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Phosphate Reduction Feasibility Study

A report to Natural England on behalf of the Herefordshire Local Nature Partnership

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Rural Hubs Partnership Herefordshire

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1: The phosphate [1] problem in Herefordshire

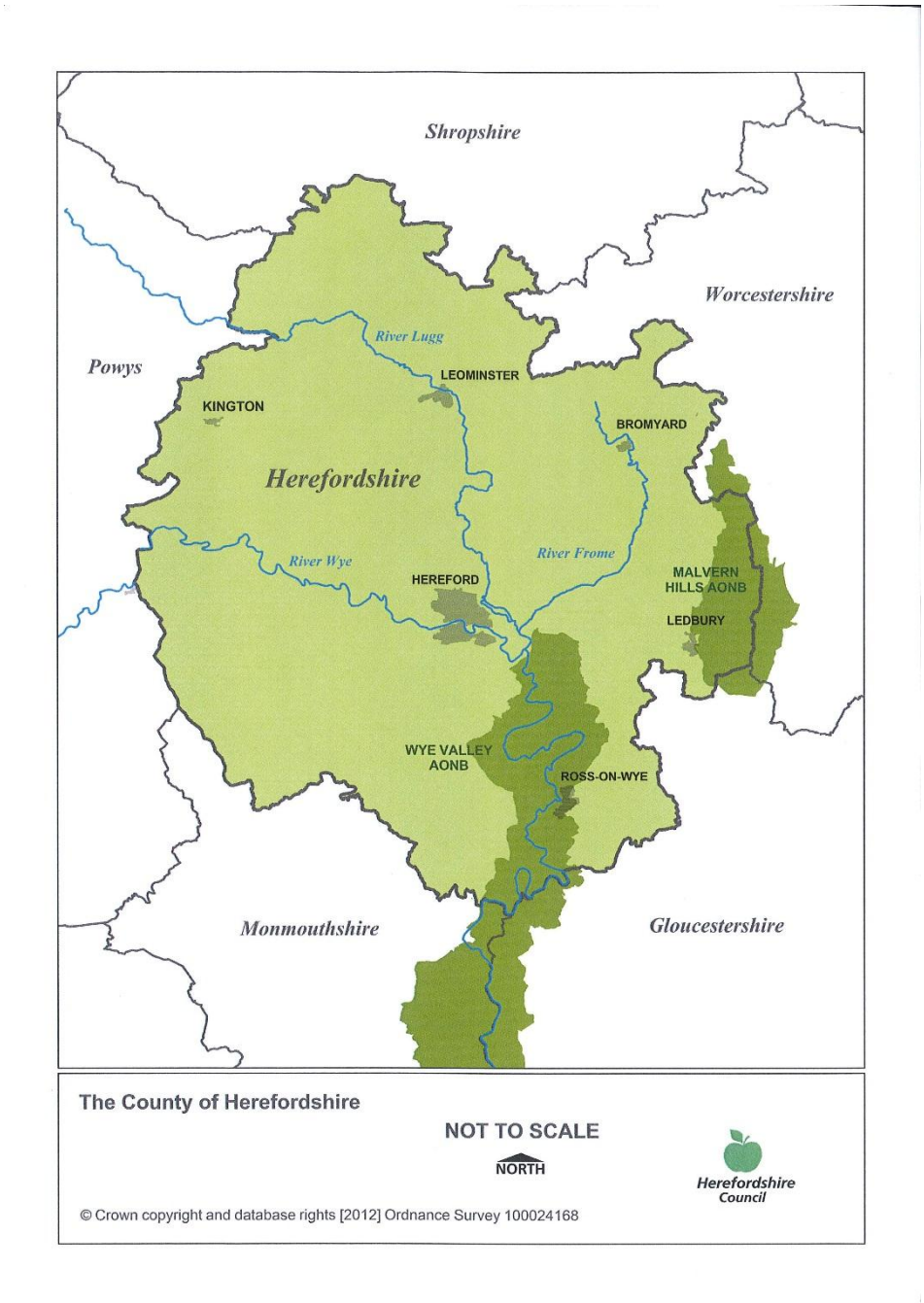


Figure 1: The principle river catchments of Herefordshire

Three major pieces of European legislation impact on Herefordshire with respect to phosphates in water:

- the Water Framework Directive
- the Habitats Directive
- the Urban Waste Water Directive

Notes

[1] Soil and water analysis measures levels of phosphorus in mg/l whilst phosphorus fertilisers are applied as phosphates (P_2O_5) and fertiliser analysis prescribes levels of phosphate. Throughout the report we use phosphorus and phosphate interchangeably.

The Water Framework Directive (Directive 2000/60/EC for "establishing a framework for the Community action in the field of water purity", adopted 22nd December 2000) is the most substantial piece of European legislation produced to date concerning water quality and a major driver for achieving sustainable water management. It requires that all inland and coastal waters within defined river basin districts must reach at least "good" status by 2027 and defines how this should be achieved through the establishment of environmental objectives and ecological targets for surface waters. Water management needs to take account of environmental, economic and social considerations. The Environment Agency has assessed all rivers in England and Wales for a number of environmental and chemical factors, including phosphate and oxygen levels, to support the implementation of the Water Framework Directive which leads to the characterisation of a water body's ecological status as: High, Good, Moderate, Poor or Bad. A water body with "High" status is considered to be in near-natural condition. In many cases, however, these classifications are the subject of debate as necessary data were not always readily available.

The "Habitats Directive" (Council Directive 92/43/EEC on the conservation of natural habitats and of wild flora and fauna, adopted 21st May 1992) is the legal framework for the EU's conservation policy, alongside the "Birds Directive" (Council Directive 79/409/EEC, adopted on 2nd April 1979). Member states are required to maintain or restore protected habitats and species at a "favourable conservation status" and contribute to a coherent European framework of protected sites (the "Natura 2000" network) by designating Special Areas of Conservation (SACs) for habitats and species listed in the Annexes of the Directive. The Directive currently lists over 1,000 plant and animal species and over 200 Habitat types, but is subject to amendment as the European Union enlarges its membership. The Lower Wye and the Lugg are designated as Special Areas of Conservation (SAC) under the Directive, and also as Sites of Special Scientific Interest (SSSI) under UK law (see Appendix 1 for more details).

Measures must be in place to manage SACs and ensure that appropriate assessment takes place of any plans and projects that are likely to have a significant impact on the integrity of an SAC. The decision-making Authority (Hereford Council) in respect of any planning applications may only permit or undertake proposals if the assessment concludes these would have no adverse effects. In the River Lugg, sections of the SAC are currently exceeding the phosphate target described in the site's "Favourable Condition" tables and is therefore considered to be failing its conservation objectives. The other section of the SAC, that part of the Wye between Hay and the Lugg confluence, is currently meeting its phosphate targets and conservation objectives but it is felt likely that wastewater discharge from future planned development, even though within existing Water Discharge Permits, would eventually result in failure of the phosphate target. The upper part of the Wye is currently meeting its conservation objectives and is not considered to be at risk from current permitted discharges (Natural England, correspondence, February 2013).

The sources of phosphorus pollution are generally categorised as "point" or "diffuse" sources (section 2). Point sources include Sewage Treatment Works (STW), also called Waste Water Treatment Works (WWTW), and some industrial sources. These are controlled by a system of Permitted Discharge Consents. Diffuse sources are those arising from agricultural land, roads, dirty water, septic tanks etc. and these are less stringently controlled, though the Codes of Good Agricultural Practice and cross-compliance rules (section 4) impact on

the agricultural sources. In 2010 the Environment Agency conducted a Review of those Consents (RoC) which are likely to impact on Natura 2000 sites. This led to continuing approval, modification or revocation as required. However, non-permitted activities such as agriculture were not within the scope of the RoC and it is likely that some sites will continue to fail water quality targets until diffuse agricultural pollution and the impact of non-sewered dwellings are also addressed.

At the time there were no statutory standards for phosphates in rivers, so the Environment Agency, Natural England and the Countryside Council for Wales (now called Natural Resources Wales) developed phosphorus thresholds which were included in the conservation objectives for the Natura 2000 sites. In some rivers, including the Wye, Natural England have argued for more stringent targets than those originally proposed due to concern about the level of protection afforded by the original proposals and this lower level (0.3mg/l) has recently been agreed as the guidance level for the Wye SAC though this is lower than the target level of 0.6mg/l which was adopted under the RoC and which is still included within Permitted Discharge Consents.

Best Available Technology (BAT) is an assessment of the effectiveness of methods to remove or reduce phosphates in waste water and sewage and Permitted Discharge Consents take account of BAT when applied to STWs. With advances in technology the limits are being revised downwards as the ability to remove phosphorus is improving. It is likely that discharge limits may be reduced to 0.5mg/l with capital spending to support this allocated in the Price Review (PR) period 2015-2020, with possible further reductions to as low as 0.1mg/l in the foreseeable future. However, these new targets are not reflected in existing consent conditions.

Furthermore, not all Waste Water Treatment Works contain Best Available Technology. The Urban Wastewater Directive (91/271/EEC, adopted 21st May 1991) is designed to protect the environment from the adverse effects of urban waste water and discharges from certain industrial sectors. It applies to the collection and treatment of waste water from agglomerations of more than 2000 population equivalents (pe) [2]. Sewage is treated by different processes as standard: primary treatment involves settling out solid matter; secondary treatment involves digesting and breaking down organic substances; and tertiary treatment may be required to protect sensitive environments including the removal of phosphate or nitrogen. By 2015, 650 STWs serving 24m people in Great Britain (representing 60% of the population served by STWs) will have phosphate removal processes in place (Environment Agency, 2013). However, 70% of the sewage sludge produced nationally as a result of these processes is currently recycled to land as biosolids (Environment Agency, 2013). Furthermore, tertiary treatment is only obligatory in STWs dealing with agglomerations of more than 10,000pe. Out of the total of c 9,000 sewage plants found in the UK, only 2,000 generate sufficient organic load to require secondary treatment processes. Therefore smaller STWs, especially those connected to rural villages, will not contain the technology to strip phosphorus from waste water and sewage.

In order to meet the requirements of the Habitats and Water Framework Directives Herefordshire Council, Natural England and the Environment Agency are committed to the development of a Nutrient Management Plan (NMP) *"To ensure the favourable conservation status of the SAC in respect of phosphate levels as soon as possible and at the latest by 2027 taking into account the existing river phosphate levels and existing water discharge permits."* (Natural England, correspondence, February 2013). The aims of the NMP are to control

and reduce phosphorus and thereby facilitate the delivery of new development within the county. The plan will need to assess the sources of phosphates and prescribe appropriate management actions to reduce their impact. It is intended to achieve the appropriate actions so that planned development can take within existing Permitted Discharge Consent conditions.

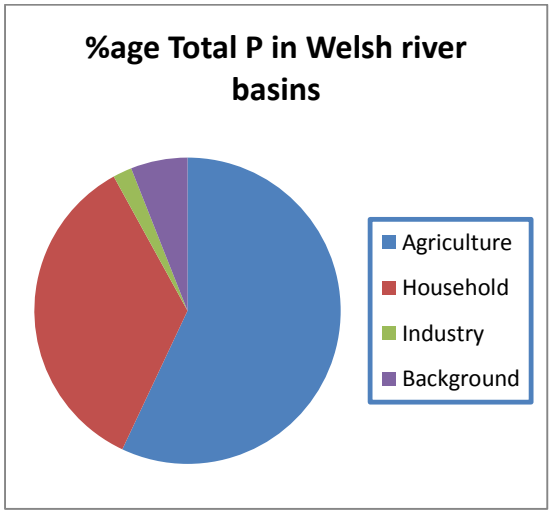
Notes

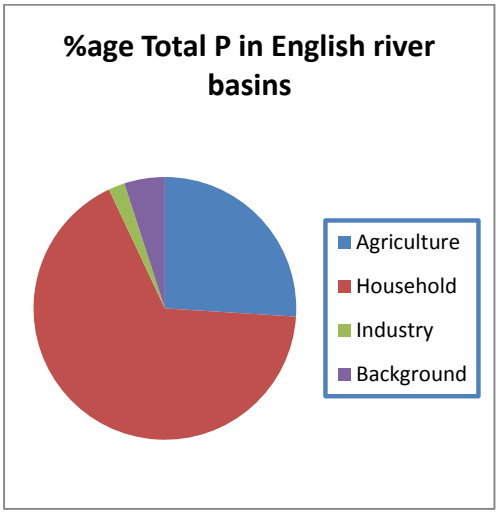
[2] population equivalent (pe) is defined as the organic biodegradable load having a five day biochemical oxygen demand (BOD5) of 60g of oxygen per day.

2: The science behind phosphate pollution

Phosphate is extremely abundant but it is also highly reactive and many of its compounds are not readily soluble. It is not found free within the environment but is widespread as a compound with different minerals. There is a low natural "background" level of phosphate released from natural sources, typically less than 5% of the total, which is caused by atmospheric deposition, soil weathering, river bank erosion, riparian vegetation and migratory fish. However the bulk of phosphate going into rivers and streams is a direct result of human activity. The two major sources of phosphate in water are from agriculture and treated water from sewage treatment works (White and Hammond, 2009). Phosphate in sewage sludge comes primarily from food wastes, urine and excreta, and detergents. Household and industrial sources in the UK account for 75% of the phosphate load in water nationally and agriculture just over 20%, but this varies widely depending on the location.

The proposed pilot project area, the Arrow River catchment is a part of the Severn River Basin on the Welsh / English border. In this catchment the relative proportion of the source of total phosphate in rivers is weighted towards agriculture (57%) in Welsh River basins and towards household sources (67%) in English River Basins (Fig. 2). In the Severn River Basin phosphate inputs to rivers are nearly equally apportioned to both agricultural and household sources (Fig. 4) and any attempt to reduce these phosphates in rivers needs to address both input sources.





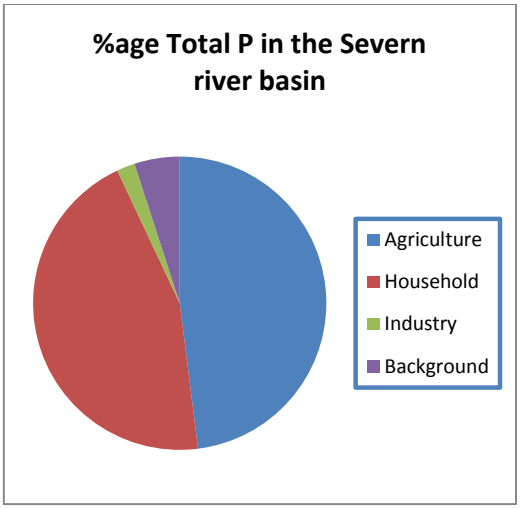


Figure 2: A comparison between the percentage sources of Total P in Welsh and English river basins (data from White and Hammond, 2006).

