



Catchment Science

Fieldscale Monitoring Handbook

ATKINS

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Welcome!

We are delighted to share our field scale handbook with you and hope that you find it useful. We have brought together a number of easy-to-install monitoring measures that can be used to help understand the effectiveness of field scale agricultural measures or Natural Flood Management schemes in your catchments.



Fieldscale Monitoring



Monitoring Objectives

The monitoring approaches in this handbook have been developed to help support teams working on Catchment and Natural Flood Management Schemes and are intended to be:

- › Low cost and rapid-deployment, constructed using 'off-the-shelf' products/materials and/or market-ready suppliers;
- › Flexible enough to target individual measures and adaptable to individual farms and their landscape setting;
- › Cover a range of different agri-environment and NFM measures being promoted across the water industry;
- › Easy to understand to help scheme participants and other stakeholders understand why monitoring is being undertaken, and to allow other project partners to collect data where suitable (eg. as part of citizen science initiatives);
- › Based broadly on tried-and-tested monitoring approaches used as part of other studies;
- › Innovation approaches to monitoring that are standardised and transferable to different catchment projects and settings; and
- › Focussed on monitoring both hydrological and water quality parameters.

Working in Partnership

In our experience, a single organisation should take the lead on managing the data coming from a monitoring network, however, the establishment, maintenance and analysis of monitoring data can be collected and shared across a range of project stakeholders including:

- › Monitoring specialists from organisations across the water industry (e.g. Environment Agency, Water Companies and environmental monitoring providers);
- › Agri-environment officers, both from Natural England and other independents;
- › Students, such as year-in-industry, BSc, MSc, and PhD students conducting their project research within a catchment;
- › Agricultural scientists, such as those at UK research institutes;
- › Local landowners, who may be interested in further understanding their landholding;
- › Citizen scientists, including wider members of the public to assist in the collection of valuable monitoring data.

If you want further information on any of the content in this handbook or would like to suggest a monitoring approach that has been helpful to you do get in touch with Jay Neale (Jay.Neale@atkinsglobal.com) and David Gasca-Tucker (David.GascaTucker@atkinsglobal.com).

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Monitoring Summary Sheets






FLOW ESTIMATION WEIRS

WHAT IT LOOKS LIKE	TARGET MEASURES
	<ul style="list-style-type: none">> All types of measures
	HOW IT WORKS
	<p>A weir is a standard approach for the measurement of flows in channels. Water levels are monitored upstream of a fixed weir of known dimensions and, through the use of standard equations, are used to estimate flow passing over the weir. The weir pictured is a 90° v-notch weir.</p>



CATCHER DEVICES

WHAT IT LOOKS LIKE	TARGET MEASURES
	<ul style="list-style-type: none"> > Arable reversion > Two-year sown legume fallow > Cultivate and Till across slope > Winter Cover crops > Cultivate compacted tillage soils > For 'Yard Catcher' only - Improved management of manure in animal housing and yards (outflow channels) <p>HOW IT WORKS</p> <p>This approach involves installation of a catcher box. These allow sediment sampling and flow estimation on preferential runoff flow pathways, field drain outlets or yard drainage system outflows.</p> <p>A small v-notch weir on the downstream end of the box allows accurate measurement of flows. Under some flow conditions, the box may facilitate settlement of suspended matter which can be sampled.</p>
MATERIALS AND CONSTRUCTION	
<p>The catcher is constructed using a large plastic crate with a piped inflow. A rectangular or v-notch weir may be cut into the downstream end of the box to allow continuous estimation of flows (when combined with a stilling well and logger within the box). All pipework used in the pictured example is 110 mm PVC.</p>	
COSTS	
<p>The cost of the pictured example were as follows:</p> <ul style="list-style-type: none"> > Connecting pipework: £20 > Water level logger: £350 > V-notch box: £15 > Timber deflector £5 <p>Materials can be bought 'off the shelf' but require some modification and assembly.</p>	
DEPLOYMENT	
<p>Catchers can be placed in various locations:</p> <ul style="list-style-type: none"> > Within an established runoff channel (as pictured); > At the outlet of a field drain; > At an existing yard drainage outflow. <p>It may be necessary to modify the design for a specific location so to direct as much flow as possible through the catcher. In the pictured example a timber deflector was installed to ensure the full runoff pathway was captured.</p>	
SAMPLING STRATEGY	
<p>So long as the catcher is properly secured it can be a permanent feature. The catcher performs at optimum during large rainfall or storm events when runoff is greatest and when water samples should be collected. Loggers can record water levels at 15-minute intervals for several years before requiring attention, however monthly/bi-monthly visits are suggested.</p>	
HEALTH AND SAFETY AND OTHER CONSIDERATIONS	
<p>Manual handling and use of hand tools.</p>	
TRIED AND TESTED?	
<p>No. Innovation approach designed for our projects</p>	



