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Consultation Document

Review of the Designated Areas and Action Programme to Tackle Nitrate Pollution in Wales

Date of issue: 29 September 2016

Action required: Responses by 23 December 2016

Overview

The Welsh Government is committed to ensuring that we have a more integrated and sustainable approach to managing water in Wales. A key part of this is reducing water pollution caused or induced by nitrates from agricultural sources. Key to achieving this is our review of Nitrate Vulnerable Zones and the Action Programme requirements that are set out in this consultation. The outcome of the review and this consultation will be used to make any appropriate changes to the designated Nitrate Vulnerable Zones (NVZ) areas and/or the measures in the NVZ Action Programme.

How to respond

Responses can be submitted online via our website:

www.wales.gov.uk/consultations
www.cymru.gov.uk/ymgyngghoriadau

Alternatively, you may send your responses to:

Water Branch
Energy, Water and Flood Division
Welsh Government
Cathays Park
Cardiff
CF10 3NQ

E-mail: water@wales.gsi.gov.uk

Further information and related documents

Large print, Braille and alternative language versions of this document are available on request.

Should you wish to ask any questions, you can email the dedicated inbox at: water@wales.gsi.gov.uk

Further Information about the Nitrates Directive (91/676//EC) can be accessed here:
http://ec.europa.eu/environment/water/water-nitrates/index_en.html

Contact details

For further information and responses:

water@wales.gsi.gov.uk

Review of NVZ Designations 2016
Water Branch
Welsh Government
Cathays Park
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Data protection

How the views and information you give us will be used

Any response you send us will be seen in full by Welsh Government staff dealing with the issues which this consultation is about. It may also be seen by other Welsh Government staff to help them plan future consultations.

The Welsh Government intends to publish a summary of the responses to this document. We may also publish responses in full. Normally, the name and address (or part of the address) of the person or organisation who sent the response are published with the response. This helps to show that the consultation was carried out properly. If you do not want your name or address published, please tell us this in writing when you send your response. We will then blank them out.

Names or addresses we blank out might still get published later, though we do not think this would happen very often. The Freedom of Information Act 2000 and the Environmental Information Regulations 2004 allow the public to ask to see information held by many public bodies, including the Welsh Government. This includes information which has not been published. However, the law also allows us to withhold information in some circumstances. If anyone asks to see information we have withheld, we will have to decide whether to release it or not. If someone has asked for their name and address not to be published, that is an important fact we would take into account. However, there might sometimes be important reasons why we would have to reveal someone's name and address, even though they have asked for them not to be published. We would get in touch with the person and ask their views before we finally decided to reveal the information.

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1. Introduction

Wales' natural resources are among our most valuable assets. They provide essential services including food, water and land. These are as fundamental to the long-term success of our economy as they are to the quality of our natural environment and the well-being of our communities.

Our resources are under pressure from challenges, including extreme weather, pollution and climate change. For example, over the past fifty years, more intensive farming methods have led to an increase in overall loadings of Nitrogen to land, and the loss of some of this Nitrogen into the aquatic environment.

A significant proportion of the UK's nitrate input to the aquatic environment originates from diffuse water pollution which can be described as individual small sources of water pollution, that collectively cause a significant impact. One of which includes sources from agricultural activities.

The Nitrates Directive (1991) (The Directive) aims to protect water quality across Europe by preventing nitrates from agricultural sources polluting ground and surface waters and by promoting the use of good farming practices. The Directive forms an integral part of the Water Framework Directive and is one of the key instruments in the protection of waters against agricultural pressures.

The Directive gives member states the option to designate discrete targeted nitrate vulnerable zones (NVZs) or to adopt a whole territory approach whereby all land within that member state will be subject to the action programme.

The outcome of referendum held on 23 June was that the UK should leave the European Union. Importantly before, and during the negotiations, the UK continues to participate in EU activities, the EU institutions, and abides by EU law. Therefore until the completion of the negotiations the Welsh Ministers are obliged to make legislation to transpose the requirements of the Directive.