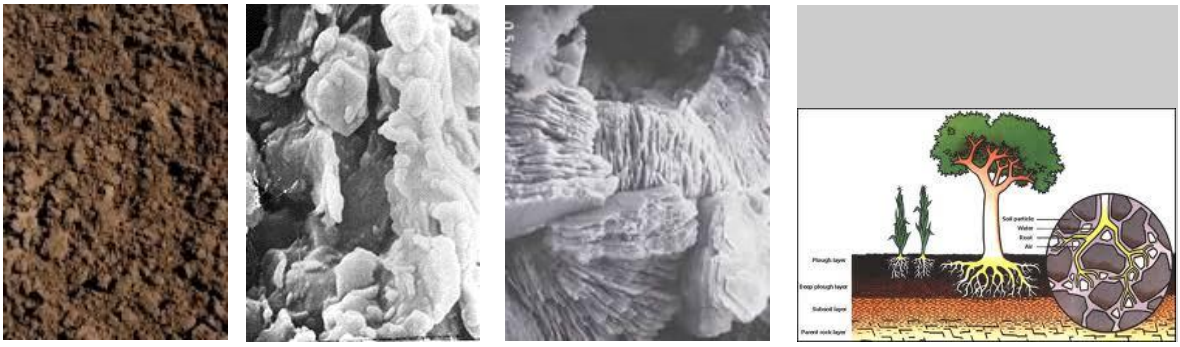
Whilst "point" source pollution enters a river source at a specific site such as a pipe discharge and is normally regulated through permitted discharge consents (section 1), "diffuse" pollution is when potentially polluting substances leach into surface waters and groundwater as a result of rainfall, soil infiltration and surface run-off, including fertilisers, pesticides, contaminants from roads and paved areas, and from atmospheric deposition. These are often sub-divided into Non-Agricultural Diffuse Pollution (NADP) and Agricultural Diffuse Pollution (ADP). Diffuse pollution therefore typically comes from unlicensed sources and dispersed land-use activities, it often occurs after rainfall and its composition is extremely variable. Given the regulatory framework surrounding point source pollution, risk assessments suggest that diffuse pollution is a bigger risk than point source pollution for rivers, lakes and groundwaters (Environment Agency, 2007)

2.1 Phosphorus as a plant nutrient

Phosphorus is an essential plant nutrient, and crop yields are dependent on crop plants being able to access adequate amounts of phosphorus from the soil. Plant roots can only absorb mineral nutrient in the form of ions from the soil solution. All plant mineral nutrients are held in the soil in various forms ranging from minerals which are a part of the soil structural framework which are only very slowly available to the soil solution, through nutrients held on the clay and humic colloids, to mineral nutrient ions adsorbed on the surface of colloids which move between the colloids and the soil solution (Fig. 3). The bulk of most mineral nutrients in soils are stored in the structural framework of the soil.

Phosphorus as a nutrient element is relatively insoluble and has a tendency to move to the left in this representative pictorial diagram (in contrast to nitrogen which inclines to move to the right). In most soils the amount of phosphorus available to plants from the soil solution is very low, seldom exceeding 0.01% of the total phosphorus in the soil. In many soils phosphorus is a limiting factor to plant growth because of its low solubility and availability.

Very slowly available	↔	**Slowly available**	↔	**Moderately available**	↔	**Freely available**	→	**Absorbed by:**
Structural framework	↔	Colloidal fraction	↔	Adsorbed fraction	↔	Soil solution	→	Plant roots



Soil colloids as seen under an electron microscope

Part of the	Part of the	Adsorbed onto the	Available as
mineral soil and organic matter	inorganic clays and humus	clay and humic colloidal surfaces	ions in the soil solution

Figure 3: The relative availability of nutrient elements to plants

When phosphorus is added to the soil in a soluble form (fertilisers, manures etc.) over time they are fixed into the soil matrix and form insoluble compounds, allowing only 10 – 15% of the applied phosphorus to be taken up by the plant. Thus plants may use up the readily available supply of phosphorus in the soil solution even when the soil contains a large supply of that nutrient. In the long term the phosphorus held in the slowly available soil fractions will move to the readily available sites in the soil matrix, but this is not always within the time frame of maximum crop growth and use. Historically farmers have compensated for this by adding excess phosphorus fertiliser to soils so over many years phosphorus has accumulated in agricultural soils. As there is a linear relationship between total phosphorus in the soil and readily available phosphate (Johnston, 2001) this has increased the relative amounts of plant available soluble phosphorus.

Soil analysis measures the phosphorus readily available to plants, that phosphate in the moderately and freely available soil pools. This plant available phosphate is expressed as an Index ranging from 0 – 9 (Table 1).

Table 1: Classification of Soil P analysis

	Index of phosphorus									
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Olsen's P (mg/l)	0-9	10-15	16-25	26-45	46-70	71-100	101-140	141-200	201-280	>280

Defra 2010

Defra (2010) recommendations are to maintain arable and grassland soils at Index 2 for phosphorus (P), (Index 3 for soils growing vegetables and potatoes), and advise farmers not to apply phosphate fertiliser to soils above the target Index. (This recommendation does not apply to land under a conservation designation where that designation and status depends on the low nutrient status of the soil.)

2.2 Sources of phosphates in arable soils

2.2.1 Inorganic sources

Globally most phosphorus exists as insoluble sediment deposits at the bottom of oceans. Some phosphate in soils comes from weathering of the rocks from which the soil is made however, in agricultural soils, most phosphate is added as fertiliser. Phosphate fertilisers are either mined from exposed ocean deposits or from sea bird guano deposits, both of which can be regarded as a finite resource. There is already concern over 'peak phosphorus' and a predicted depletion of easily accessible sources of phosphate as Asia and Africa increase their use of mined phosphate fertilisers. The advantage of using an inorganic source of phosphate is that the farmer can choose the chemical make up of his fertiliser according to the present balance (Index) of nutrients in the soil and future crop requirements.

2.2.2 Organic sources

Other sources of phosphorus are organic recycled resources, i.e. crop residues, animal manures and sewage sludge. Organic manures have a complex chemical make-up which varies according to source. Some examples are shown in Table 2. The nutrient content of sewage sludge varies depending on the inputs to the sewage works (i.e. domestic or industrial). Large scale modern sewage works treat sewage to remove phosphate from the effluent. If that treatment is by precipitation with iron or aluminium compounds the resulting sludge, although high in total phosphate, will be low in plant available soluble phosphate.

Table 2: Approximate water and nutrient contents of commonly available organic fertilisers

		Percentage of dry weight			
Material	**% water**	**Total N**	**Total P**	**Total K**	**Approx. ratio N:P**
Dairy slurry	75	2.4	0.7	2.1	3.5:1
Pig slurry	72	2.1	0.8	1.2	2.5:1
Poultry manure	35	4.4	2.1	2.6	2:1
Sewage sludge	80	4.5	2.0	0.3	2:1
Municipal Solid Waste (MSW)	40	1.2	0.3	0.4	4:1
Horse manure	63	1.4	0.4	1.0	3.5:1

Taken from Brady and Weil, 2008; Source – various.

Note: UK figures often show higher N:P ratios, but still in the range of 3 - 5:1. The higher N:P ratios often depend on the amount of litter in the manure.

The ratio of N : P in plant tissues is approximately 10 : 1, i.e. plants need ten times as much nitrogen as phosphorus, but manures only contain between 1 – 4 times as much nitrogen as phosphorus (Table 2). Thus the ratio of P to N in most organic sources is higher than that in plant tissues. In particular manures from intensive animal units (especially poultry and pig units) contain levels of phosphorus higher than that of extensively outdoor raised animals. This is because of phosphorus added to animal feeds. Animal feed derived from grain contains phosphorus in the form of phytic acid which non-ruminant animals (chickens, pigs) cannot digest. Thus intensive livestock enterprises of pigs and chickens are fed feed supplements containing phosphorus (calcium-P mineral feed) of which up to 80% of the phosphorus ingested is excreted resulting in manure artificially high in phosphorus. Plant absorption of organic phosphorus is relatively low compared to the inorganic form so phosphorus in manures (organic phosphorus) has to be transformed into mineral inorganic ions (by soil micro-organisms) before plant absorption. Thus organic phosphorus (in the form of slurry spread on the land) poses a direct leaching threat to water courses.

In recent years farmers have applied organic manures to soils based on calculations to meet crop nitrogen needs (Defra 2012, Johnston and Dawson 2005). As a result the use of organic fertiliser may be supplying excessive levels of phosphorus to soils already high in phosphorus; hence the trend towards over-saturation of soil phosphorus continues.

Crop residues returned to the soil recycle phosphates back into the soil where micro-organisms can convert organic phosphate to soluble inorganic phosphate ready for crop plant uptake. Nutrient management planning should take this recycled phosphorus into account when planning fertiliser and manure applications.

2.3 Sources of phosphates in grassland soils

The majority of phosphorus applied to grassland comes from organic manures, usually animal manures recycled from livestock fed on the grass. There is presently insufficient data (where such data would be of most use) on applications of organic manures to grassland systems (Johnston and Dawson 2005), although it is likely that there will be +ve phosphate balances with the decrease in volume of animal production offset by a move from extensive grass fed systems to intensive indoor systems with an increase in the use of animal feedstuffs imported onto the farm.

2.4 The phosphate problem

Phosphorus from agricultural soils along with point source runoff from industrial and water treatment works has added phosphorus to watercourses, which pollution creates enhanced eutrophication. Nutrient use in agriculture presently contributes approximately 50 - 60% nitrates (Defra 2010) and 26% phosphates (White and Hammond 2006) in UK surface waters. Although there are many parcels of UK farmland that are still phosphorus deficient, historically cultivated land has, in general, received phosphorus in excess of that removed by crop harvest. This has led to a build-up of excessive phosphorus in some soils. It must be noted however that the recent concern with phosphate enrichment of watercourses is not due to a commensurate recent increase in the use of phosphate fertilisers. Phosphate applications to land have not increased over the past 20 years, in fact they have decreased (Figs. 4 and 5). Although there was a significant +ve balance in phosphate inputs compared with phosphate removed at harvest from soils between 1973 and the mid-1990s, since then a –ve balance has pertained reducing soil phosphate Indices (Johnston and Dawson 2005).

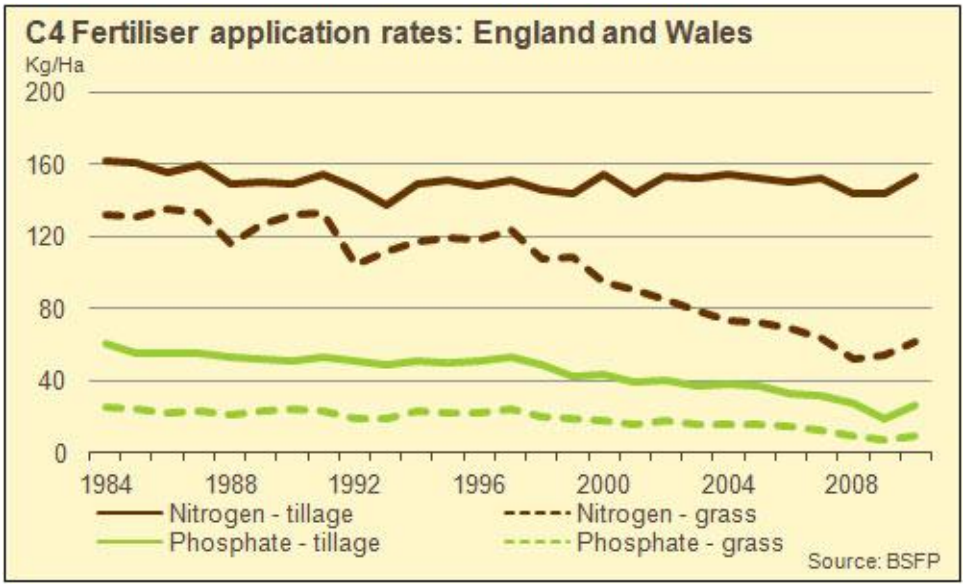


Figure 4: Fertiliser application rates in England and Wales, 1984 – 2010. (Defra 2011)

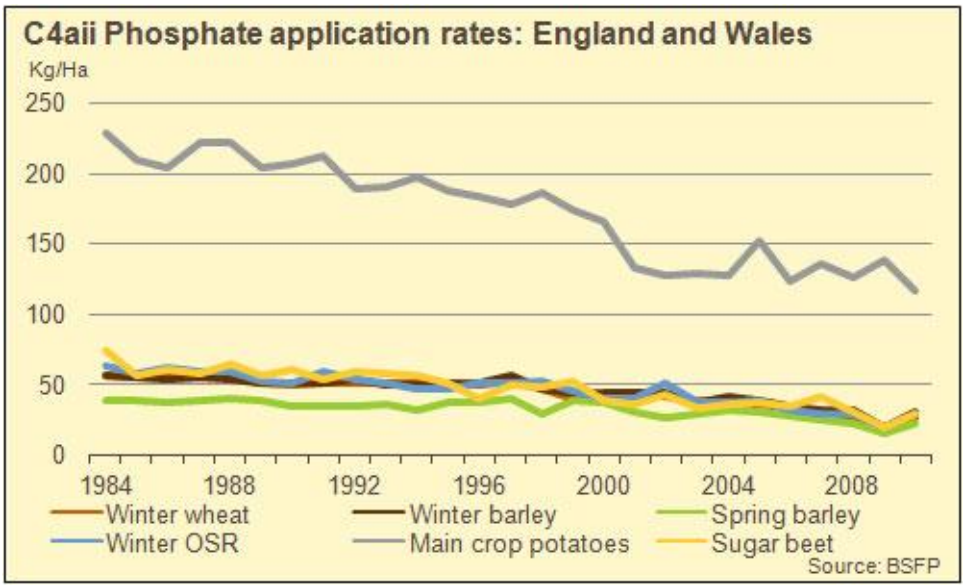


Figure 5: Phosphate application rates by crop type in England and Wales, 1984 – 2010. (Defra, 2011)

It is the relative importance of agricultural sources of phosphate pollution of water that has increased as other pollution sources such as sewage treatment works have declined. At the same time the structure of agricultural production has led to regional imbalances. Manures are often over-applied with respect to phosphorus, especially on fields convenient to intensive livestock facilities; and the concentration of livestock production fed on grain based feed has led to excesses of phosphates in soils in certain regions. Existing evidence (Defra 2012) suggests that many farmers make little allowance for the phosphorus in organic manures, either when applying that manure to the land, or in calculations of how much phosphate fertiliser to apply to land.

Johnston and Dawson (2005) assert that the phosphate problem is complex and not uniform throughout the water catchment. Not all fields contribute equally to phosphate loads in rivers and there is a need to identify fields liable to make significant contributions to the problem through erosion, inappropriate cultivations, inappropriate manure management, animal husbandry, soil health, or high P Index, from those that do not, i.e. losses due to management / events. Furthermore, phosphorus concentration in watercourses has been found in particular to relate to near stream (60m) distribution of soils with high P Indices (Gburek et al., 2002). It is suggested (Johnston and Dawson, 2005) that most agricultural sources of phosphorus transported from soil to water come from specific fields or as a result of specific actions by farmers. These land areas should be considered as specific point sources and targeted for specific remedial action.

Present high levels of phosphorus in watercourses may arise from:

- An historic high level of phosphate in agricultural soils;
- Poor management of cultivated soils;
- Poor management of organic manures;
- Poor soil health;

- Inputs from non-agricultural sources, e.g. from small, often rural, sewage treatment works which do not have phosphate removal systems; industrial sources.
- Inputs from the recycling of river and lake sediments. Water turbulence can disturb phosphate rich sediment and release phosphates into the water. This input is difficult to control and would continue to adversely affect water over many years.

2.5 Losses of phosphates from soils

Losses of phosphorus from soils are principally through plant removal (harvest) (~80%), soil erosion (~15%), dissolved surface runoff (~5%), and groundwater leaching (<1%) (Brady and Weil 2008). (Note: these figures are very approximate and originate from research on US soils but give the general proportions and principles). The vast bulk of phosphate remains within the soil. The eroded loss is not of significance to crop nutrition but is of significance to the water quality of impacted watercourses.