SPOT SAMPLING

WHAT IT LOOKS LIKE	TARGET MEASURES
	<ul style="list-style-type: none">› All types of measures
	HOW IT WORKS
	<p>Spot sampling involves the collection of water samples from fields, ditches and rivers by trained field staff. Samples are then sent for analysis by an accredited laboratory.</p> <p>Spot sampling allows for the testing of a wide range of water quality parameters.</p> <p>In addition to sample collection, field observations should be made (e.g. weather conditions, approximate river levels/flows (qualitative) and any relevant site-specific information) and a digital photo of the river and site at the time of sampling are to be taken and retained for reference as required.</p>
	<p>Appropriate sample bottles for water quality parameters of interest (usually supplied by laboratory); telescopic sampling scoop (or similar collection device); plastic funnel.</p>
	<ul style="list-style-type: none">› Laboratory analysis costs: £65-£100 per sample (greater if looking for a longer list of parameters)› Field staff time: £300-£400/day
	<p>Samples to be taken from monitoring locations as required (e.g. in a field downstream of a runoff catcher/in a ditch/ in river). Surface samples to be taken just below the water surface level, avoiding any visible scum or debris.</p>
	<p>Routine sampling to be carried out at key sites, with additional sampling to be undertaken alongside storm events/ capturing samples from runoff catcher/drain catcher.</p>
	<ul style="list-style-type: none">› Telescopic sampling scoop to be used to ensure staff can maintain safe distance from water when sampling› Gloves to be used to ensure sample is not contaminated and operative is protected from waterborne diseases etc.› Lifejackets to be worn if sampling over or on the water as well as any other site-specific PPE deemed necessary.
	<p>Yes. Standard approach used by the Environment Agency as part of WFD monitoring.</p>



AUTO SAMPLING

WHAT IT LOOKS LIKE	TARGET MEASURES
	<ul style="list-style-type: none">› All types of measures
	<h3 data-bbox="673 472 1220 514">HOW IT WORKS</h3> <p data-bbox="673 514 1220 767">This involves the use of an autosampler device that automatically collects water samples based on an environmental trigger (e.g. rainfall). The unit is triggered remotely, and samples are then collected by field staff and analysed by a laboratory. The autosampler pictured holds a carousel of up to 24 bottles allowing for multiple samples to be taken over the course of an event.</p>
MATERIALS AND CONSTRUCTION	
<p data-bbox="114 809 1220 913">Consists of the use of a manufactured autosampling device (e.g. from ISCO). Unit to be placed on the river bank on a stable surface (weights could be used to keep unit level). Sampling tube deployed in to river.</p>	
COSTS	
<p data-bbox="114 955 1220 1106">Costs of this sampling kit are mid-range:</p> <ul style="list-style-type: none">› Unit cost from ISCO: £5000› Field staff Time (£300-400 per day)› Laboratory analysis costs: £65-£100 per sample (greater if looking for a longer list of parameters)	
DEPLOYMENT	
<p data-bbox="114 1148 1220 1279">Autosampler is best placed alongside existing real-time water quality sampling equipment or level sensors to aid successful triggering during storm events.</p> <p data-bbox="114 1279 1220 1279">Sample tube length must be measured to ensure good operation.</p>	
SAMPLING STRATEGY	
<ul style="list-style-type: none">› Units to be located at key points within a catchment where run-off is occurring to gather information during storm events.› Units may be repositioned/redeployed where necessary and can be considered mobile.	
HEALTH AND SAFETY AND OTHER CONSIDERATIONS	
<p data-bbox="114 1477 1220 1608">Whilst mobile, the units are heavy, so two people required to transport unit.</p> <p data-bbox="114 1523 1220 1608">Take care when working close to water's edge for unit and sample tubing deployment. Lifejackets must be worn if working close to deep water.</p>	
TRIED AND TESTED?	
<p data-bbox="114 1650 1220 1713">Yes. Standard approach used by the Environment Agency as part of WFD monitoring.</p>	