The issue of nitrate pollution will still need to be tackled whatever the outcome of the EU negotiations. Therefore we propose to seek your views through this consultation on how best to tackle this issue both in the short and long term.

This consultation document invites opinions from individuals and organisations on:

- options for future designation of NVZs – a targeted approach to designation of discrete NVZ areas or applying the action programme throughout the whole of Wales.
- Proposals to modify the Action Programme measures implemented within the NVZs.

These proposed new areas follow the latest evidence and data from Natural Resources Wales about waters in Wales that are classed as nitrate polluted waters under the current Nitrate Pollution Prevention (Wales) Regulations 2013.

Implementation of the proposals in the Action Programme following the designation process will contribute to an integrated approach to tackling diffuse pollution in water courses. This will in turn contribute to meeting other water quality requirements in Wales.

The Action Programme proposals in this consultation document are underpinned by detailed scientific evidence generated through research commissioned by the Department for

Environment, Food and Rural Affairs (Defra) to inform the implementation of the Nitrates Directive in the UK.

2. What are the main issues?

Water Strategy for Wales

The Welsh Government's Water Strategy for Wales published in May 2015 outlined 6 key themes. The section, *Water for nature, people and business*, sets out how the quality and quantity of our water resources will be sustainably managed, meeting society's needs and offering opportunities for green growth but also protecting and enhancing our natural environment.

One of the key areas for action highlighted within this section is that of preventing water pollution which is essential to the protection of our water quality.

Our current system for the control of point source pollution from sewage treatment systems and industrial activities are regulated by Natural Resources Wales, through a system of permits and monitoring. This ensures that our water environment is well protected from these sources although we accept that there is still more work to be done in this area. Diffuse pollution occurs as the result of a wide range of activities resulting in small sources of pollution which can be difficult to identify and control. They occur in all sectors, as well as resulting from our own activities as individuals.

To address diffuse water pollution, we will ensure that we have a joined up approach to land and water management. We will also work with the construction, forestry and agriculture sectors to understand, review and where appropriate, change current practices and regulatory approaches.