2.5.1 Soil erosion

Phosphates enter water courses primarily through soil erosion. Cultivation disturbs soil and exposes it to wind and water erosion. In the UK the principle erosion agent is water; rates of erosion depend on rainfall intensity, soil infiltration capacity, soil structural stability, and land topography. Soil erosion selectively removes clay, fine silt and organic matter, those parts of the soil that are the most active in crop growth through water and nutrient holding capacity and which are rich in phosphorus. Compared to the original topsoil, eroded sediment often holds more than twice the concentration of phosphorus than the originating topsoil in the field. Overland flow transporting fine sediments is the likely main route of phosphorus losses from arable land, especially prevalent from structurally unstable soils, capped or saturated soils (Catt et al., 1998). Over 80% of over winter losses of sediment and surface runoff on moderate slopes are associated with unvegetated and compacted tramlines (Silgram et al. 2010). Soil erosion from livestock pasture principally derives from poached soils, or where stock has free access to watercourses which causes bank erosion and disturbance of river sediments.

2.5.2 Dissolved surface runoff

Dissolved organic phosphorus resulting from animal manures tends to be more mobile than dissolved inorganic forms of phosphorus, so are more readily leached through the soil or are present in surface runoff from soils on which manure has been applied, or from manure heaps. Dissolved surface transport of phosphorus to water occurs mostly from livestock pastures where manure is spread on the surface of the land. Phosphorus from surface spread manures only moves slowly down the soil profile so on grassland the soil profile demonstrates phosphorus enrichment of the surface layer, decreasing downwards through the soil profile. Surface runoff is especially likely if manures are spread shortly before heavy rainfall events, especially on compacted or already water saturated soils (Preedy et al., 2001; Smith et al., 2001, Turner and Haygarth, 2000).

Poultry manure contains especially high levels of soluble and easily leached phosphorus (Sharpley and Moyer, 2000; Shephard and Withers, 1999) (Table 3).

Table 3. The relative leaching of phosphorus from different organic manures

	Phosphorus leached by 5 simulated rainfalls (mg P / kg material)	
Manure	**Inorganic P**	**Organic P**
Dairy slurry	1,925	375
Pig slurry	3,994	972
Poultry litter	2,918	400
Poultry manure	4,380	1,531

(Source: Brady and Weil (2008), after Sharpley and Moyer (2000))

2.5.3 Groundwater leaching

Phosphorus bearing clay particles and soluble phosphorus may be lost in drain outflows. This is particularly evident from soils with low structural stability which are naturally inclined to waterlogging, or from soils which are heavily fissured or cracked. Field experiments have demonstrated that high levels of phosphate in soils results in correspondingly high levels of phosphorus in drain flow for both arable soils (Heckrath et al., 1995) and grassland (Smith et al., 1995). The dominant pathway of phosphate loss from arable soils along Harpers Brook in the Anglian River Basin was via land drains after heavy autumn rains (Environment Agency 2012).

Phosphate may also be lost through leaching of soluble phosphate in the soil solution or on particles carried in water at the interface of permeable topsoil and impermeable subsoil or rock. At P Index 2 very little water soluble phosphorus is leached through the soil profile. It is only when soils are fully saturated with 'fixed' phosphorus that soluble phosphorus is available to move through the soil matrix.

2.6 The importance of soil health

Catt et al (1998), examining phosphorus losses from soils, indicated that the size of phosphorus loss is more nearly related to soil structural stability than to the total phosphorus content of soils. Healthy soil is not just an inert physical medium but a dynamic physical, chemical and biological matrix. Healthy soils demonstrate good soil structure, high rainfall infiltration rates, and biological activity. Much of this is predicated on organic matter levels in the soil which promotes good soil structure allowing crop roots to exploit the soil effectively. Organic matter maintains soil structural stability, reducing erosion risk. Organic matter enhances soil nutrient levels by holding nutrients such as phosphorus adsorbed on humic colloidal surfaces. Organic matter improves soil rainfall infiltration rates, soil water holding capacity and soil drainage.

In addition organic matter promotes soil biological activity. Soil biological activity enhances phosphate availability to crop plants by:

- Soil organisms, through feeding, death and decomposition convert bound organic nutrients into soluble inorganic, plant accessible nutrients.
- Earthworms enhance soil fertility and structural properties. Earthworm casts increase aggregate stability, lower bulk density, and contain higher soluble phosphorus than the surrounding soil.
- Mycorrhizal fungal hyphae are able to absorb phosphorus ions in the soil solution, and may even be able to access relatively insoluble phosphorus bound onto soil particles. Phosphorus accessed in this way can be transported to plant roots within the hyphae, so extending the reach of the plant's root system increasing root uptake efficiency by providing up to 10 times as much adsorption surface as does the plant root system alone. Practices that encourage mycorrhizal fungi may enhance phosphorus uptake and reduce the need for excessive phosphate applications.

All biological soil enhancements are damaged by cultivations and physical soil disturbance.

3: The policy framework

The European legislation that impacts on water quality was addressed in section 1. The implementation of this in the UK is through a hierarchy of approaches, beginning with River Basin Management Plans.

3.1 River Basin Management Plans

The over-arching document for work on river catchments is the River Basin Management Plan (RBMP). The plan which includes the Wye and the Lugg is the Severn RBMP, produced in December 2009 (Environment Agency, 2009). These plans were drawn up under the Water Framework Directive and are reviewed every six years. The next iteration of the Severn RBMP is expected by the end of 2015/early 2016. To support this review the Environment Agency has recently hosted a series of meetings looking at Significant Water Management Issues ("SWMI's - Swimmies"). The aim of these discussions was to identify the significant issues emerging from, and to be addressed through, Water Basin Management Plans. (RKP Partnership, 6th Match 2013 and 14th March 2013, Environment Agency, 2103) A national consultation on SWMIs is to be launched for three months from 22nd June 2013 and a River Basin District consultation will be launched for 6 months from 22nd June 2013.

Each RBMP establishes priorities for the River Basin and sets targets to be achieved. The key issues identified for the Severn Basin are:

- Diffuse pollution from agriculture and other rural activities
- Point source pollution from water industry sewage works
- Physical modification of water bodies
- Diffuse pollution from urban sources

Co-ordination across the Basin is achieved via the Severn River Basin District Liaison Panel, comprising representatives of businesses, planning authorities, environmental organisations, consumers, navigation, fishing and recreational bodies, together with government and other statutory agencies.

However, it is felt by many of those consulted that a River Basin is too large an area for the effective delivery of necessary management practices. The Severn River Basin District covers 21,590km^2 and a population of over 5.3m people (Environment Agency, 2009). A critical appraisal of the Draft River Basin Management Plan (Evans, 2009) recommended that pressures and actions should be published at a catchment level, whilst the River Basin remained as a European reporting unit. *"The plan operates at a scale beyond the scope of most parties. We acknowledge that this is a reporting unit, rather than a management unit as it is beyond the remit of delivery organisations such as devolved Regional Agencies, Assemblies, Water Companies and NGO's….."* (Evans, 2009, p11)

3.2 Catchment Management Plans

The next stage in the hierarchy of approach is a Catchment Management Plan supervised by a Catchment Management Partnership. Defra announced its intention to establish pilot catchment partnerships in 2011 and organisations were invited to submit proposals for these. Out of the 100 catchments in England 10 were chosen initially in April 2011 and a further 15 added in January 2012. The Teme Catchment Partnership (Appendix 2) is an example. The Wye Catchment was not chosen as a pilot area.

Defra funding has also been made available to 41 initiatives outside of the pilot areas where organisations can demonstrate a catchment-centred approach. The Garren and Gamber portion of the Wye Catchment is benefiting from this funding, led by the Wye and Usk Foundation. There is currently no equivalent organisation across the Wye and the Lugg to a Catchment Management Partnership, though Defra has announced its intention for more catchment management approaches and the Herefordshire Local Nature Partnership is discussing what a catchment approach might entail organisationally. However, although there is currently no Catchment Management Partnership for the Wye or the Lugg, there are nevertheless catchment-wide approaches and plans, dealing with water abstraction and catchment restoration.

3.2.1 Catchment Abstraction Management Strategies

The Wye Catchment Abstraction Management Strategy (CAMS) (Environment Agency, 2008), is the basis for the licensing policy within the Wye Catchment and represents how water resources are to be managed until 2014. The strategy is affected by the phosphates issue because it has to take into any review of the Habitats Directive' Review of Consents (RoC) that affect the catchment.

3.2.2 Catchment Restoration

The Catchment Restoration Fund for England, administered by the Environment Agency, enables third sector groups to bring forward projects at a catchment level. These must address one or more of the following:

- Restore natural features in and around watercourses
- Reduce the impact of man-made structures on wildlife in watercourses
- Reduce the impact of diffuse pollution that arises from rural and urban land use

To date, 42 projects have been approved with a combined value of £24.5m. More details of the impact of this fund on the Wye are contained in section 4.

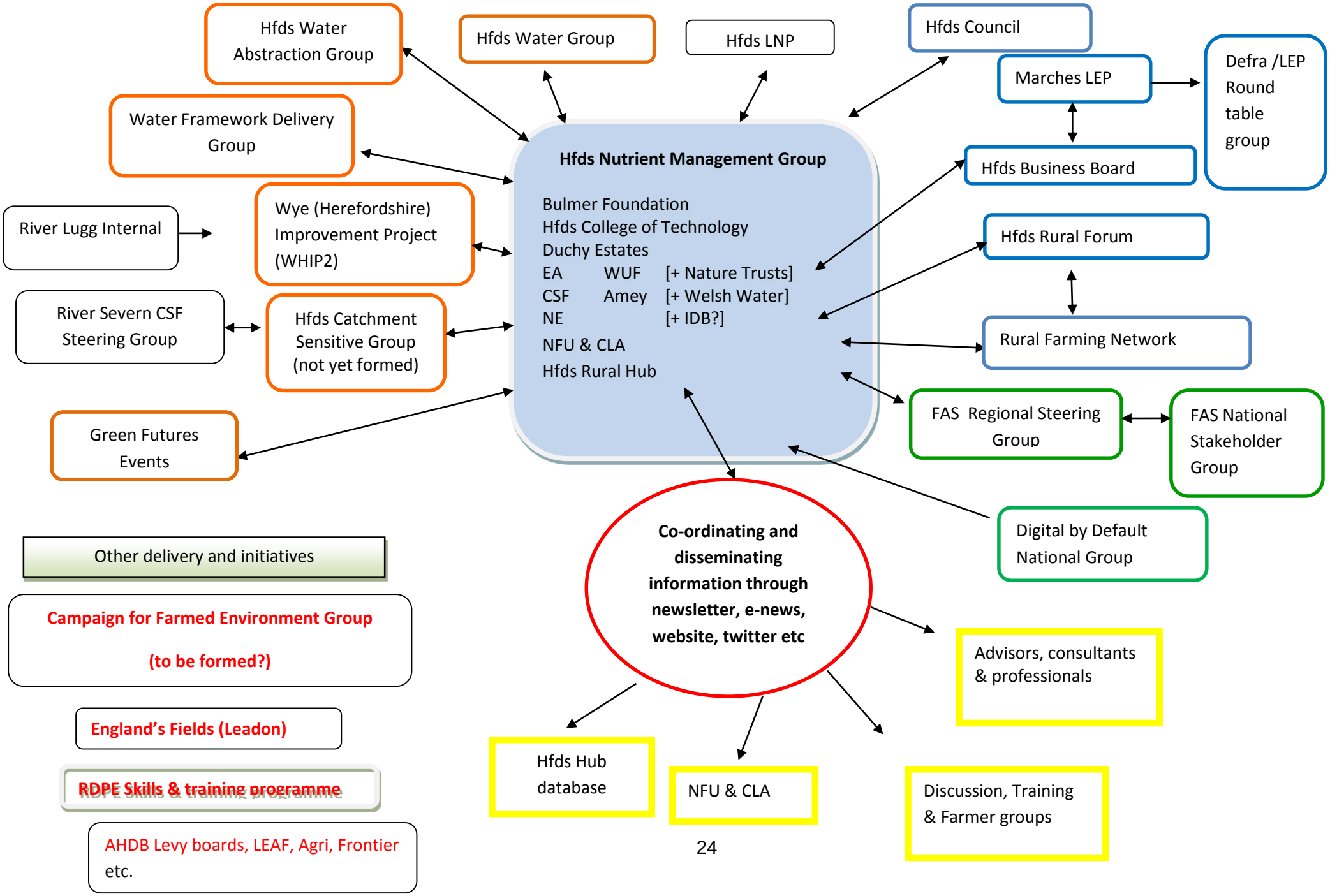
3.3 A governance model for Herefordshire

Given the current lack of a Catchment Management Partnership for Herefordshire, the study team convened two meetings that built on an existing group that the Rural Hub and Bulmer Foundation had been convening

for over a year, the Herefordshire Land-Based Knowledge Transfer Group. This group was augmented with organisations that were able to deliver measures to combat diffuse pollution and is now termed the Herefordshire Nutrient Management Group (Figure 6). The membership list currently comprises the Bulmer Foundation, Herefordshire Rural Hub, Duchy Estates, Catchment Sensitive Farming, Wye and Usk Foundation, Environment Agency, Natural England, National Farmers Union, Country Landowners Association, Holme Lacy College, Cider and Perry Orchards Network of Excellence, and Amey, though not all members have been able to attend every meeting (see Appendix 3).

The group seeks to clarify the messages that need to be delivered and aid co-ordination of delivery across the county. It has agreed to continue to meet and help implement the Nutrient Management Plan. At a meeting of the Herefordshire Local Nature Partnership on 11th March 2013 this group was adopted as the water topic group for the LNP. Discussions are progressing to add the Herefordshire Nature Trust to the membership and to develop a formal relationship with the county's Strategic Water Group that is to advise the Council on the Nutrient Management Plan (a schematic diagram is given below). Further consideration is needed to ensure that Welsh interests are also represented and the group could be expanded to address non-agricultural diffuse sources as part of a more holistic approach (section 5).

Figure 6: Herefordshire Co-ordinated Delivery Plan – Nutrient Management issues



Section 4: Policy into practice, Agricultural Diffuse Pollution

Land managers benefit from a wide range of advisory organisations and publications, in fact possibly too many to achieve a coherent response! Some of these have legislative grounding, others are advisory but it is often difficult to distinguish between them. For an assessment of the effectiveness of these approaches see section 4.3.

4.1 Legislation and guidance

4.1.1 The Codes of Good Agricultural Practice (COGAP)

The Codes of Good Agricultural Practice or COGAP (Defra, 2009) provides practical advice to land managers to help protect the environment. Allied to the requirements of the Water Framework Directive, COGAP takes an integrated approach which replaces three previously separate documents for Water, Air and Soil respectively. Parts of COGAP (that relating to water pollution) form a Statutory Code under Section 97 of the Water Resources Act 1991, which would be taken into account should any enforcement proceedings take place for water pollution.

The code identifies phosphorus as a potential pollutant and advocates:

- Careful management of livestock manures
- Assessing the composition of animal feed to affect the composition of the resulting manure so as to reduce surplus nitrogen and phosphorus, i.e. matching the requirement of the feed to the requirements of the stock
- Adopting a Nutrient Management Plan to ensure the most efficient use of fertilisers and reduce leaching of nitrogen or accumulation of phosphorus.

The protection and management of soils is recognised as important, as is good nutrient management. Farmers are advised to ensure that anyone advising them on fertiliser use should be qualified under FACTS (Fertilisers Advisers Certification and Training Scheme) and be a member of the FACTS Annual Scheme or the BASIS Professional Register (Fertilisers). The Code deals at some length with fertiliser management to minimise leaching.

Recommendations related to phosphorus are to match the level of phosphorus to the requirements of the crop or livestock, and not to apply inorganic fertiliser or organic manures to soils which contain more than the recommended amounts of phosphorus. For most crops, no additional phosphorus is recommended for soils at soil phosphorus Index 4 or above (Defra, 2010). If the soil phosphorus index is already 3 or above then no more phosphorus should be applied than will be removed by any crops in the rotation. Phosphorus leaching should be addressed through a nutrient management plan.