FLUVIAL AUDIT

WHAT IT LOOKS LIKE	TARGET MEASURES
	<p>Any measure designed to significantly reduce sediment runoff into a channel, or allowing channels to return to more natural state, e.g.</p> <ul style="list-style-type: none">> Using vegetation buffer strips;> Improved management of manure in animal housing and yards (outflow channels);> Keep stock away from watercourses;> In channel measures to slow flow
MATERIALS AND CONSTRUCTION	HOW IT WORKS
<p>Check-sheet of feature types to record (e.g. GeoRHS categories); detailed base map of reach to be surveyed; clipboard, pencil, rubber, pens (or mobile mapping device).</p>	<p>A series of at least two surveys recording locations and dimensions of geomorphological forms along a 500m reach of channel. Interpretation of the change in geomorphological forms before and after implementation of target measures will inform how measures have affected geomorphological processes and hence how effective they have been.</p>
COSTS	<p>Mainly linked to staffing surveys, estimated as follows:</p> <ul style="list-style-type: none">> Field work – 1 person day (2 people, ½ day ea.) per 500m reach (£300-400 per day)> Follow-up desk work (GIS) to capture data – 1 person day per 500m reach (£300-400 per day)> To capture 1 pre and 1 post measure implementation data set requires 2 person days (plus any associated time to accommodate H&S management, land access and travel time)
DEPLOYMENT	<p>Method most effective if deployed in channels where effects of measures are most pronounced e.g.:</p> <ul style="list-style-type: none">> Small ditch with a significant proportion of its catchment area covered by a farm yard;> Measures being put in place to reduce sediment ingress to ditch from farm yard;> A channel regularly used by cattle for watering with measures being put in place (e.g. fencing) to exclude cattle from channel
SAMPLING STRATEGY	<p>Minimum of one survey prior to or soon after implementation (i.e. one year after employment of method). Ideally there should be multiple surveys in different seasons (e.g. 2 pre and 3 post) to confirm effect and evolution of measures and potentially determine trends.</p>
HEALTH AND SAFETY AND OTHER CONSIDERATIONS	<p>Sensible precautions for field work adjacent to water, such as the use of lifejackets and relevant PPE.</p>
TRIED AND TESTED?	<p>Yes. https://www.therrc.co.uk/MOT/References/EA_DEFRA_Guidebook_of_applied_fluvial_geomorphology.pdf and Sear DA, Newson MD, Brooks A. 1995. Sediment related river maintenance: the role of fluvial geomorphology. Earth Surface Processes and Landforms 20, 629-647.</p>



FIXED POINT PHOTOGRAPHY

WHAT IT LOOKS LIKE



TARGET MEASURES

- > All types of measures.

HOW IT WORKS

A fixed-point photography platform allows repeat photos to be taken of a feature. The fixed platform ensures that a photo can be taken over many occasions from the exact same viewpoint to build reliable photographic evidence (which can be used to create an animated time lapse).

MATERIALS AND CONSTRUCTION

The fixed photo point consists of a wooden post driven into the ground with a post cap providing a level platform from which to take repeat photos from. A suitable platform could also be affixed to an existing post if present.

COSTS

Time to build is low as the materials can be bought 'off the shelf' and on-site assembly is minimal:

- > Timber - £10

DEPLOYMENT

Permanent post marker to be located at key points to illustrate change over time. Consideration should be given to locating markers at particular run-off locations where in line with linear features. It is important that the post is secure and that it is positioned in a location unlikely to be disturbed (by farm vehicles etc.).

SAMPLING STRATEGY

Photos to be taken on every site visit in conjunction with other monitoring. Where sites are only scheduled to be visited infrequently, photos should be taken at least twice per year, once in winter and once in summer so as to coincide with minimum and maximum vegetation growth.