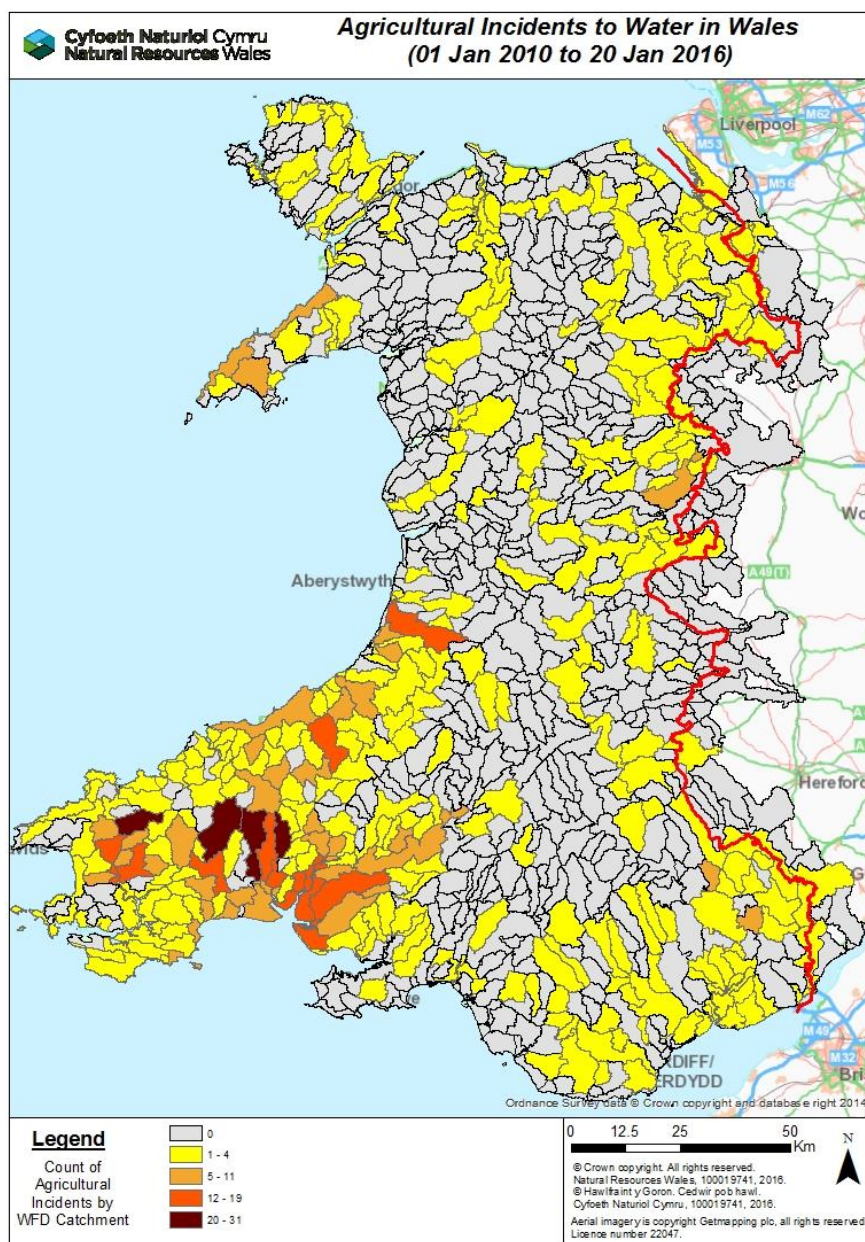
Nitrate loss from agriculture

There are two main reasons for ensuring nitrate concentrations in coastal waters, estuaries, rivers, lakes and groundwaters are maintained below prescribed limits:

- High nitrate concentrations can contaminate drinking water sources. As prescribed in the EC Drinking Water Directives (80/778/EC and 98/83/EC), water companies are required to provide drinking water containing nitrate concentrations less than 50 mg/l. Drinking water that is high in nitrates can interfere with the ability of red blood cells to transport oxygen with babies being particularly prone to this impact.
- High nitrate concentrations can contribute to an overall deterioration in water quality and lead to eutrophication, where nutrient enrichment can result in an undesirable disturbance of the aquatic ecosystem. High levels of nutrients such as nitrate can encourage prolific growth of aquatic organisms including toxic algal blooms and can reduce the oxygen status of water (deoxygenation) leading to fish kills. This reduces the biodiversity and conservation value of aquatic systems as well as the navigational and recreational value of water bodies.

The existing Action Programme measures and the additional measures contained within this consultation are likely to have greatest operational and financial impact upon dairy and beef farming practices. This is a proportionate response to the observation that between 2010 and 2015, an average of 61% of recorded agricultural pollution incidents per year, were from dairy farms and 19% from beef farms.