COGAP recommends a suite of management plans, comprising:

- A Manure Management Plan, addressing livestock manures (slurry and soil manure) and dirty water
- A Nutrient Management Plan, addressing the use of inorganic fertilisers, in conjunction with the Manure Management Plan
- A Soil Management Plan, dealing with soil structure and mapping crops and rotations to the capabilities of the soil.
- A Crop Protection Management Plan, addressing pesticide use and considering alternatives top pesticides

Note that Soil Management Plans are additional to Soil Protection Reviews, which are a requirement of cross-compliance (see below).

The section of COGAP on soil management advises controlling run-off and erosion by introducing grass strips or larger areas on sloping arable land to intercept the flow and buffer strips alongside surface waters at the bottom of slopes. To quote from the document *"However, you should not rely on such areas at the expense of good soil management in the rest of the field."* (COGAP para 348)

In theory, the Manure Management Plan will determine when and where to provide solid manures, slurry and dirty water whilst the Nutrient Management Plan will determine an appropriate application rate. Contractors should be briefed on any pollution risks and advised on safe application rates. Livestock manures, dirty water and organic wastes should not be applied when soil is waterlogged, frozen, snow covered, cracked down to field drains or backfill or where the field has been mole drained or subs-oiled over drains within the last twelve months. Spreading should not take place if heavy rain is forecast in 48 hours. Livestock manures or dirty water should not be applied within 10 metres of a ditch, pond or surface water or within 50 metres of any spring, well, borehole or reservoir and not on steep slopes where the risk of run-off is high.

Defra publishes a "Farm Practice Survey" detailing the extent to which farmers have adopted measures recommended within COGAP (Defra, 2011). Statistics are collated for the West Midlands, rather than Herefordshire alone and relevant data for 2011 are produced below (Tables 4 and 5). There has been a general improvement over the years in the uptake of COGAP recommendations, for example the adoption of Nutrient Management Plans has risen from 46% of holdings in 2006, to 55% in 2009 and 62% in 2011, but there is still a way to go.

Table 4: Adoption of Nutrient Management Plans (% of holdings)

	West Midlands	All England
	58%	62%
Of these:		
Created by the farmer without professional advice	21%	23%
Created by the farmer with professional advice	52%	43%
Created by an advisor or contractor	27%	27%

Within the livestock sector, other than dairying, 40% of Nutrient Management Plans in the West Midlands were created by farmers without professional advice, 43% by farmers with professional advice and 17% by an advisor or contractor. The professional sources of advice are predominantly fertiliser advisers or agronomists (74% of advisers cited).

Table 5: Management of manure (figures are % of holdings)

	West Midlands	All England
Adoption of Manure Management Plans	69%	67%
Regular testing of soil and manure	65%	70%
Solid manure stored in heaps on a solid base	48%	48%
Solid manure stored in temporary heaps in fields	69%	66%

The figure for regular testing of soil and manure drops markedly for lowland livestock farms, where only 44% undertake regular testing.

Whilst the identification of soil erosion risk and the adoption of suitable control measures is a fundamental feature of cross-compliance, many farm advisers suggest the mechanism is unlikely to provide adequate protection against soil erosion because *"Firstly, it is possible that many farmers will not correctly identify risk levels on high risk fields; and secondly, EA Enforcement Officers believe the SPR is an unenforceable mechanism because provided a farmer has completed his SPR, identified a risk level for each field and allocated the appropriate number of optional measures, he cannot be deemed non compliant even if he is causing a significant soil erosion problem on his farm"* (Maltby et al, 2011 p 30). There are currently no mandatory requirements within cross-compliance for farmers to prevent degradation of river banks from livestock, a common cause of soil erosion. There are no requirements within cross-compliance for farmers to limit the application rates of phosphorus, or on the timings and methods of phosphorus applications.

4.1.2 Cross-compliance conditions

Since January 1st 2005 direct payments, including the Single Farm Payment, have been conditional on meeting "cross-compliance" provisions i.e. baseline standards for agriculture. In 2007 cross-compliance was extended to new land-based Rural Development schemes. There are two key elements:

- Standards of good agricultural and environmental condition (GAEC), which require farmers to protect soils and maintain a range of habitat and landscape features characteristic of the English countryside.
- Statutory Management Requirements (SMRs), which apply to all Member states of the European Union and cover a range of issues dealing with the environment; public, plant and animal health; and animal welfare.

Cross-compliance conditions are monitored by the Rural Payments Agency (RPA) as part of the assessment for the Single Farm Payment (Rural Payments Agency, 2012) and RPA Inspectors visit farms to undertake this task. Although COGAP (see above) contains information relevant to the cross-compliance measures, a separate publication also exists detailing the provisions with respect to good soil management (Rural Payments Agency, 2009a) and the requirement of a Soil Protection Review (Rural Payments Agency, 2009b)

Cross-compliance regulations have specific recommendations with respect to soil and water management, but the discussion is only with respect to pollution from nitrogen, not phosphorus. In summary:

- Fertilisers and organic manures should not be applied within 2 metres of the centre of hedges, a watercourse or a field ditch, or to land within 1 metre of the top of the bank of a watercourse.
- Land which has been cropped and harvested using a combine harvester or mower must not be left in a state in which run-off is likely from the last day of harvest until the last day of February.
- Although leaving uncultivated stubbles may be beneficial to wildlife, the risk of run-off or erosion must also be considered.

A Soil Protection Review (SPR) is a legal requirement for those claiming Single Farm Payment. An SPR addresses degradation threats to soil, requiring farmers to identify and record current and potential problems with their soils, assess and record the soil types and degradation risks to their land, select and take appropriate measures to prevent and/or remedy any problems and risks, and review risks and measures annually. Consideration must also be given, and records maintained, concerning access to and repair of waterlogged land, post harvest measures undertaken to protect land and the use of buffer strips for water resource protection. SPRs must be completed or updated by 31st December each year and must be available for inspection by Rural Payments Agency inspectors. They can be completed online (www.wholefarm.defra.gov.uk).

The action required is to produce a soil risk table for each soil type, identifying the degree of risk and the location on the farm. This is coupled with a Farm Soil Plan which identifies what action will be taken to remedy the risk and a review to assess whether the action was effective or not.

4.1.3 Agri-environment schemes

Protection of soil and water is a primary objective of the Environmental Stewardship Scheme (Natural England, 2008). Farmers wishing to participate in the Entry Level Stewardship (ELS) will gain points for good soil management practices. Higher Level Stewardship (HLS) provides options specifically relating to land and fertiliser use and grazing management and payments may be available for capital items which contribute to increased protection of the environment, such as hedgerow planting, fencing, ditch restoration, cross-drains under farm tracks etc.

Whilst Environmental Stewardship offers sources of funding to adopt changes in land use and protect water courses there is concern that the options are not prescriptive enough to deal with the issue. For example, unless buffer strips are very wide (12m+) they are unlikely to prevent soils reaching water courses on fields with anything greater than a 7-10 degree slope. Farmers are reluctant to put buffer strips on the most productive land and the evidence is that they often site them on marginal land which is not necessarily at greatest risk from erosion. Re-weighting the allocation of points away from hedgerow management options towards resource protection measures might prove more effective. Stewardship is often seen as an entitlement payment for delivering basic environmental standards under cross-compliance, rather than a payment which is sufficient to warrant adopting additional activities which might involve taking land out of production.

Capital grants through the Environmental Stewardship Programme and the Catchment Sensitive Farming Initiative are able to support farm infrastructure improvements (fencing, tracks, hard standing) which can lead to significant reductions in soil erosion. However there are no agri-environmental payments currently available for winter housing, which are vimportant to keep animals away from vulnerable fields in the winter. Reducing phosphate levels is not an explicit objective of Environmental Stewardship, but there are measures in the scheme which stipulate a reduction in manure applications, such as ELS maize management options. However, they are unlikely to impact on farmers with high phosphorus indices (Maltby et al, 2011).

4.1.4 Environmental regulation – Anti Pollution Works Notices

The Environment Agency has the ability to issue Anti Pollution Works Notices (APWNs) under Section 161 of the Water Resources Act 1991 to deal with soil related water pollution. However APWNs are time consuming to prepare and recent guidance from the Agency indicates they should only be issued where it is possible to demonstrate a category 1, 2 or 3 level incident. Furthermore, APWNs are not suitable for tackling excessive phosphorus levels in soils or for specifying requirements for timing and

methods of applications due to the need for establishing source, pathway and receptor which is difficult for phosphorus (Maltby et al, 2011).

The Defra Strategic Evidence and Partnership Project (Maltby et al, 2011) report also discussed the likelihood of phosphorus being included within Water Protection Zones (similar to Nitrate Vulnerable Zones) but in response Defra indicated that these would not be considered until a catchment management approach had been tried which targeted existing regulatory, advice and incentives and monitored to see whether additional measures were required.

4.2 The Herefordshire Nutrient Management Partnership

There are various organisations working with the farming community which can assist in adopting land management practices that can help reduce phosphate levels. The organisations that are listed below form the Herefordshire Nutrient Management Partnership.

4.2.1 The Bulmer Foundation

The Foundation is a sustainability charity focused on Herefordshire that runs projects covering land-use, food, health and well-being and education and works closely with a range of strategic partners. It convenes the Herefordshire Land-Based Knowledge Transfer group and manages the Cider and Perry Orchards network of Excellence. It is a founding member of Herefordshire Local Nature Partnership and Herefordshire Food Partnership. The Director has been tasked by Herefordshire Council to engage nationally with the Rural Local Enterprise Partnerships and ascertain whether there is a need for a specialist water sub-group to be developed. He also chairs the Hereford Rural Forum on behalf of the Rural and Farming Network.

4.2.2 Herefordshire Rural Hub

Herefordshire Rural Hub acts as an information conduit for all farming related events that are held in the county and disseminates this on a monthly basis by newsletter and e-news to approx 1500 farmers. The Hub has been the co-ordinator of the Green Futures (GF) programme over the past 8 years but the delivery has been done through the collaboration of key organisations working in partnership to form a team who work across the West Midlands. The partners are the NFU,CLA, Environment Agency, Natural England, CSF, the Campaign for the Farmed Environment, the Farming Advice Service and the Rural Hubs Network. The West Midlands Green Futures programme has been a vehicle for bridging the gap between agencies, support organisations and farmers. The Hub is the Defra-accredited Rural and Farming Network for this area of the country.

4.2.3 The England Catchment Sensitive Farming Initiative

Catchment Sensitive Farming (CSF) is a joint initiative between Natural England and the Environment Agency, funded by Defra and the Rural Development Programme for England (RDPE). It is designed to deliver practical solutions and targeted support to enable farmers and land managers to take voluntary action to reduce diffuse water pollution from agriculture. Capital Grants are available within priority catchments, including the Wye and the Lugg, and the scheme is administered by Catchment Sensitive Farming Officers (CSFOs) hosted by Natural England. There are two officers covering Herefordshire, working on the Wye, and the Lugg and Leadon respectively. Within a priority catchment further prioritisation is given to targeting grants in any given year to sub-catchment areas (Natural England, CSF5/23 and CSF5/72013)

4.2.4 The Wye and Usk Foundation

Nationally, the Rivers Trust is an umbrella organisation for a series of catchment-based local trusts. The principle trust in Herefordshire is the Wye and Usk Foundation (WUF). The Wye Foundation began in 1995 and the main focus was to conserve and enhance rivers for fishing. In 1998 it launched the Wye Habitat Improvement Project (WHIP) and in 2000 it became a registered charity as the Wye and Usk Foundation. WHIP2 is now the main project focussed on Herefordshire, which started in June 2010 as a 3-year, £1.6m funded programme through the Defra Catchment Restoration Fund. The project seeks to remove barriers to fish migration and tackle agricultural sources of diffuse pollution. Working alongside CSF, 16 water bodies were prioritised for farm advisory visits starting from June 2012. By the end of the programme it is intended that 400 farms will have received an advisory visit and 320 whole-farm plans will have been produced advising on good agricultural practices and offering practical solutions to reduce diffuse pollution. Farm advisory work started in September 2012 on the Upper Arrow, Gladestry, Curl and Tippets catchments.

4.2.5 National Farmers Union (NFU)

The NFU is a membership organisation and has the potential to convey information to a large number of farmers through its many communication channels and events. As a voice for the industry, the NFU is often a useful medium through which to operate to ensure that messages are focused, balanced and respectful to the needs of agricultural businesses alongside wider objectives.. It is already involved in water issues and has national and regional specialists. It has been participating in a pilot phosphate reduction scheme in two catchments in the Anglian Region (NFU, undated); Harpers Brook in Northamptonshire and Bourn Brook in Cambridgeshire. To accompany these initiatives it co-produced a publication targeted at the farming community, *"Tackling our phosphate problem; Farming's role in restoring waters suffering phosphate pollution."* (NFU & Environment Agency, undated) The NFU is an active participant in the Herefordshire Land-based Phosphorus Group. A recent survey amongst Herefordshire members indicated that management of soils was a key concern to the participating farmers along with access to water and water quality (Clare Greener, pers. comm.).

4.2.6 Country Land and Business Association

CLA is a membership organisation including large estates which have a significant part to play in land ownership and land management in Herefordshire. They can assist with information dissemination via newsletters and their website, www.cla.org.uk

4.2.7 Internal Drainage Boards

The River Lugg Internal Drainage Board (IDB) is responsible for 210km of water course, mainly arterial water courses which it is not practical for individual landowners to manage. IDB powers derive from the Land Drainage Act 1991, but they are permissive not obligatory and its fundamental role is to manage the water level within its "District". Management has to address three issues:

- Year round conveyance of flows
- Storage of flood peaks
- Retention and protection of flora and fauna dependent on, or resident in, the water corridor.

To support the latter, the IDB has produced a Biodiversity Action Plan (River Lugg Internal Drainage Board, 2010). Since all properties within a drainage board district are deemed to derive benefit from its activities all are subject to a drainage rate, based on a rateable value applied to agricultural land and a precept on the Council tax or non-domestic rates. The River Lugg IDB has an annual income currently of £185k.

Only a small part of the designated River Lugg SSSI falls within the IDB's remit. It undertakes annual maintenance works on river banks and weed control on the river bottom. The IDB does not consider that managing sources of silt fall within its remit and that this is more properly the province of cross-compliance measures. It can use Bye-Laws to prevent damage to the banks and drains and is empowered to serve notices on landowners, though this is rarely used. Maintenance work within the SSSI is subject to approval by Natural England.

4.4 Next steps

4.4.1 General conclusions

The general conclusions of the investigation into catchment sensitive approaches within the DSEPP report (Maltby et al, 2011) are born out within Herefordshire. These are summarised below (bullet points) together with our response for a Herefordshire-based project.

- There is a need to improve governance within the catchment management planning process, ensuring greater co-ordination and clearer definition of problems and solutions.

We have suggested a model for governance in section 3.3 The only access currently to any mass mail-out database is through Defra which is very expensive. There is a need to collate an accurate database of Herefordshire farmers, sectorised to farming type and geography, including e-mail addresses and mobile phone numbers. Within the constraints of data-protection legislation, a "Herefordshire

umbrella" dataset, available to the organisations delivering the phosphate reduction programme, would be an enormous asset.

- Transparent, equitable and enforceable regulations are required; *"an unambiguous enforcement process needs to be established and, most importantly, communicated to the agricultural sector"* (Maltby et al, page 36). Cross-compliance does not need to be increased, it needs to be enforced.

