50 Wensum catchment reference samples with associated PLSR calibration for % organic matter

## Forecasting and Telemetry

A detailed weekly weather forecasting service is provided courtesy of Weatherquest, allowing us prepare in advance for storm event sampling. This is supported by a network of weather stations across the catchment.

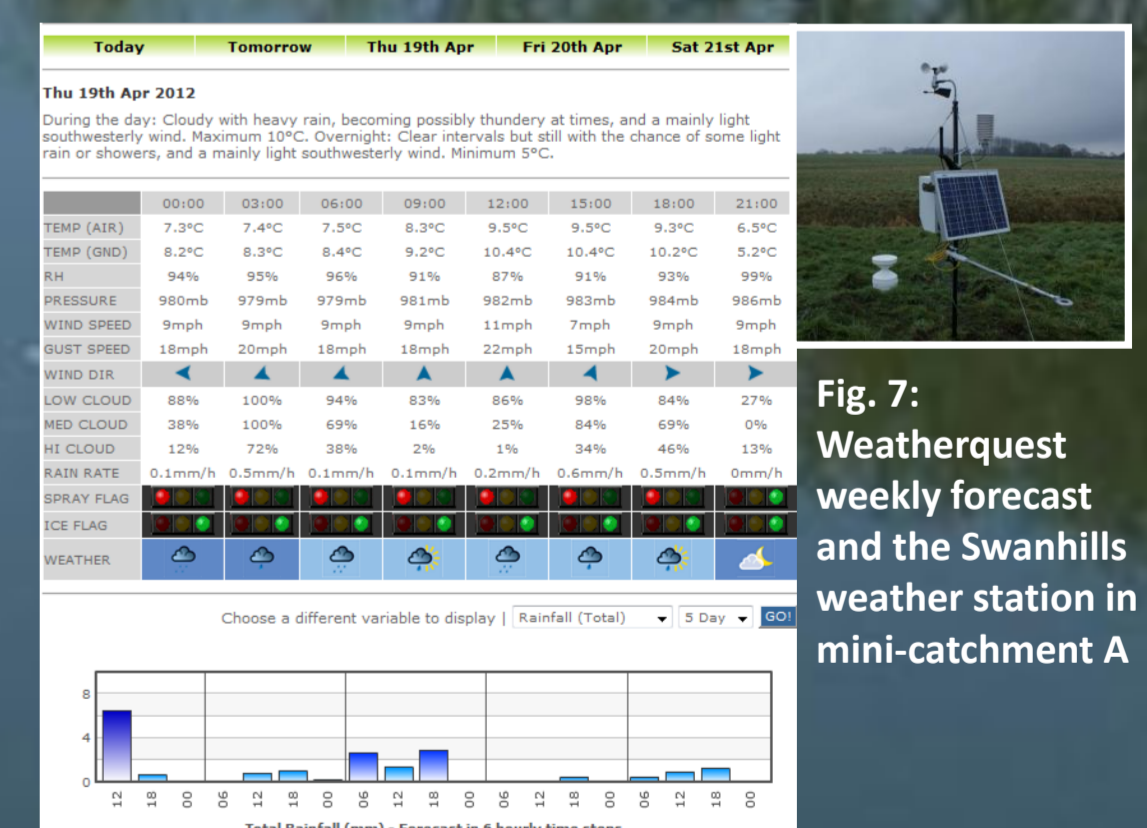


Fig. 7: Weatherquest weekly forecast and the Swanhills weather station in mini-catchment A

The advanced bankside monitoring stations have web enabled sensor technology that facilitates the continuous 30-minute interval and event-based sampling of both particulate and dissolved organic and inorganic constituents of stream water.

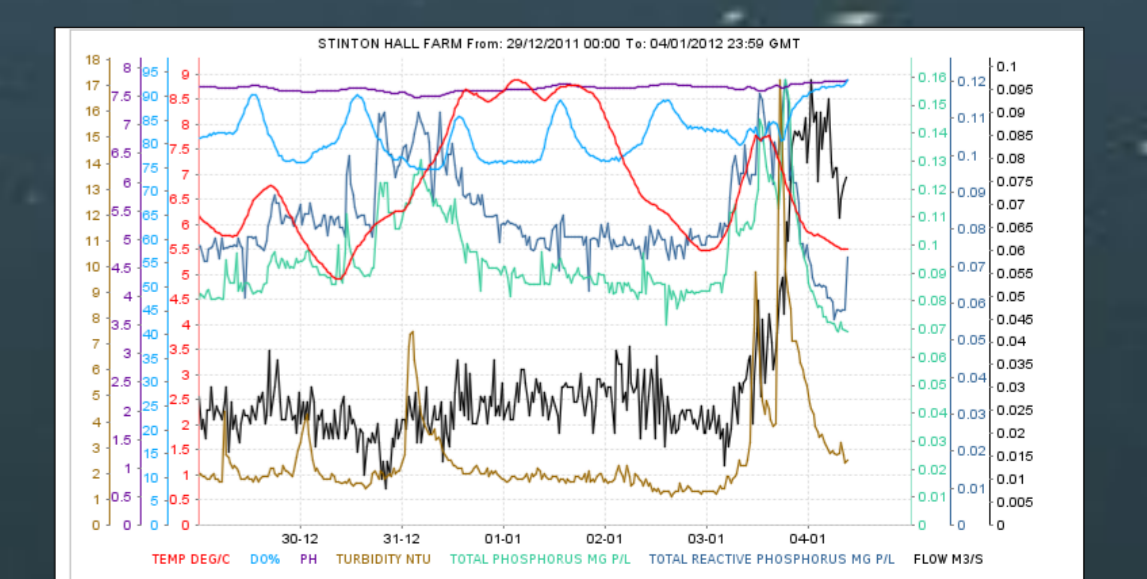


Fig. 8: Near real-time telemetry for bankside monitoring site E, provided courtesy of Meteor Communications Ltd