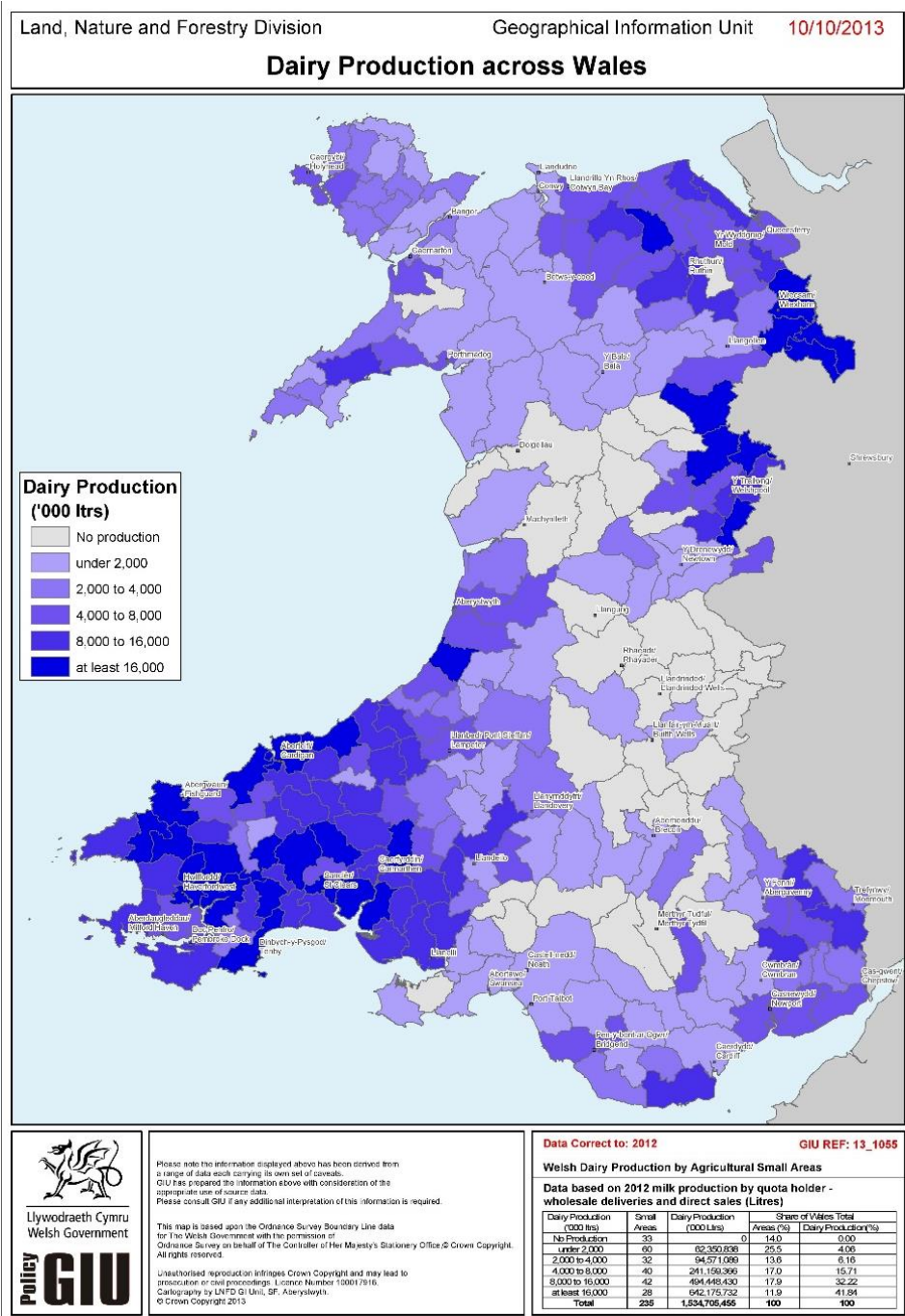
Between 1 April 2013 and 20 January 2016, 248 slurry pollution incidents were recorded, an average of 1.6 every week. In this period, 78% of slurry incidents were caused by dairy farms. It is important to note that these figures only refer to incidents reported to NRW. A number of incidents occur which are not reported meaning that the actual figure may be somewhat higher than presented here.



Between 2010 and 2015, soil and sediment losses to water accounted for 7% of reported pollution incidents, demonstrating that more needs to be done to prevent soil erosion, both to protect water quality and to protect soils. Soil loss causes water pollution issues, in particular sediment and phosphorus. Soil erosion is also responsible for degradation of the land resource on-site, with associated loss of soil function to deliver essential ecosystem goods and services such as food production, carbon sequestration and chemical buffering.

While the aim of this consultation is to address nitrogen losses to the environment, we also wish to consider the wider benefits and unintended consequences of the measures

introduced to ensure the outcome is in alignment with other natural resource management legislation and activities.



Farms with livestock, particularly dairy and beef producers, generate manure during the housing of their animals. This manure is removed to slurry stores. As these are usually outdoors, over time rainfall adds to the volume stored. Farms will spray the slurry to their fields when the weather and field conditions allow, usually in the summer months. Spreading slurry in the winter leads to loss of valuable nutrients to water due to increased rainfall and reduced uptake of nutrients by the vegetation on which it is spread. This means that the slurry stores must be large enough to hold both the slurry generated by the farm and winter rain to enable the farm to remove and spray the slurry when conditions are appropriate. Normally this requires the storage to be large enough to hold the volume of manure generated plus 4 months of winter rainfall.