Discussions are required with the Rural Payments Agency to ensure greater co-ordination between cross-compliance measures and a phosphate reduction approach. There have been instances where the RPA has acted in ways that have hindered progress. The Eden Rivers Trust (Bob Harris, pers. comm.) reported on a situation in which a farmer fenced off land near the river bank to prevent cattle from eroding the bank, only to be fined by the RPA for reducing the size of the fields on which he was claiming Single Farm Payments (SFP). The fear of reduction in SFP or levying of fines mitigated against remedial action being undertaken by other farmers in the vicinity.

- A pro-active walkover approach should be continued as this would engage farmers who have failed to engage thus far.

This is agreed, but there is concern at the low numbers of Officers involved in promoting CSF and that funding is only guaranteed until the end of 2014. The DSEPP report also commented *"It does not appear the CSF programme has been successful at reaching those 'difficult to engage' farmers i.e. those farmers who tend not to proactively seek advice and who are often believed to have significant pollution issues on their farms."* (Maltby et al, 2011, p32). This has, however, been partially remedied by the Green Futures approach within Herefordshire (Appendix 3). The Wye and Usk Foundation take this approach (the WHIP2 Project) but what is required is a longer-term engagement to ensure that behavioural change is taking place within the farming community.

- There is a need to invest in the skills base of extension providers, such as Catchment Sensitive Farming. Research on behavioural change in farmers consistently identifies the need for one-to-one advice delivered by a trusted and skilled adviser.

We have included as an Appendix (Appendix 5) comments from Simon Draper, an agronomist who delivers specialist soils advice with the Farming Advice Service. The personal correspondence is his reflection on the past five year's experience of working in Herefordshire. Whilst he highlights greater awareness of manures and fertilisers, soil management is still a weak area. *"The problem with soil management is that this is the weakest area with advisers/agronomists who visit farms on a regular basis…..There is a need to train advisers to be able to feel confident to impart basic soil knowledge"* (Draper, pers. comm..), accepting that there is no financial incentive for them to do so. His recommendation is to establish farmer groups who can attend workshops together, calibrate

themselves and support themselves on each other's farms. This is an approach we would like to trial within the proposed pilot catchment.

- Consideration should be given to integrate CSF, ELS and HLS advice provision to avoid fragmented delivery and encourage a common vision.

Defra is advocating an Integrated Advisory Delivery Model which may address these issues. We are awaiting conclusions on this work but it is essential that there is consultation and engagement with local delivery bodies.

There is a need for all advisers to have access to accurate and timely data from the Environment Agency and water companies to underpin the quality of their advice. An e-mail alert message or regular bulletins to advisers and agronomists would help address this. There is a requirement to form an advisers/agronomists group to ensure that this happens.

- The current ELS scheme should be re-shaped to focus repayments on targeted resource protection measures, augmented where possible by private sector and other finance.

The study team looked at the possibility of reproducing the SWMI workshops (section 3) within Herefordshire, so that they could be tailored to our local situation ("Herefordshire proofing"). This would also have provided an opportunity to discuss how a localised ELS/HLS scheme might look i.e. establishing ELS resource protection measures more in tune with the county's needs. The consultants who conducted the national SWMI workshops have quoted c£5,000 for a Herefordshire equivalent. Discussions have also taken place with members of the Environment Agency on the possibility of organising an event with their input. We would like to recommend that such an event takes place in Herefordshire to support the delivery of the Nutrient Management Plan.

4.4.2 A localised approach

Any approach to deliver change must also account for local nuances and local delivery; a catchment-approach is able to identify broad issues, a sub-catchment approach is required to implement behavioural change. In order to target areas for remedial action there is a need to distinguish non-problematic sites from those sites identified as having a high potential to cause phosphorus pollution of water courses. To achieve this, soil testing for nutrient, pH and organic matter status is a cheap and effective management information tool. Walking the river shortly after heavy rainfall events to identify vulnerable sites is also a useful management information gathering exercise.

Land along the River Arrow valley floor is subject to waterlogging and seasonal flooding with a risk of soil erosion if soils are poached, and high risk of surface runoff of spread manures in the event of heavy rainfall events, especially if soils are compacted, poorly structured or water saturated. The latest Defra statistics (for 2012) still show that only 68% farms have a Nutrient Management Plan and only 23% of farmers analyse manures for nutrient content. Manure management is likely to be a specific issue with respect to phosphorus pollution in the catchment but there is little available information on manure management practices. A farmers' survey may identify specific vulnerable land areas and practices.

Phosphorus concentration in watercourses has been found to relate to near stream (within 60m) distribution of soils with high P Indices (Gburek et al., 2002). Catt et al. (1998) postulates that the size of phosphorus loss is more nearly related to soil structural stability than to the total phosphorus content of soils. Arrow river catchment soils are described (Ragg, 1984) as susceptible to declines in structural stability because of problems with seasonal waterlogging, surface capping, slaking and subsequent soil erosion, especially after heavy rain on exposed soils, and especially where organic matter levels are low and surface structure is weak. Farmer and farm surveys and soil testing may identify specific potential problem sites.

For each identified potential problem site a critical value for soil criteria could be identified. This will vary according to soil texture and depth, e.g. deep well-structured soils will have lower critical values than shallow poorly structured soils. This is a piece of work we would like to undertake within the proposed pilot project area. The University of Worcester is keen to collaborate with this and are already actively involved in monitoring on the River Severn (Dr Ian Maddock, pers. comm.)

5: Policy into practice, Non–Agricultural Diffuse Pollution

The components of a community-centred initiative are in place in that the information which is needed is readily available, but it needs to be packaged and delivered in exciting ways. A phosphate reduction approach would need to include some or all of the following approaches.

5.1 Components of the message

5.1.1 Sustainable Drainage Systems (SUDS)

The problems of urban diffuse pollution are complex. To stop pollutants reaching water courses in built-up areas run-off can be managed by a range of techniques known as Sustainable Drainage Systems (SUDS). These create a more natural pattern of run-off, slowing down the flow of rainwater so that more passes through the soil where pollutants are retained and broken down. SUDS includes rainwater re-use, soakaways, use of permeable surfaces, ponds and wetlands. It can be linked to the development of "Green Infrastructure" and retrofitted into existing developments. Scope exists to integrate these approaches within Herefordshire Council's Green Infrastructure Strategy (Herefordshire Council, 2010).

5.1.2 Use and maintenance of septic tanks and cess pits

In rural locations, such as Herefordshire, there are a large number of properties which are not connected to mains sewers. Instead, septic tanks or package treatment plants are used for the containment of domestic waste water. Nationally, it is estimated that there are 300,000 septic tanks in England and Wales, treating sewage from 1 million people (Environment Agency, 2012).

A septic tank is usually a two or three chamber system which holds sewage allowing the solids to form into sludge at the bottom of the tank. Here it is broken down and the remaining liquid drains through a pipe into a drainage field or soakaway, which is critical for removing any remaining pollutants before the liquid reaches a watercourse or the water under the ground. If properly maintained and emptied regularly septic tanks do not pose a major threat to water quality, however studies indicate that they can be significant sources of pollution where that is not the case. For example, the Allerton Project (Stoate et al, 2012) carried out detailed monitoring of phosphates in the stream water both upstream and downstream of two groups of houses in Loddington village and found that phosphate concentrations downstream of the houses were up to ten times higher than those upstream.

Package sewage treatment plants are more sophisticated units than septic tanks, such as a "Klargester" or a "Biodisc". They often have equipment above ground such as a pump or raised cover. Package sewage treatment plants are mini versions of municipal sewage works, treating the sewage within the unit rather than using the soil in a soakaway like a septic tank. An electrical pump is required to provide air to the treatment plant which encourages aerobic bacteria to grow that breaks down the sewage. This results in a high quality effluent being produced which can be discharged, though this may still contain a high proportion of phosphate. In the Loch Leven Special Protection Area and Ramsar Site, guidance given to planning applicants who wish to develop within the catchment suggests than an acceptable way to mitigate the phosphorus load of any proposed new development is to upgrade the septic tank of an existing property to an active system that reduces phosphorus, and that this may be in conjunction with a third party (i.e. the planning gain affects both the proposed new development and existing households with septic tanks). To achieve this the applicant must produce legal agreements with the third party and sign a separate agreement with the Local Authority to guarantee the maintenance of the small treatment plant (defined as a plant with pe <50), (Scottish Natural Heritage, 2011).

Registration of septic tanks and package sewage treatment works was introduced in both England and Wales in 2010 as part of the implementation of the Water framework Directive. However, although registration remains compulsory in Wales in England it has been transformed into a voluntary scheme. Registration is not required where:

- Discharge is to ground and is of 2 cubic meters per day or less via a septic tank and infiltration system (soakaway) and is outside a Source Protection Zone*. This is equivalent to nine people occupying a single property.
- Discharge is to surface water and is of 5 cubic metres per day or less via a package sewage treatment plant. This is equivalent to approximately 31 people occupying a single property.
- Sewage is only domestic, i.e. it originates predominantly from the human metabolism and household activities
- The sewage system is maintained in accordance with the manufacturer's instructions or those of the British Water codes of practice and technical guides, and a record is kept of any maintenance including regular emptying
- Discharge does not cause pollution of surface water or of groundwater (Environment Agency, 2012)

*Source Protection Zones (SPZs) are protection zones for approximately 2,000 groundwater sources such as wells, boreholes and springs for public drinking water supply. Zones are protected in conjunction with a Groundwater protection Policy to establish pollution prevention measures in high risk areas.

It is not possible to ascertain the current level of maintenance and quality of existing septic tanks and there is no formal registration system in England that enables monitoring. In the upper reaches of the River Clun a community group called Land, Life and Livelihoods has been funded to undertake a community septic tank survey (Appendix 3). The survey is due to be completed by the end of March

2013 and early indications are that most septic tank owners were willing to allow the volunteers to enter their property and survey the tanks.

5.1.3 Promoting alternatives to domestic cleaning agents

Dishwasher detergents and laundry detergents account for 9% and 7% respectively of the phosphate content of Sewage Treatment Works (Environment Agency, 2013), though this is a significant reduction from the 1970s when they accounted for 50% of the phosphate load in sewage. In March 2010 Defra announced restrictions on the phosphate content of domestic laundry detergents, with effect from 2015, and the European Union agreed in March 2012 to apply measures to domestic laundry products (from June 2013) and dishwasher detergents (from 2017) (Environment Agency, 2013). Nevertheless, practical measures can be taken now to reduce or replace phosphate-rich cleaning products with alternatives. Ensuring that alternative (P-free) products are available may be undertaken in conjunction with promotional campaigns with suppliers to ensure cost-effective early adoption, but alternatives already exist within normal household products (Appendix 4).

5.1.4 Changing the way we wash our cars

Changing behaviour might address the weekly ritual (for some) of cleaning cars. Cars washed on drive-ways or other hard surfaces leads to soapy water entering drains, and the waste water contains detergents and dirt which contribute nutrients, including phosphates. To avoid this, a practical tip is to wash cars on a lawn or grass where the water and nutrients will help the lawn to grow. Use a bucket rather than a hose pipe to reduce water usage. Garages might be persuaded to promote this through leaflets and posters when cars are sold and/or filled up with petrol.

5.1.5 Promoting good gardening practices

Through allotments and gardening societies, including leaflets at local horticultural and village shows, awareness can be raised of the tendency most people have to over-fertilise lawns and gardens, behaviour which contributes to the phosphate load. Good gardening might become acquainted with not applying fertiliser applications to lawns until symptoms of nutrient deficiency occur, such as yellow patches. If fertilisers are to be applied they should be used sparingly and when the plants are growing rapidly. Sweep paved areas rather than hosing them down to prevent soil, grass clippings and other waste entering street drains.

5.2 Organisations and initiatives involved in knowledge-transfer

The following organisations have been contacted in the course of the study and are available to help deliver a phosphate awareness initiative. Organisations were contacted who could help role out a campaign across Herefordshire generally, or more locally within the proposed pilot area.

5.2.2 The Herefordshire in Transition Alliance (HiT Alliance)

HiT Alliance is a collective of community environmental groups drawn from across the county and allied to the Transition Movement. Phosphates were discussed at the alliance meeting on January 28th. The Bulmer Foundation is a member of the Alliance and hosts the meetings. HiT Alliance is able to disseminate information via regular newsletters and a website hosted by New Leaf (5.2.4 below). One of the major events promoted through the HiT Alliance each year is "Spring Greens" (5.3.1 below).

Two of the local HiT groups are active in the proposed pilot area:

- The Arrowvale Environment Group (AEG) based around Pembridge
- Kington Local Environment and Energy Network (KLEEN)

AEG would be participants in a community-led approach within Pembridge, Staunton-on-Arrow, Byton and Lyonshall (the four parishes that constitute the group's centre of activity). Discussions have taken place with Richie Cotterill, the convener of KLEEN, resulting in a "Water Under the Bridge" meeting which is taking place in Kington on April 11th (with Nick Read) to discuss a phosphate awareness project.

5.2.2 HVOSS

Herefordshire Voluntary Organisations Support Service is one of two organisations that provide infrastructure support to the voluntary sector within the county. Discussions have taken place with Will Lindesay, the HVOSS Director, and Helen Yeomans, Project Officer for REACH. REACH was a LEADER funded project that operated within the proposed pilot area though funding comes to an end in March 2013. It helped communities engage with project development and the legacy of this remains even though no project officers will be in place. However, HVOSS will still be able to assist with information and advice and is able to disseminate information via regular e-newsletters, HVOSS Updates and its website www.hvoss.org.uk. The Bulmer Foundation is a member of HVOSS and the phosphates issue was raised in the March 2013 HVOSS Update.

5.2.3 Community First

Community First is the Rural Community Council for Herefordshire and Worcestershire and is the other organisation, in addition to HVOSS, that provides broad infrastructure support for the sector within Herefordshire. Discussions took place with Richard Quallington, CEO of Community First, and Lorna Pearcey, the Sustainable Communities Officer. The Bulmer Foundation and Community First have been running a collaborative project called ECOHERE with LEADER funding which has been working with communities to develop "Sustainability Action Plans". ECOHERE is LEADER funded though this will come to an end in August 2013. However the groups that have been supported are part of a network and are available to assist with further work. Community First will also be able to assist with disseminating information via its e-newsletter and website, www.comfirst.org.uk. It offers support to village hall committees and this would be a particular avenue of raising awareness within the community.

5.2.4 New Leaf

New Leaf is a small not-for-profit co-operative working in Herefordshire which was originally developed with the help of the Bulmer foundation. Its remit is to help to develop ways of saving energy and living more sustainable. It provides the secretariat for the HiT Alliance and for the development

of Spring Greens and also co-ordinates h.energy week (5.3.2 below). New Leaf received funding from DECC to develop an h.energy savers training course which has equipped almost 50 people from across the county to lead groups of 6-10 people from their communities in addressing household energy efficiency. The course is supported by a work book and each week of the course looks at a different theme and one of the themes is water. Although the emphasis in this section, entitled "Spend Less on Water" is on reducing water usage in order to save both water and money, it would be relatively easy to introduce material that was relevant to phosphates. Each area of the house is addressed in turn: kitchens, bathrooms, gardens etc and within each of these the promotional messages could be reinforced or added appropriately.

5.3 Community events

Many Herefordshire-based events are available to support the development of a phosphorus awareness campaign. The most pressing need is likely to be co-ordination and resources.

5.3.1 Spring Greens

One of the major environmental events within Herefordshire is Spring Greens, held on the first Bank-Holiday week end in May each year at the Court of Noke, situated in the Arrow Catchment just outside Lyonshall. It is an event that draws environmental activists from across the county and includes practical demonstrations, trade stands, seminars etc. A seminar is to be hosted at this year's Spring Greens (on 4th/5th May) to discuss water issues and the venue offers further possibilities for helping to progress a phosphate awarenss programme.