HEALTH AND SAFETY AND OTHER CONSIDERATIONS


Steel toe cap boots and gloves to be used when installing post as well as all relevant PPE.

TRIED AND TESTED?

Yes. Fixed point photography is a standardised way of observing change in the natural environment.




CORING

WHAT IT LOOKS LIKE	TARGET MEASURES
	<ul style="list-style-type: none">> Creation of wetlands;> Creation of swales;> Creation of Ponds and Scrapes;> Small leaky woody dam;> Large leaky woody dam;> Improved management of manure in animal housing and yards (outflow channels).
	HOW IT WORKS
	<p>The sediment corer has a pointed end that pierces the bed sediment. The pipe is perforated to drain any water in the corer as it is pulled out. This is important to keep the soil core intact. The core can then be extruded using a plunger, or the sediment scraped out.</p>




SEDIMENT SETTLER

WHAT IT LOOKS LIKE	TARGET MEASURES
	<ul style="list-style-type: none">> Creation of wetlands;> Creation of swales;> Creation of Ponds and Scrapes;> Small leaky woody dam;> Large leaky woody dam.
MATERIALS AND CONSTRUCTION	
<p>The sediment settler consists of a shallow box or tray with a small base of concrete poured into the base of the box and is left to dry. The concrete should be of sufficient depth to weigh the box down and keep it steady at the bottom of the pond, wetland or watercourse. The picture above shows a box 15cm deep, 18 cm wide, 28cm long).</p>	
COSTS	
<p>The costs of this sampling kit are low and are as follows:</p> <ul style="list-style-type: none">> Shallow plastic tupperware box: £5;> Concrete ballast: £3. <p>Time to build is low as the materials can be bought 'off the shelf' and minimal assembly is required.</p>	
DEPLOYMENT	
<p>The sediment settler is placed within the watercourse or water feature, close to where it is deepest and widest or closest to the flow path thought to contribute sediment.</p>	
SAMPLING STRATEGY	
<p>It should be left for a sufficiently long period of time that enough sediment can be deposited into the box. When collecting the catcher, the lid of the box is placed on top before the sampler is raised from the bed. This ensures the integrity of the sample and that no sediment is lost. Because the catcher is of a known surface area, accumulation rates per unit area can be calculated using this method.</p>	
HEALTH AND SAFETY AND OTHER CONSIDERATIONS	
<p>Waders and life jackets will be required in ponds of the type discussed in this example.</p>	
TRIED AND TESTED?	
<p>Yes. Adapted from other similar approaches.</p>	



SOIL SAMPLING

WHAT IT LOOKS LIKE	TARGET MEASURES
	<ul style="list-style-type: none">> All types of measures
	HOW IT WORKS <p>This sampling helps to understand the Phosphorus, Nitrogen and Potassium in the soil and is a standard agricultural practice.</p>
MATERIALS AND CONSTRUCTION	
A coring device is required for this sampling approach, although a trowel of a suitable length could also be used.	
COSTS	
Costs may vary but are generally: <ul style="list-style-type: none">> Laboratory analysis costs: £65-£100 per sample (greater if looking for a longer list of parameters)> Staff time: £300-£400/day	
SAMPLING STRATEGY	
On arable land that is regularly ploughed samples should be taken to a depth of 0-20 cm - on grassland a depth of <10cm is recommended. Relevant guidance indicates that at least 25 individual cores should be taken and bulked together to give a single soil sample for analysis of half to one kilogram in weight. These cores should be taken by walking the field in a 'W' or other representative pattern.	
HEALTH AND SAFETY AND OTHER CONSIDERATIONS	
Steel toe cap boots and gloves required plus any relevant PPE required for specific site needs.	
TRIED AND TESTED?	
Yes. See Natural England (2018). Soil Sampling for Habitat Creation and Recreation. Natural England Technical Information Note TIN035 (http://publications.naturalengland.org.uk/publication/31015).	