An assessment of slurry storage has shown that of 127 farms visited in South West Wales, with 138 slurry stores, 56% of slurry stores were over 25 years old, whilst 22% of slurry stores were non-compliant with regulatory requirements and 65% of exempt and non-compliant stores have less than 4 months storage. Regulations governing the storage of slurry require structures to be built with a minimum life expectancy of 20 years, so a large number of stores in use are likely to be beyond their life expectancy. A NVZ Action Programme survey carried out in 2013 revealed the average storage capacity of those responding, prior to designation, was just 1.4 months.

This suggests that there may be high levels of poor nutrient management across Wales and the Action Programme measures within the NVZs will target actions in the areas where water quality is at greatest risk from agriculture.

Deficiencies in slurry storage and poor nutrient management can lead to significant pollution incidents, such as those demonstrated in the images below, which are hugely detrimental to water quality in Wales.

Image 1: Overflowing slurry store, with slurry entering a watercourse at the left hand field boundary. Under the Water Resources (Control of Pollution) (Silage, Slurry and Agricultural Fuel Oil) (Wales) Regulations 2010 a slurry store must provide a minimum amount of freeboard. This requirement is for the structural integrity of the store and not to provide additional capacity in case of emergency. Where the freeboard is not maintained, the store is at risk of catastrophic failure:



Image 2: Slurry application in winter and on frozen soil is a consequence of inadequate slurry storage and poor nutrient management. As the snow melts some of the slurry will be washed directly into the water environment and the nutrients reaching the soil will not be used by plants as it is too cold for them to grow. Nutrients will therefore travel through the soil profile into the water environment.



Image 3: Nitrate pollution of surface water by manure, such as that occurring in this image, increases the Biological Oxygen Demand (BOD) of surface waters. The BOD is the measure of the amount of oxygen taken up by bacteria entering a watercourse. The higher the level, the more oxygen that is stripped from the water and, at high levels, aquatic life can suffocate.



3. Legislative context

The Directive aims to reduce water pollution by nitrates from agricultural sources and to prevent such pollution occurring in the future. The Directive requires the Welsh Government to identify surface or ground waters that are, or could be high in nitrate from agricultural sources.

The Nitrate Pollution Prevention (Wales) Regulations 2013 (the Regulations) give effect to that Directive and their objective is to reduce water pollution caused or induced by nitrates from agricultural sources and to prevent any further pollution. The regulations require us to assess and designate areas as Nitrate Vulnerable Zones (NVZs) and produce an Action Programme of measures to reduce levels of Nitrogen entering watercourses.

The construction standards of the Water Resources (Control of Pollution) (Silage, Slurry and Agricultural Fuel Oil) (Wales) Regulations 2010 (the SSAFO Regulations) also give effect to the Directive. The SSAFO Regulations are currently under review and any changes are expected to be made alongside any changes to the NVZ designations and Action Programme measures.

The Environment (Wales) Act 2015 provides for us to plan and manage Wales' natural resources in a more proactive, sustainable and joined-up way.

Our aim is to make the most of the opportunities that Wales' natural resources present while safeguarding and building the resilience of natural systems to continue to provide these benefits over the long term. Central to the Act is the need to adopt a new, more integrated approach to managing our natural resources in order to achieve long-term sustainability. The Act provides an iterative framework that ensures managing our natural resources in a sustainable way will be a core consideration in decision-making.

Natural Resources Wales (NRW) will shortly be producing the first State of Natural Resources Report (SoNaRR). This will give an assessment of natural resources and how well we're doing to manage them in a sustainable way.

We are currently working on a national policy that sets out the priorities, risks and opportunities for managing our natural resources sustainably. The policy will take into account the findings of the State of Natural Resources report.

The measures taken to comply with the Regulations in Wales support our Sustainable Development Principle and a number of the Well-being goals under the Well-being of Future Generations (Wales) Act 2015 and our policy aspiration in the Water Strategy for Wales to tackle diffuse pollution in Wales. We must ensure we take preventative action to meet our needs now and for future generations.