5.3.2 h.energy week

h.energy week is now an established feature on the Herefordshire calendar during October (this year's week is the 12th to 20th October). Originally conceived as a week-long event to showcase energy saving initiatives within the county, this year's week is to adopt water as its theme allowing the opportunity to raise phosphates as an issue for the county. There are typically seminars, films and demonstrations spread throughout the locality, including the Courtyard theatre, private homes, community buildings and farms. A programme of events is produced and disseminated in advance allowing people to choose which sites to visit during the week. In 2012 the week hosted more than 100 events, a 64% rise on the previous year, and attracted an estimated 4,000 people (New Leaf website), but it also generates considerable additional publicity. Herefordshire Council are a supporter of the event.

5.3.3 The "value of water" film

The Bulmer Foundation in partnership with Rural Media, a Herefordshire based film-making company, made a series of films in 2012 dealing with different aspects of sustainability. In 2013 as the theme for h.energy week will be water, the Foundation together with New Leaf, Concern Universal and Rural Media are collaborating on a project to develop a second film, engaging students from schools across the county, looking at the value of water. Phosphates will be a component within this and the first planning meeting is scheduled for 4th April

5.3.4 Herefordshire festivals

Herefordshire lends itself to creative approaches to raising the phosphate issue. Both Presteign Music Festival and Spring Greens occur within, or in close proximity to, the suggested pilot area. There is also h.art week, promoting arts and crafts throughout the county, Ledbury Poetry Week and Hay Festival which could be venues to creatively promote our water environment.

In 2013 the Bulmer Foundation, in association with Hereford Cathedral, will be hosting a celebration of orchards including a service in the Cathedral on Ascension Day, May 9th. This will coincide with the Cathedral hosting orchard art, a project supported by the Bulmer foundation which enables people with learning disabilities to use orchards for artistic expression. Similar events could be planned to promote the value of the water resources within the county. As an example, the Land, Life and Livelihoods group in Clun promoted a Water Harvest Festival (Appendix 2) to help the community appreciate the value of their local river. The event included:

- Creative writing classes
- Textiles
- Children's events including painting and drawing workshops
- Singing and composing
- Natural history events, pond dipping etc
- River walks
- Practical demonstrations such as reed beds and treatment of waste water
- Promotion of local sources of help and advice

The community outputs (music, drawings, stories, needlework etc.) were exhibited in community centres and churches.

5.3.5 Working with schools

Children should be enlisted to support the initiative. The Phosphorus Awareness Project run by the South East Regional Centre for Urban Landcare in Western Australia (www.sercul.org.au) produced worksheets that children could take home and, with their parents, record the detergents that were being used and enabled them to determine how much phosphorus was being put into the environment. Land, Life and Livelihoods (Appendix 2) are promoting "Citizen Science" where children and members of the local community are engaged in sediment monitoring and analysis of the results. There are already activities, such as those organised by the Wye and Usk Foundation and Hereford Nature Trust, which have engaged with children in looking at water quality issues.

The eco-schools initiative is an international award programme operating in over 51 countries and overseen in England by the charity Keep Britain Tidy. The scheme guides schools on a journey of sustainability, providing a framework to help enable them to embed sustainability principles into the heart of school life. Water is one of nine topic areas which is assessed and for which schools may receive awards as they reduce their environmental impact. In Herefordshire 97 out of 103 schools are

registered with the eco-schools initiative (Herefordshire Council website), supported by an eco-schools officer within Herefordshire Council.

6: Resources for a phosphate awareness programme

Whilst government funding may be allocated to a phosphate reduction programme, and funding already exists for Catchment Sensitive Farming, River Restoration etc., there may also be other potential sources of support.

6.1 Private Sector Investment

Paid Ecosystem Services (PES) are where people or non-governmental organisations fund payments direct to landowners to deliver specific environmental outcomes. The DSEPP report (Maltby et al, 2011) considered the potential for water companies to provide private sector investment and noted that South West water was spending £9m on moorland and farmland projects and £1m on catchment investigation, but that the majority of water companies had not, at that date, invested in catchment management projects. OFWAT are required to sanction this investment through its Periodic Review (PR) process of water company spending. (Also see Appendix 3, case study 4)

6.2 Developer contribution schemes

A developer contributor scheme is being introduced in the River Mease Special Area of Conservation under its Water Quality (Phosphate) Management Plan (David Tyldesley and Associates, 2012, also see Case Studies, Appendix 3). All new development in the catchment which contributes additional wastewater to the foul water catchment areas of specific wastewater treatment works are subject to a developer contribution. Developments for which connection to a mains water network is not a viable option are assessed on a case by case basis. Developer contributions are normally secured through a planning obligation, which may be bilateral agreements between the Local Planning Authority and a developer, or a unilateral undertaking by a developer to provide them. They are normally entered into under section 106 of the Town and Country Planning Act 1990 (as amended) and referred to as "section 106 agreements." Whilst such planning obligations have normally been used to secure infrastructure improvements only on larger sites historically, in the River Mease catchment they are being introduced for any new development which connects to mains drainage.

On the Mease, as on the Wye, there is volumetric headroom [1] or surplus capacity available within existing wastewater treatment consents, but as the long term availability of such headroom depends on the implementation of the Water Quality Management Plan it is considered legitimate to levy a contribution. The Developer Contribution must also link to any planning policies operating within the

area and this is being addressed through the Local Development Frameworks' Core Strategies and supplementary planning documents to ensure they have appropriate policies in place.

Discussions have been held with the Planning Department of Herefordshire Council to ascertain whether the Community Infrastructure Levy (CIL) might be appropriate for funding phosphorus reduction measures. Regulation 122 of the Community Infrastructure Levy Regulations 2010 requires that any planning obligation to be taken into account in the determination of a planning application that is capable of being charged a CIL must meet three tests:

- Be necessary to make the proposed development acceptable in planning terms
- Be directly related to the proposed development
- Be fairly and reasonably related in scale and kind to the development.

The effectiveness of using CIL may also depend on getting the relevant questions addressed through the Neighbourhood Planning Process. CIL funding can only be targeted at issues that were raised during the planning process and therefore issues such as sewerage or drainage, e.g. putting households onto main drainage systems which are not currently connected, need to be addressed through this. CIL can include retrofit measures, such as stripping phosphorus at source.

The Neighbourhood Planning process is being rolled out across Herefordshire, including Pembridge and Lyonshall within the proposed pilot area.

6.3 European funding programmes

Discussions have been taking place to ensure that there are Discussions have been taking place to ensure that there are appropriate priorities written into the UK strategy for European funding streams for 2014-2020. The European Regional Development Fund (ERDF), the European Social Fund (ESF), the European Agricultural Fund for Rural Development (EAFRD, part of the Common Agricultural Policy) and the European Maritime and Fisheries Fund are being focused through a Common Strategic Framework (CSF). Local Enterprise Partnerships (LEPs) are tasked with developing an EU Investment Strategy for their location to compliment their wider economic strategic plan (HM Government, 2013). As part of this process LEPs have been recommended to engage with other stakeholders in their areas, including their Rural and Farming Networks (RFNs) and Local Nature Partnerships (LNPs). This presents an opportunity, therefore, to develop a coherent response to the phosphate issue that may ultimately realise European funding after 2014.

The study team wrote a paragraph for the Marches LEP business plan that ensured that phosphates were given a high priority in the developing document. They also participated in discussions hosted

by Herefordshire Council and the Marches LEP to discuss priorities funding for the West Midlands under CSF and, amongst these, priorities 5 and 6 were identified as:

- Climate change adaptation, risk prevention and management
- Protecting the environment and resource efficiency

As a sub text, these priorities contain measures to "improve water quality", "limit soil erosion and improve soil quality" and "reduce pollution from both urban and rural sources." (West Midlands European Service, 2012) It is hoped, therefore, that there will be opportunities to realise European funding when the new measures come on stream.

Although the mechanisms of delivery are also under discussion, one option that has been proposed is of Integrated Territorial Investments (ITIs), a multi-sectoral, integrated approach to development based on an agreed strategy for a defined geographical area. The UK government does not favour ITIs as a funding mechanism but the concept of having geographically defined target areas is almost certain to be included within the European funding portfolio. Nick Read, on behalf of the Marches Local Enterprise Partnership (LEP), has been asked to canvass other LEPs to see whether a specialist water sub-group is a next step towards building momentum for attracting European funding to address water-based issues. This work will be continuing throughout 2013.

Notes

[1] "Headroom" is the unused component of a permit that allows for variation in the efficacy of any treatment of waste water or which provides scope for additional capacity at a treatment works. Headroom can be generated if there are differences between the current and permitted effluent quality, or between the current and permitted effluent flow rates. It is the term that is most appropriately applied to the regulatory framework. "Environmental capacity" is the difference that exists between the concentrations of pollutants entering the receiving water and that water's environmental target, which also implies that there may be additional scope to increase loads on a site without breeching the target.

7. Developments since 2013

In the two years since this report was originally published the Nutrient Management Plan has begun to take shape, and various structures have been created to support both its development and its implementation.

7.1 The development of the Nutrient Management Plan (NMP)

Atkins consultants were commissioned by the Environment Agency, Natural England and Herefordshire Council to develop the evidence base for a Nutrient Management Plan for the River Wye and River Lugg Special Areas of Conservation. This involved the use of modelling to understand the relative contributions of phosphate from both point and diffuse sources. Two computer models were used, SAGIS (Source Apportionment Geographical Information System) and FARMSCOPER, which examined the relative contributions of phosphate arising from different farming practices. The model was run for various scenarios and took account of predicted population growth within the County.

Once the baseline data had been established, the model was re-run to look at the potential effects of different mitigating actions, such as introducing Best Available Technology (BAT) in selected sewage works so that point source pollution was reduced to 0.1 mg/L (compared to current BAT standards assumed to be 1mg/L). Alongside this, mitigation of diffuse pollution through the adoption of different agricultural practices was also modelled. The end product was a "menu of options", actions that could be taken and an assessment of their effectiveness in reducing the phosphate load entering the rivers. This activity was completed by May 2014.

7.2 The NMP Stakeholders' Group

In October 2013 the Bulmer Foundation convened a meeting of the networks and organisations that would need to be involved in the successful delivery of a Nutrient Management Plan, on behalf of English Nature and the Environment Agency. The representatives included many of the organisations identified in Figure 6 (page 17). The aim of this initial meeting was to introduce the group to the need for a Nutrient Management Plan and outline the work that had been undertaken to date. They were also asked to continue to engage with the development of the NMP and this group has become the Nutrient Management Plan Stakeholders' Group.

The Group has been involved in looking at the "menu of options" and helping to focus on those which are most cost effective and which can be delivered. Further workshops and seminars were held during 2014 as the "Options" Appraisal was refined. The final part of the NMP, the Action Plan, was published in November 2014 and submitted to the Herefordshire Core Strategy Examination in Public as the County's plan to comply with the requirements of the Habitats Directive. The next stage is to implement the Action Plan.

7.3 The Wye Catchment Management Partnership

Catchment Management Partnerships (CMP) were piloted by the Environment Agency in 10 pilot catchments from 2011 onwards (see Case Study, page 41). The Wye had not been included as a pilot, but in 2014 the decision was taken to extend the concept to all English Catchments. Catchment Management Partnerships enable strategy and engagement to take place at a catchment level, including the business community, voluntary and statutory agencies. The

Partnership therefore comprises organisations and networks that are involved in water management or which are most affected by water issues, including nature conservation, recreation, economic development, the land-based sector, water abstraction etc.

In 2014 the Wye and Usk Foundation (WUF) and Natural resources Wales (NRW) were jointly tasked by Defra and the Welsh Government to establish a Catchment Partnership for the Wye. A series of workshops were held during 2014 to identify the key issues of concern and enable dialogue with relevant stakeholders. The Wye has an additional layer of complexity in that it straddles the English-Welsh border and therefore needs to include complimentary organisations from both nations. Water quality is a key issue for the Catchment and it seemed most appropriate to constitute the NMP Stakeholders Group as a specialised sub-group of the Wye CMP.

7.4 Green Futures+

Within the NMP Stakeholders Group a more focused series of meetings took place looking specifically at diffuse pollution and the measures to be adopted by the land-based sector. The organisations involved are essentially those listed in section 4.2 of the report (page 21) with the addition of the Campaign for the Farmed Environment (CFE). CFE is a voluntary initiative to encourage farmers to farm in environmentally beneficial ways. A CFE Local Liaison Group was established in Herefordshire in 2014 and their scoping study identified water and soil management as priorities for the County. In February 2015 these organisations combined to form Green Futures+ (Green Futures “Plus”) building on the success of the Green Futures Initiative (see Case Study, page 44). These are the key agencies involved in the delivery of the diffuse pollution components of the Nutrient Management Plan. The core group comprises: the Bulmer Foundation, Herefordshire Rural Hub, the National Farmers Union, the Country Land and Business Association, Catchment Sensitive Farming, the Campaign for the Farmed Environment, the Environment Agency and English Nature.

Green Futures+ members are already actively engaged with the land-based sector and their concern is to ensure that the key messages of the Nutrient Management Plan are delivered coherently and consistently.

References

Brady, N. C. and Weil, R. R. (2008) *The nature and properties of soils.* 14th edition. Pearson Education International: New Jersey.

Catt, J. A., Howse, K. R., Farina, R., Brockie, D., Todd, A., Chambers, B. J., Hodgkinson, R., Harris, G. L. and Quinton, J. N. (1998) Phosphorus losses from arable land in England. *Soil Use and Management* 14, 168 – 174.

David Tyldesley and Associates (2012), *River Mease Special Area of Conservation Water Quality Management Plan*, Developer Contribution Scheme

Defra (2009) *Protecting our Water, Soil and Air: A Code of Good Agricultural Practice for farmers, growers and land managers*, The Stationary Office

Defra (2010) *Fertiliser Manual* (RB209), 8th Edition, The Stationary Office

Defra (2011) *Farm Practices Survey 2011 – England*, National Statistics Office

Defra (2012) *British Survey of Fertiliser Practice. Fertiliser use on farm crops for crop year 2011.* Defra.

Defra (2012) *Farm Practices Survey 2012.* Defra Statistics.

Environment Agency (2007) *The unseen threat to water quality*; Diffuse water pollution in England and Wales report

Environment Agency (2008) *Water abstraction getting the balance right: The Wye Catchment Abstraction Management Strategy*

Environment Agency (2009) *Water for Life and Livelihoods: River Basin Management Plan, Severn River Basin District*, Main Document

Environment Agency and Natural England (2011) *River Mease SAC Water Quality (Phosphate) Management Plan,* Final Document, June 2011.

Environment Agency (2012) *Position statement 116 v2.0*, The registration of small sewage discharges in England

Environment Agency (2013) *Managing nutrients in agricultural systems, Phosphorus: evidence for problems and solutions*, Technical paper for the National Stakeholder Workshop on Significant Water Management Issues, held on 22nd February 2013.

Evans, S (2009) *Critical analysis of the Draft River Basin Management plans for the Wye and/or Usk catchments*, Wye and Usk Foundation

Gburek, W. J., Sharpley, A. N., Heathwaite, A. L. and Folmar, G. J. (2002) Phosphorus management at the watershed scale: A modification of the phosphorus Index. *Journal of Environmental Quality* 29, 130 – 144.

Heckrath, G., Brookes, P. C., Poulton, P. R. and Goulding, K. W. T. (1995) Phosphorus leaching from soils containing different phosphorus concentrations in the Broadbalk experiment. *Journal of Environmental Quality* 24, 904 – 910.