SOIL ACCUMULATOR

WHAT IT LOOKS LIKE	TARGET MEASURES
	<ul style="list-style-type: none">> Arable reversion;> Two-year sown legume fallow;> Cultivate and Till across slope;> Winter Cover crops;> Cultivate compacted tillage soils.
	HOW IT WORKS
	<p>Silt fence is installed at a field corner or edge on runoff flow pathway to aid quantification of sediment volumes in runoff.</p>



WATER LEVEL MONITORING

WHAT IT LOOKS LIKE	TARGET MEASURES
	<ul style="list-style-type: none">> In channel features (e.g. woody debris)> Storage areas (as pictured)
	<h3>HOW IT WORKS</h3> <p>The self-contained logger installed inside the stilling well is programmed to measure pressure (from which water levels can be calculated) at a specified interval (typically 15 minutes). This data can then be downloaded in the field using a laptop to retrieve the data.</p>
MATERIALS AND CONSTRUCTION	
<p>The key components of the construction of a water level monitoring location are a stilling well and stage board to measure water levels upstream and/or house a logger, and the weir itself.</p> <p>Stilling wells are fabricated from 63 mm OD HDPE slotted pipe, fixed to a 50 x 50 mm timber post and fitted with a lockable cap.</p>	
COSTS	
<p>Water level monitoring installations each comprising a logger housed in stilling well and stage board breakdown below:</p> <ul style="list-style-type: none">> Stilling well: £25> Stageboard: £60> Post and fixings: £10> Water level logger: £350> 10m direct read cable (so logger can be downloaded from bank): £90 <p>To calculate water levels, a barometric logger measuring air pressure is also required (£300). Only one of these is required per site.</p>	
DEPLOYMENT	
<p>Once installed loggers can record water levels at 15-minute intervals for several years before requiring attention, although monthly or bi-monthly visits are suggested.</p>	
SAMPLING STRATEGY	
<p>Once deployed, the level monitoring location can be left unattended for extended periods although monthly or bi-monthly visits are suggested. Maintenance should comprise cleaning the stage board to ensure it remains clearly legible and clearance of silt from in and around the stilling well.</p>	
HEALTH AND SAFETY AND OTHER CONSIDERATIONS	
<p>Installations of this type of equipment could take place in watercourses and therefore relevant PPE (waders, life jackets etc.) should be worn.</p>	
TRIED AND TESTED?	
<p>Yes. Industry standard monitoring technique.</p>	



SOIL STICK

WHAT IT LOOKS LIKE	TARGET MEASURES
	<ul style="list-style-type: none">> Cultivate and Till across slope;> Winter Cover crops;> Management of wetlands, ponds, swales and scrapes;> Water features to intercept water, sediment and nutrients;> Small leaky woody dam;> Large leaky woody dam;> Check dams.
	<h3 data-bbox="673 599 1225 643">HOW IT WORKS</h3> <p data-bbox="673 643 1225 923">The soil stick provides a quick visual reference for soil accumulation or erosion from a field.</p>
MATERIALS AND CONSTRUCTION	
<p data-bbox="114 967 1225 1030">A graduated post (e.g. wooden fence post with metal rule attached for accurate measurement).</p>	
COSTS	
<p data-bbox="114 1073 1225 1117">The cost of this sampling kit is low and is as follows:</p> <ul style="list-style-type: none">> Post and metal rule £10. <p data-bbox="114 1157 1225 1209">Time to build is low as the materials can be bought 'off the shelf' and require minimal fabrication.</p>	
DEPLOYMENT	
<p data-bbox="114 1252 1225 1372">The soil stick should be located in areas susceptible to soil erosion or accumulation. The soil stick should be graduated and driven in to the soil. Starting depth should be recorded on initial deployment. It is important that the post is secure and that it is positioned in a location unlikely to be disturbed (by farm vehicles etc.) as monitoring of soil erosion or accumulation is dependent on the stick remaining in a fixed position.</p>	
SAMPLING STRATEGY	
<p data-bbox="114 1416 1225 1487">Photos/readings to be taken on an ad-hoc basis throughout the year, coinciding with other site visits and also from landowner during farm operations (where possible).</p>	
HEALTH AND SAFETY AND OTHER CONSIDERATIONS	
<p data-bbox="114 1530 1225 1582">Suitable PPE during installation.</p>	
TRIED AND TESTED?	
<p data-bbox="114 1626 1225 1698">Yes. Standard approach used to measure rates of accretion.</p>	