- A prosperous Wales – Our objective is to promote coordinated development and management of water, land and related resources in order to maximise economic and social benefit in an equitable manner while enhancing the resilience of our ecosystems. Well managed use of water resources and water quality could offer opportunities to attract businesses requiring secure, high quality water to invest in Wales, supporting our aims of green growth and job creation.

- A resilient Wales – ensure that the aquatic ecosystems in Wales are able to cope with increased pressures from climate change and changes in farming practices. The Welsh Government is committed to building resilient ecosystems, this means taking a preventative approach, addressing the underlying issues rather than treating the symptoms, and improving the long term ability of our ecosystems to provide services and adapt to pressures and changes.
- A healthier Wales – to protect human health and living resources, improved water quality which will safeguard water for other uses e.g. recreational opportunities.
- A Wales of Cohesive Communities – an improved aquatic environment will encourage increased flora, fauna and wildlife making communities more attractive. Rural communities, tourism and farming and food sectors are heavily interdependent. Reduced pollution benefits tourism, which facilitates more direct economic benefits by strengthening local supply chains between producers and tourism businesses. Ensuring water is maintained in catchments is also a key factor for well-being.

The Regulations currently require monitoring of nitrates in ground and surface waters and where necessary designation of land as a NVZ to provide the appropriate protection. We are required to review the designations of NVZs and the effectiveness of the action programme every four years. The outcome of the review is used to inform whether we continue with designated areas of NVZs or apply the action programme throughout the whole of Wales and to inform amendments to the measures in the Action Programme. The last review undertaken by the Welsh Government in 2012 resulted in the designation of 2.4% of the land area of Wales as a NVZ and introduced a strengthened range of measures in the Nitrates Action Programme that farms located within NVZs must comply with.

This consultation document covers all elements of the proposed changes to the designated NVZs and Action Programme. The maps on our website show the proposed NVZ areas in Wales and will allow farmers to interrogate down to field level boundaries.

<http://lle.gov.wales/apps/nvz>

4. Designated Areas

The Regulations establish an Action Programme, which sets out specific good agricultural practice measures for landowners to follow in order to reduce nitrate pollution. The Directive requires that we either apply the Action Programme throughout Wales (whole Wales NVZ designation), or to specific areas designated as areas of land that drain into polluted waters and that contribute to the pollution of those waters. If we designate specific areas of land, only landowners within the NVZ must implement the action programme measures (with landowners in other areas being subject only to other national baseline standards). If we instead apply for Action Programme throughout Wales, all landowners in Wales must comply with the action programme.

If the Action Programme is not applied throughout Wales, we have to designate NVZs using specific tests and review these designations every four years. The tests require the designation of land draining into:

- Groundwaters or surface fresh water systems that contain, or could contain (e.g. due to an upward trend) if protective action (i.e. applying Action Programme measures) is

not taken, nitrate concentrations above 50 mg/litre; a significant part of which comes from agricultural sources;

- Freshwaters (e.g. lakes, rivers), estuaries, coastal waters and marine waters that are (or may become so in the near future if protective action is not taken) eutrophic when Nitrogen compounds (e.g. nitrate from fertiliser or manure) enrich the waters and cause accelerated growth of higher forms of plant life and algae. This produces an undesirable disturbance to the balance of organisms and to the quality of water.

5. Action Programme requirements

The Regulations require affected landowners to follow Action Programme measures with the aim of reducing nitrate pollution. The Action Programme consists of statutory measures of good agricultural practice, including:

- controlling the dates (closed periods) and conditions under which Nitrogen fertiliser and organic materials are spread;
- having sufficient facilities for storage of manures and slurries;
- limiting Nitrogen fertiliser applications to the crop requirement only;
- limiting quantities of organic material applied per hectare per year;
- limiting the total quantity of organic material plus excreta applied at farm level;
- controlling the areas where Nitrogen fertilisers (both organic and inorganic) can be applied;
- controls on application methods; and
- preparing plans and keeping adequate farm records.