Johnston, A. E. (2001) Principles of crop nutrition for sustainable food production. Proceedings No. 459. *The International Fertiliser Society.* York, UK. 39pp.

Johnston, A. E. and Dawson, C. J. (2005) *Phosphorus in agriculture and in relation to water quality.* Agricultural Industries Confederation

Herefordshire Council (2010) *Green Infrastructure Strategy*, (part of the Local Development Framework)

HM Government (2013) *Next steps on delivery of the EU Common Strategic Framework 2014-2020*, Letter to LEP Chairs, 7th February 2013

Howells, J (2011) *Scoping Study Clun Community Led Catchment Management Project*, commissioned by the Shropshire Hills AONB Partnership on behalf of Land, Life and Livelihoods, Resources for Change, July 2011

Inman, A (2011) A Review of Current Policy Tools and Funding Mechanisms Available to Address Water Pollution From Agriculture in England, (Component B) of Maltby et al, *Defra Strategic Evidence and Partnership Project*

Maltby, A., Walker, M., Buckingham, E., Paling, N., Kendal, H. and Sherrott, C. (2011*) Defra Strategic Evidence and Partnership Project*

National Farmers Union & Environment Agency (undated) *Tackling our phosphate problem: Farming's role in restoring waters suffering from phosphate pollution*

Natural England (2008) *Environmental Stewardship Handbooks; Entry Level Stewardship* (ELS) ISBN 978-1-84754-080-5 (2008), *Organic Entry Level Stewardship* (OELS) PB 10381; *Higher Level Stewardship* (HLS) ISBN 978-1-84754-082-1

Natural England (2013) *Capital Grant Scheme – Funding Priority Statement 2013/14*, Catchment 7: River Lugg, CSF5/7

Natural England (2013) *Capital Grant Scheme – Funding Priority Statement 2013/14*, Catchment 23: River Wye, CSF5/23

Natural England (2013) Agreement between Natural England and the Environment Agency to produce a Nutrient Management Plan for the River Wye SAC, published correspondence to Herefordshire Council, 13th February 2013

Preedy, N., McTiernan, K., Matthews, R., Heathwaite, A. L. and Haygarth, P. M. (2001) Rapid incidental phosphorus transfers from grassland. *Journal of Environmental Quality* 30, 2105 – 2112.

Ragg, J.M. (1984) *Soils and their use in Midland and Western England*, Harpenden, Soil Survey of England and Wales Bulletin Series 12

River Lugg Internal Drainage Board (2010) *Biodiversity Action Plan*

RKP Partnership Ltd (2013) *Environment Agency: Significant Water Management Issues* (SWMI), Nutrient Management stakeholder workshop, draft report, 6th March 2013

RKP Partnership Ltd (2013) *Environment Agency: Significant Water Management Issues* (SWMI), Soil Management stakeholder workshop, draft report, 14th March 2013

Rural Payments Agency (2009a) *Cross Compliance Guidance for Soil Management*, 2010 Edition, PB 13315, Rural Payments Agency and Defra, Crown Copyright

Rural Payments Agency (2009b) *Soil Protection Review 2010*, PB 13311, Rural Payments Agency and Defra, Crown Copyright

Rural Payments Agency (2012) T*he Guide to Cross Compliance in England*, 2013 Edition. Rural Payments Agency and Defra, Crown Copyright

Scottish Natural Heritage (2011) *Loch Leven Special protection Area and Ramsar Site: Advice to planning applicants for phosphorus and foul drainage in the catchment*

Sharpley, A. N., and Moyer, B. (2000) Phosphorus forms in manure and compost and their release during simulated rainfall. *Journal of Environmental Quality* 29, 1462 – 1469.

Shephard, M. A. and Withers, P. J. A. (1999) Application of poultry litter and triple superphosphate fertiliser to a sandy soil: effects on soil phosphorus status and profile distribution. *Nutrient Cycling in Agroecosystems* 54, 233 – 242.

Silgram, M., Jackson, R. J., Bailey, A. P. and Quinton, J. N. (2010) Hillslope-scale surface runoff, sediment, and nutrient losses associated with tramline wheelings. *Earth Surface Processes and Landforms.* (Special Issue – Soil erosion in agriculture) **35**, 699-706.

Smith, K. A., Brewer, A. J., Crabb, J. and Dauven, A. (2001) A survey of the production and use of animal manures in England and Wales. III. Cattle manures. *Soil Use and Management* 17, 77 – 87.

Smith, R. V., Lennox, X. D., Jordan, C., Foy, R. H. and McHale, E. (1995) Increase in soluble phosphorus transported in drain flow from a grassland catchment in response to soil phosphorus accumulation. *Soil Use and Management* 11, 204 – 209.

Smith, S. J., Sharpley, A. N., Naney, J. W., Berg, W. A. and Jones, O. R. (1991) Water quality impacts associated with wheat culture in in the Southern Plains. *Journal of Environmental Quality* 20, 244 – 249.

Stoat, C., Leake, A., Jarvis, P. and Szczur, J. (2012) *Fields for the future, The Allerton project – A winning blueprint for farming, wildlife and the environment*, Game and Wildlife Conservation Trust

Turner, B. L. and Haygarth, P. M. (2000) Phosphorus forms and concentrations in leachate under four grassland soil types. *Soil Science Society of America Journal* 64, 1090 – 1099.

West Midlands European Service (2012) Presentation given at a workshop on the EU funding programme 2014-2020, the Kindle Centre, Hereford, 5th November 2012

White, P. J. and Hammond, J. P. (2006) *Updating the estimate of the sources of phosphorus in UK waters.* A Defra funded project WT0701CSF. Defra.

White, P. J., and Hammond, J. P. (2009) The sources of phosphorus in the waters of Great Britain, *Journal of Environmental Quality* 38: 13-26

APPENDIX 1 Consultees and outputs from the study

Study Team

- Nick Read, Bulmer Foundation
- Dr Nancy Oakes, Bulmer Foundation
- Cathy Meredith, Herefordshire Rural Hub

Herefordshire Nutrient Management Pertnership

The members of the study team, plus -

- Roger Owen, Natural England
- Dane Broomfield, Environment Agency
- Tony Norman, Wye & Usk Foundation
- Mike Williams, Wye & Usk Foundation
- Caroline Hanks, Wye & Usk Foundation
- Kate Adams, Catchment Sensitive Farming
- Sarah Falkner, National Farmers Union*
- Clare Greener, National Farmers Union
- Martin Jackson, Amey
- David Curtis, Duchy of Cornwall*
- Rob Dunn, Herefordshire College of Technology*
- Emily Durrant, Cider and Perry Orchards Network of Excellence (ONE)*
- Donna Tavernor, Country Landowners Association*

*unable to attend group meetings but included in correspondence and/or met separately

Other Herefordshire consultees

- Cllr Roger Phillips, Cabinet Member for Economic Development, Herefordshire Council
- Vinia Abesamis, Senior Policy and Funding Officer, Herefordshire Council
- Bill Bloxham, Planning Department Herefordshire Council
- Yvonne Coleman, Planning Department, Herefordshire Council
- Samantha Banks, Neighbourhood Plans, Herefordshire Council
- Sir Ben Gill, Marches Local Enterprise Partnership
- Helen Yeomans, REACH Project, Kington
- Angela Fitch, Federation of Small Businesses
- Charles Pudge, Chairman, River Lugg Internal Drainage Board
- Leslie Harrison, Consultant, River Lugg Internal Drainage Board
- Richie Cotterill, Kington Local Environment and Energy Network
- Arrowvale Environment Group
- Will Lindsey, Director, Herefordshire Voluntary Organisation Support Service (HVOSS)
- Richard Quallington, Chief Executive Officer, Community First
- Lorna Pearcey, Sustainable Communities Officer, Community First
- Herefordshire in Transition Alliance

- Herefordshire Local Nature Partnership
- Sir Ben Gill, Marches Local Enterprise Partnership

Non-Herefordshire consultees

- Mike Payne, Environmental Consultant, National Farmers Union
- Simon Draper, Agronomist with the Farming Advice Service
- Joy Greenall, Land Life & Livelihoods
- Michael Whithouse, Land Life & Livelihoods
- Prof Bob Harris, Defra Demonstration Test Catchments (DTC) Secretariat
- Ken Downward, Catchment Sensitive Farming Officer, Clun Catchment
- Anna Hall, Environment Agency
- Mark Scott, Environment Agency
- Dr Ian Maddock, Institute of Science and the Environment, University of Worcester
- Paul Henderson, Dwr Cymru Welsh Water

Meetings attended/hosted during the study period

- National Farmers Union County Committee, 6th February 2013
- Farming Advice Service, National Stakeholders Group, Stoneleigh, 7th February 2013
- Water Framework Directive, Wye Catchment Delivery Group, 21st February 2013
- Environment Agency, National Stakeholders Workshop, "Managing Nutrients in Agricultural Systems", 22nd February 2013
- Environment Agency, National Stakeholder Workshop, "Managing Soils", 28th February 2013
- Farming Advice Service, Regional Steering Group, 12th March 2013

Dissemination of best practice events within the County (since January 1st)

- 6 Soils Repair Workshops have been hosted plus a potato event in partnership with Catchment Sensitive Farming
- Two Green Futures events were held in Herefordshire at which soil and water issues were discussed

Outputs during the course of the study

- Presentation to Herefordshire Business Board
- Contribution to Herefordshire's submission to the future of European funding workshops and development of an Integrated territorial Investment (ITI) approach
- Submission to the Tri-Annual review of the Environment Agency and Natural England
- Submission to the Marches Local Enterprise Partnership Business Plan
- Article for the HVOSS Update
- Briefing and discussion with Owen Patterson, MP, Secretary of State for Environment, Food & Rural Affairs

APPENDIX 2 Special Areas of Conservation

1. The River Wye (Lower Wye)

The River Wye (Lower Wye) Site of Special Scientific Interest (SSSI) and Special Area of Conservation (SAC) is designated because of a number of important species. Those listed in the Annexes of the EU Habitats Directive (Council Directive 92/43/EEC) are the Allis Shad (*Alosa alosa*), Twaite Shad (*Alosa fallax*), Sea Lamprey (*Petromyzon marinus*), Brook Lamprey (*Lampetra planeri*), River Lamprey (*Lampetra fluviatilis*), Atlantic Salmon (*Salmo salar*), Bullhead (*Cottus gobio*), Grayling (*Thymallus thymallus*), Common Otter (*Lutra lutra*), Atlantic Stream Crayfish (*Austropotamobius pallipes*), Freshwater Pearl Mussel (*Margaritifera margaritifera*) and floating vegetation of *Ranunculu*s. The River Wye (Lower Wye) SSSI has also been designated as a salmonid fishery under the EC Freshwater Fish Directive (78/659/EC).

It is a large linear ecosystem acting as an important wildlife corridor, and essential migration route and key breeding area for many species. Its diversity is a product of the underlying geology, soil type, adjacent land use and a near-natural fluvio-geomorphological regime.

The Wye forms one of the largest near-natural rivers in England and Wales, with the main channel being 250km long from source to confluence, draining a catchment of 4,136km2 (the fourth largest flow of any river in England and Wales). The river shows a clear downstream succession in plant communities reflecting variation in its geology, flow rate and land use and exhibits a natural increase in dissolved minerals as it flows over the underlying geology of Old Red Sandstone and Carboniferous Limestone. Localised differences in water chemistry occur where major tributaries, such as the River Lugg, enter the main channel. The catchment of the Lower Wye is 2,513km2 in area and predominantly low lying. Radnor Forest and the Black Mountains are the most significant upland areas.

2. The River Lugg

The River Lugg's Habitat Directive designated species are the Atlantic Stream Crayfish (*Austropotamobius pallipes*), Common Otter (*Lutra lutra*), Atlantic Salmon (*Salmo salar*), Bullhead (*Cottus* gobio) and Twaite Shad (*Alosa fallax*). It river also encompasses the River Lugg Meanders SSSI designated under the Geological Conservation Review. The Welsh section of the river lies within the Radnor Environmentally Sensitive Area (ESA). From its upland source in Powys, in mid-Wales, to its confluence with the Wye below Hereford in England, it is considered to be one of the best British mainland examples of both a clay river and a river displaying a transition from nutrient-poor to naturally nutrient-rich water chemistry.

The Lugg rises at 500m at pool Hill in Powys and descends rapidly before flowing through a more gentle landscape and onto a broad alluvial floodplain where it joins the River Wye. Despite being canalised in some small sections of its 101km length and running through an intensively farmed catchment in its middle and lower reaches, it is a largely unpolluted natural river and supports plant communities and other populations of special interest. The river experiences variations in geology, flow and substrate throughout its length giving rise to interesting variations in river plant communities ranging from naturally species-poor communities in the upland channels which are prone to spate, to those representative of mature lowland rivers.

APPENDIX 3 Case Studies

1. Land Life & Livelihoods

Land, Life & Livelihoods (LLL) is a farmer/community group covering three parishes within the Clun Forest (Bettws-y-Crwyn, Newcastle on Clun and Mainstone), formed 7 years ago. The Shropshire Hills AONB Office hosted a five year project called "Blue Remembered Hills" and a project officer was employed to help communities within the AONB develop community-led projects, under the generic title of "Down to Earth…." "Down to Earth in the Clun Forest" was the forerunner to Land Life and Livelihoods as it provided the initial mechanism for local engagement. Community consultations indicated that people valued the river and the role that farmers played in maintaining the unique landscape and biodiversity of the AONB and so a landscape project developed called "Farming, Wildlife and Landscape." The steering group for this project effectively became the steering group for LLL after the Blue Remembered Hills funding came to an end. Since the end of the Blue Remembered Hills project the core work of LLL has been funded by LEADER, enabling it to have some administrative support and fund meetings and newsletters etc. (though this funding is coming to an end), augmented by Sustainable Development Fund (SDF) grants for discrete projects from the AONB Office. The reputation of the group has grown and it now provides representatives to the AONB Partnership, the Clun River Partnership and the Teme Catchment Partnership (see below). A recent development is that the local Catchment Sensitive Farming Officer is using the LLL Steering Group as his local support group, rather than create a separate group to oversee his activities. LLL meetings are regularly attended by representatives from Natural England and the Environment Agency.

The idea of a Community-Led Catchment Management Plan initially arose because of concern amongst the farming community that the end of the Environmental Stewardship Scheme would lead to a reduction in farm income. The significance of the river presented an opportunity to engage in a river-based project that might help to generate income as well as protect or enhance biodiversity; including the potential for tourism, fishing etc. Since the Clun had been designated a Special Area of Conservation (SAC) because of the freshwater pearl mussel this also enabled some grant aid to be made available through the AONB Office for work along the river corridor (but not the wider catchment). A meeting was held between the major stakeholders in the river system: landowners and communities (represented by LLL), the AONB, Shropshire County Council, the Environment Agency and Natural England, resulting in a small grant (£2k) from Shropshire County Council to pay for a scoping study to explore the idea of a Community-Led Catchment Plan (Howells J, 2011). This was conducted by Resources for Change, an environmental consultancy based in Powys. The consultant, Joy Howells, lived locally and eventually joined the steering group of LLL. There was widespread community consultation throughout this process and the final report addressed both the scientific parameters required to maintain river quality, including phosphates, and the economic and social importance of the river. The resulting action plan has not been fully implemented, but it represents a

framework within which implementation can be progressed as resources become available (for examples - see below).