TIME LAPSE AND WIRELESS CAMERAS

WHAT IT LOOKS LIKE	TARGET MEASURES
	<ul style="list-style-type: none"> > Water levels > Feature functioning and inform ongoing maintenance requirements
	<th data-bbox="674 491 1225 533">HOW IT WORKS</th>
<p>These types of camera work on the same principal as fixed point photography but allow for automated image capture.</p> <p>Time Lapse cameras (not pictured) take photos at a set frequency. They are smaller than wireless cameras and can be moved easily, however require to user to visit the site to download and clear the memory as well as to change batteries.</p> <p>Wireless cameras (pictured) are a semi-permanent installation, where photos are taken remotely and transmitted to an online portal for archiving and viewing. Photos can be taken at fixed intervals or on demand using the online portal. The model pictured is a Meteor Communications Camera Pillar System.</p>	
MATERIALS AND CONSTRUCTION	
<p>Time Lapse cameras can often be placed upon pre-existing structures but may need a stand construction where there is no suitable alternative.</p> <p>Wireless cameras are likely to require the construction of a tamperproof and waterproof camera housing structure to which a mount for solar panels may also be required.</p>	
COSTS	
<p>These are an upgrade on the £10 fixed point photography stand:</p> <ul style="list-style-type: none"> > Automatic time-lapse camera: ~£400 > Wireless camera with remote recording: (~£400-2,500 depending on model with £300/a subscription). 	
DEPLOYMENT	
<p>Time lapse cameras can be deployed in a variety of places due to their discrete size.</p> <p>Wireless cameras would require a fixed mounting system, designed for the areas in question.</p>	
SAMPLING STRATEGY	
<p>A time-lapse or wireless camera could be programmed to capture images every hour; with time lapse cameras needing to be regularly attended to have the data downloaded and wiped – intervals depending on memory size and capture frequency.</p>	
HEALTH AND SAFETY AND OTHER CONSIDERATIONS	
<p>Areas of emplacement may have soft and wet under footing to which wellies and waterproofs are advised. Construction and fixation to objects may require relevant hand and eye wear so as to avoid the likely hood of debris such as splinters.</p>	
TRIED AND TESTED?	
<p>Yes. Commonly used for catchment projects and extensively used by the Environment Agency.</p>	



DRONE PHOTOGRAPHY

WHAT IT LOOKS LIKE	TARGET MEASURES
	<ul style="list-style-type: none">> All measures.> Particularly effective at showing the 'bigger picture' rather than at an individual measure scale.
	<h3 data-bbox="674 500 1225 540">HOW IT WORKS</h3> <p data-bbox="674 548 1225 639">Drones or UAVs (Unmanned Aerial Vehicles) can be used to capture aerial imagery of a site or can be fitted with a range of specialist sensors for additional data acquisition (e.g. LiDAR).</p>
MATERIALS AND CONSTRUCTION	
No materials or construction required – drone only.	
COSTS	
<p data-bbox="114 1041 1225 1132">Drones may be either bought for commercial use or hired out; both requiring a licenced pilot as well as permission from the Civil Aviation Authority. The prices vary depending on the work needed to be carried out, but a one-off drone shoot would be more cost effective if both the drone and pilot were of a short hire period, such as a day. To train and buy a drone the following costs may be incurred:</p> <ul data-bbox="114 1140 1225 1220" style="list-style-type: none">> A drone may range from: £500 – £10,000> Pilot training and licensing to gain UK CAA PfCO: ~£1000> Permission from the CAA: small annual registration charge ~£20	
DEPLOYMENT	
Drones are ideally suited to be flown in clear, dry conditions where there is little cross wind. Failure to fly in such conditions may result in poor data acquisition or damage/loss of drone.	
SAMPLING STRATEGY	
Drones are flown over an area interest and take imagery of the catchment.	
HEALTH AND SAFETY AND OTHER CONSIDERATIONS	
Operation of drones of a weight greater than 250g and lighter than 20kg fall under the guidance of the Civil Aviation Authority (CAA). Permission will need to be obtained from the CAA, the types of permission will vary depending on location of the site.	
TRIED AND TESTED?	
Yes. Has been used successfully for our catchment projects. Image Courtesy of Kestrel Photography.	



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