Oversight of activity throughout the Clun Catchment is co-ordinated by the Shropshire Hills AONB Office through a "River Partnership", though this has not been able to attract many working farmers except through LLL's participation (which represents a small geographical part of the overall catchment). The emphasis of the River Partnership's activities is the protection and enhancement of the river for the benefit of the pearl water mussels, rather than the wider socio-economic agenda of LLL's Catchment Management Plan. However the Partnership has enabled greater collaboration and co-operation between agencies. A river basin strategic framework is provided through the Teme Catchment Partnership (see below). It is understood that a Nutrient Management Plan is being developed for the Clun, but LLL has not been asked to participate in its development thus far.

Funding (or contributions in kind) have been obtained for four initiatives which are currently helping to implement the action plan.

i. Citizen science

Flows of water vary in many of the tributaries of the Teme, of which the Clun is one (see below) and LLL have adopted a unique approach to gather data and harness community involvement in the catchment initiative. Volunteers in the Upper Clun have received some training from the Environment Agency and are involved in measuring flows in the river valley and identifying invertebrate species in the river bed. Biological sampling will contribute towards understanding the health of the river and flow monitoring helps build a better picture of how flow varies seasonally and in response to rainfall.

Volunteers are also taking soil and sediment samples from fields, river banks and road verges to help trace the origin of silt that is considered to be a major problem to the river bed. Three sediment traps have been established in the river. ADAS are processing the sediment samples (estimated cost c£8k) and undertaking data analysis. The volunteers are supported by the "Rivers Officer" from the Shropshire Hills AONB Office, and the presence of this officer is felt to be an important component in the success of using volunteers in this way. The Germans refer to "expert pensioners" i.e. people with skills and time, and it is felt that these represent a largely untapped resource. Shropshire County Council are also undertaking a survey of the road drains in the Upper Clun.

LLL hopes to set up a "Community Observatory" to manage information collection, collation and dissemination both within the communities involved and with external organisations. Newcastle on Clun Primary School was able to gain grant funding from the Environment Agency to buy laptops that are used to help process the data and engage the children in a greater understanding of the river

monitoring and its significance. This is tied in to a wider approach with organised days on river dipping etc., involving both children and parents.

ii. **Septic tank survey**

£20k funding was obtained from the Environment Agency to undertake a septic tank survey within the catchment using local volunteers. The purpose of the survey is to ascertain the extent to which septic tanks may be contributing to phosphate pollution, and whether a capital funding is required to repair or restore septic tanks. The volunteers are paid to undertake a questionnaire survey of householders and a survey of the septic tanks, looking for evidence of leaking (discharges, rank grass etc), and the proximity of the septic tank to water courses. Early results suggest that most septic tanks are in a reasonable state of repair.

iii. **Farmers' Dens on diffuse pollution**.

Farmers' Dens are one-to-one meetings that have been operating in the area for some years with, for example, planning officers, FWAG Advisers etc. The Catchment Sensitive Farming (CSF) Officer for the area is available for consultations at various locations within the Clun Valley and farmers "book" an appointment to discuss issues of mutual concern.

iv. **Creative use of festivals**

LLL, in conjunction with the churches and local community groups, organised a "Water Harvest festival" in mid-October 2012. Prior to the event eight creative workshops focussed on the subject of water and/or the river which were free of charge to those attending, and most of which were oversubscribed. These included spinning and weaving (i.e. using textiles to explore images of the river), creative writing, painting and drawing workshops with the school children looking at the science and natural history of the river, and a singing and recording event. All of the work was displayed and performed at the Water Harvest Festival. Approximately 150 people attended over the two-day period, a significant proportion of the local population. The week-end also included displays about community groups, riverside walks, talks about wildlife and demonstrations on water harvesting and treatment of waste water.

2. The Teme Catchment Partnership

The Clun is a part of the Teme Catchment, which was selected as a Pilot Catchment under a Defra-funded scheme, started in 2011. The pilots are required to *"provide a clear understanding of the issues of the catchment, involve local communities in decision making by sharing evidence, listening to their ideas, working out priorities for action and seeking to deliver integrated actions that address local issues in a cost effective way and protect local resources."* (Richard Benyon, Minister for Natural Environment and Fisheries, 22nd March 2011). This approach encourages strategic co-ordination

involving statutory and public bodies and, where practicable, community groups though LLL is currently the only community group represented. The Teme Catchment Partnership was inaugurated in early 2012, chaired by the Severn Rivers Trust.

A professional facilitator helped the development of a Teme Catchment Partnership Plan [Ref XXXX]. The agreed vision for the Catchment is *"Healthy functioning rivers flowing through a balanced living landscape, cherished by all in the Teme Catchment."* Included within this vision are specific actions such as:

- Water bodies with high ecological status
- River sediment reduced to natural levels through improved practices, such as sustainable urban and rural drainage and good buffer strips along river banks on cultivated land and fewer livestock accessing the river.
- That there should be no need for pesticide removal from drinking water

The Partnership is committed to *"working with everyone who wants to help realise this vision. This includes individuals, land managers, local communities, businesses, voluntary bodies, local authorities and government agencies."* (Partnership Plan, p 5) The strategic vision is being implemented at local level through a wide range of organisations, with impetus provided through a funded Project Officer whose remit is to visit communities and groups along the Teme to help them engage with the project.

Diffuse water pollution from agricultural sources, including phosphates, sediment and pesticides, has been identified as an important contributor to a reduction in water quality. The experience of the group is that although a great deal has been done to reduce the phosphate load, by changing farming activities and better treatment at sewage works, improvements to water quality are slowing. Sediment levels, known to be significant for phosphates, are of concern, arising from intensive agricultural practices, poaching by livestock, land drainage, and through destabilisation of the river banks as alder trees are killed due to *Phytophthora*. Increased use of farm chemicals has led to contaminants in the water courses which adversely affect the quality of groundwater used for water supply and can lead to long term effects on the biological quality of watercourses. The loss of pesticides to the water environment is considered to be 5% of the application, though may be significantly higher if rainfall occurs soon after application.

Point source pollution and wastewater are also significant. Most villages have wastewater treatment plants (WWTP) and discharges should be within consent levels set by the Environment Agency. However smaller treatment works are unlikely to have phosphorus removal plant and may contribute significant amounts of nitrogen and phosphorus to the aquatic environment. The rural nature of the catchment has large numbers of properties not connected to mains sewage and using septic tanks for water treatment. A survey conducted by the Shropshire Hills AONB Partnership found that there was little understanding of septic tanks amongst householders, and that many domestic systems were old and under-serviced and their installation dates pre-dated modern regulations that would now apply.

Phosphates in detergents and products derived from domestic laundry and cleaning materials enter the waste stream due to ineffective treatment, though phosphates will be banned from laundry products from 2015 onwards. Other products used in dishwashers, bathrooms and car cleaning products still contain phosphates.

3. Green Futures Co-ordinated Delivery Programme

The Green Futures delivery programme began in 2005 to help the farming community adjust to changes to the Common Agricultural Policy and Single Farm Payments. Cross compliance rules, waste management regulations and environmental stewardship schemes all needed explaining to farmers and whilst Defra-funded national programmes helped deliver this it was clear that information was not being acted on by those businesses who were in most need. Agencies, in particular, find that there is a cohort of farmers who are defined as "the hard to reach" because of the following reasons:

- They are not always aware of new legislation, market changes and funding programmes which will impact their business because:
- They often work alone and have insufficient time to investigate new developments and insufficient money to invest in improvements.
- Training and paper work from the lead agencies can be difficult to understand and relate to the farm. It is often difficult to sift through the information to establish what is relevant to a specific farm enterprise and there is a fear of getting it wrong.
- Existing networks for technical support are insufficient and do not tend to include the 'hard to reach'.
- Levels of stress have increased. There are farmers that are feeling increasingly isolated and are becoming 'harder to reach' as a result.
- Much of today's information is only available electronically through websites but it is recognised that there is still a high proportion of famers who are not IT- enabled and therefore unable to source updated material.

By adopting a "one stop" and non threatening approach to knowledge-transfer the Green Futures events attract those farmers who traditionally do not attend meetings and, in Herefordshire in January, 180 farmers attended the workshop held at Hereford Cattle Market and were brought up to date with Cross Compliance changes for 2013, Waste Exemptions, Catchment Farming Initiative, Environmental Scheme update, CAP Reform and the Campaign for the Farmed Environment.

4. River Mease SAC Water Quality (Phosphate) Management Plan

The River Mease, which straddles Leicestershire, Derbyshire and Staffordshire, is a Special Area of Conservation whose target levels for phosphate are being breached. In response, Natural England and the Environment Agency have produced a Water Quality (Phosphate) Management Plan (Environment Agency and Natural England, 2011). Of interest to the Herefordshire study is the use of developer contributions to help fund the necessary work to reduce phosphate levels (see section 6).

The Mease report identified foul water effluent from the existing built environment as a major source of point source pollution of phosphates. Whilst the preferred disposal route for foul effluent from any development is normally via a public sewer and treated at a public Sewage Treatment Works (STW), it was felt that adding additional wastewater to existing public sewers would simply lead to an increase in phosphates entering the SAC without the necessary infrastructure in place to reduce the phosphate content. Discussions have started with Water Companies to look at the necessary infrastructure changes required to remedy this via a Natural Environment Programme (NEP), which is part of a 5-yearly cyclical Asset Management Plan (AMP). The AMP, in turn, is reviewed via a Periodic Review which drives water industry investment for the following AMP cycle. OFWAT and the Consumer Council for Water are key components of securing support for the AMP.

The Developer Contribution will help to fund two components in the control of diffuse pollution:

i. Silt traps

Silt traps are helpful to prevent road run-off by removing any silt that holds phosphorus and which has the potential to become soluble phosphorus downstream. Silt traps are normally constructed with a “wetland”, i.e. a water-holding pond planted up, with the silt trap at the end which lets the water out. Data collected from the River Eye suggested that silt traps can remove up to 50% of the phosphorus content entering the river, though for planning purposes a figure of 25% was used. Wetland plants need to be harvested at the end of the growing season to prevent die-back and any further return of phosphorus to the river, estimated to remove 1g of P for every 5kg of plant material, such as reeds. Whilst the effect of silt traps is instantaneous they require maintenance and annual harvesting, so they are often viewed as a short-term measure. The estimated cost per trap was £45,000 including monitoring (Appendix 1, to the Mease SAC Report).

ii. River restoration

River restoration is a longer-term process but one that will ultimately lead to sustainable reductions in phosphates. The River Mease River Restoration Plan identified 22 projects which included: floodplain restoration, wetland and wet woodland creation, riparian planting and restoration, removal of modified bank structures and re-naturalising the bank profile, and weir removal. A properly

functioning floodplain slows down surface water input and thereby reduces sediment, and also allows the river to undertake the natural process of sediment deposition onto the floodplain in flood situations. Taking a floodplain out of agricultural se will also reduce the input of P-rich fertilisers to the land. Unlike silt raps, there is a significant lead time before restoration measures start to deliver measurable phosphate reductions.

Appendix 4 Phosphate-free cleaning products available from existing household products

Examples are taken from a leaflet produced by the Phosphorus Awareness project run by the South East Centre for Urban Landcare in Western Australia, www.sercul.org.uk

Bicarbonate of soda (baking soda) - spread dry bicarbonate on the surface of the thing to be cleaned and then rub with a damp cloth. If the powder is wet before application it won't work.

Lemon or lime - lemon contains citric acid which will clean and bleach. It leaves a fresh smell and can be used to clean and brighten plates, cutlery, glasses, chopping boards, furniture etc.

Salt (sodium chloride) - salt may be used as a disinfectant to bathe cuts and grazes and clean chopping boards. It is an abrasive to polish brass and copper and any other surface where an abrasive cleaner would normally be used.

Soap – a gel made from grated or left over pieces of soap can wash hair, clothes or dishes. Avoid using scented soap.

Vinegar – all vinegars contain acetic acid which acts as the cleaning ingredient. White vinegar is best for cleaning as it is colourless, it can be used to clean glass, chrome, tiles, slates, lino and cork floors, brass and copper, windows, mouldy surfaces, baths, toilets and basins.

Washing powder (sodium carbonate) – washing powder is a natural substance that can also be used to clean grease from walls and painted areas, pots and pans and blocked drains.

Equal parts of vinegar and warm water – to clean windows and linoleum

Two parts of vegetable oil to one part of lemon juice, to use as furniture polish on wooden furniture

Equal parts of bicarbonate of soda and salt – for any surface that needs an abrasive cleaner

Appendix 5 State of soils in Herefordshire

Personal correspondence from Simon Draper, agronomist with the Farming Advice Service

Fertiliser and manure use

In the last 5 years, there has been a better awareness and utilisation of manures and a much greater awareness of manufactured of fertiliser use. This has led to change in practice which can now be seen across the county of Herefordshire. The reason why fertiliser practice has changed is due to primarily, in my view, to the advisory services indicating the potential cost savings that can be achieved with the better and more accurate use of fertilisers, Many farmers are now applying what is required to their crops . This can be seen by the greater use of straight materials indicating farmers are now more comfortable with applying what is needed.

Alongside this manure use has also improved but the changes have been on a slower timescale reflecting the fact that capital investment in more accurate slurry and manure spreaders is required, however farmers have recognised the need to change and the risk of pollution from manures.

Soil structure

In my view the state of the soil as indicated by soil structure has in general not improved over the past 5 years since visiting the county, however on individual farms there has been significant improvement indicating that farmers are keen to learn and change their management of their soils.

Farmer perception of the problem has increased in the last 5 years and most farmers when questioned would now recognise that their soil structure would not be ideal and could be bettered. Therefore the question is why is it not happening?

In contrast to the nutrient/manure situation the problem with soil management is that this is the weakest area with advisors/agronomists who visit farms on a regular basis. In order to enact change the farmer must feel confident with the advice that he is given and willing to enact change, to be able to feel confident it is important that there is regular meetings between his advisor and the farmer and the farmer should at those meetings feel confident that his advisor has full knowledge of the subject and therefore is prepared to make the step change required.

Unfortunately with soil management it is the weak/blind spot for many advisors and so many farmers are left to their own understanding of the soil to achieve improvements. For farmers to do this they need to be able to view soil structure and determine what is wrong and how it may be corrected. Whilst this is not difficult to achieve, it is only being done once or twice a year and therefore the farmer needs to 'calibrate' himself to ensure that he is seeing the same thin year on year. This could be best achieved by the advisor/agronomist present on the farm. In order to do this the advisor/agronomist needs to feel confident he can give the correct advice, currently most advisors feel this is not an area they are confident in.

Where there are serious soil erosion issues then most advisors will not give advice in these areas as wrong advice can lead to making the matter worse and many advisors feel this is beyond their scope.

Therefore there is a need to train advisors to be able to feel confident to impart basic soil knowledge, however with the current workload that advisors are undertaking they feel that this is a step to far as

they are unlikely to receive a further remuneration for it and therefore they view it as no benefit to themselves and their business and in fact if they were to get things wrong could have a serious deleterious effect.

To remedy this , either specific advisors who feel competent in soil advice will work in Herefordshire but a better option may be to have groups of farmers at workshops where they can calibrate themselves and ensure on a regular basis that are noticing the same symptoms on a yearly basis. This is the work that the Rural Hub (funded by the E.A) currently does and could in future be used as an avenue to help soil structure and reduce pollution in the water courses. This though still doesn't solve the problem of the advisors as they in general do not have enough time to venture into soils – the odd one may do so but for most they already have a full book and therefore don't want to take on much more and certainly aren't really interested if they cannot make money from it and are just offering the farmer another service.

The only other area of untapped advice would be the machinery guys but we need to do a big training job on them as they know what the machines do but not what we want to achieve.

I think the main target ought to be the farmers themselves and organising soil groups so that they cannot learn from each other by visiting each other's farm and seeing what each is doing to achieve good soil management.

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