The measures are intended to contribute to sustainable development by limiting and/or reducing agricultural losses of nitrate through good agricultural practice coupled with limits on fertiliser and slurry/manure loadings and timings, whilst promoting sustainable and adaptable farming. Good practice measures to limit losses of other pollutants are also included.

There are specific benefits arising from implementing these measures, including:

- Reducing the escape of nitrate and other nutrients into the water environment to reduce further the risk of eutrophication and excessive plant growth. Eutrophication occurs when there are excessive levels of nutrients in rivers and lakes, causing excessive growth of algae and plants. This increases the cost of drinking water abstraction and treatment, adversely affects angling, water sports and other recreational activities, and causes the loss of sensitive plants and animals in rivers and lakes.
- Helping to ensure industries dependent on high water quality remain viable, these include agriculture, fisheries, horticulture, food processing, recreation and tourism.
- Helping to protect habitats important for wildlife conservation and to prevent decreases in biodiversity.
- Helping to maintain and improve the quality of drinking water, and reduce the complexity and cost of water treatment, including for approximately 250,000 people in Wales who rely on private supplies.

In addition to the risk of nitrate pollution, loss of applied Nitrogen by leaching and surface runoff represents an economic loss to landowners. Manures and slurries are a valuable resource as they provide available Nitrogen to plants. Adequate allowance for the nutrients

supplied in organic materials can therefore reduce the need for applications of more costly bagged mineral fertiliser. As a result, more efficient, targeted applications of Nitrogen coupled with better accounting for the nutrient value in applied organic fertilisers can lead to lower overall fertiliser costs for individual farm businesses.

Natural Resources Wales (NRW) is responsible for enforcement of the Regulations in Wales, including Action Programme measures. The Action Programme requirements also fall under the scope of the Basic Payment Scheme (BPS) cross-compliance measures. Accordingly, where relevant, inspections assess compliance with NVZ Action Programme measures and penalties can be applied to BPS payments where breaches are found.

Further information on the action programme measures can be found in the regulations using the following, external link:

<http://www.legislation.gov.uk/wsi/2013/2506/contents/made>

6. Timeline Overview

We intend to introduce new regulations in 2017.

Designations

If the Welsh Ministers decide to designate discrete NVZs, there will then be a period during which any challenges to the designations could be made through the appeal process. Following consideration and adjudication of these appeals, the Welsh Government will publish final NVZ boundaries.

Action Programme

Changes to the Action Programme measures will apply once the regulations come into force in 2017.

In previous reviews we have recognised that a number of landowners will not be able to comply with some of the proposed measures straight away. We also recognise that slurry storage facilities and the amendment of the manure nitrogen efficiency standard values may require further consideration of the timeline to phase in implementations. Transitional periods will be established where necessary to provide landowners with sufficient time to adopt the rules.

7. Proposals for designating new NVZs in Wales

We have two options when it comes to deciding where to target the action programme measures. Our first option requires **as a minimum**, the designation of discrete NVZ areas that drain into polluted waters, within which an Action Programme of measures is implemented by landowners. Our second option is to designate 'whole territory' NVZs and apply the Action Programmes across the whole of the nation. Most of the northern EU countries have opted for the 'whole territory' approach, including the UK in respect of Northern Ireland.

Option 1 – Targeted approach to designation of discrete NVZ areas.

To date we have taken a targeted approach and designated NVZs, which currently cover approximately 2.4% of land in Wales. This is consistent with the objectives of Natural Resource Management, which aims to reduce pollution where it occurs and ensure that those who contribute to it take action to reduce the pollution. In other words, this approach encapsulates the ‘polluter pays principle’. It also ensures that burdens are not imposed on those whose land does not drain to nitrate-polluted waters and therefore assures that any costs to the industry are directly associated with the implementation of the regulations.

However, the four yearly cycle of reviewing water quality creates uncertainty for landowners, whose land may be removed from NVZ designation at one round and then re-designated at the next, or vice versa. This can make it difficult for landowners to take a long term view and make the right investment decisions for their business. Having land within an NVZ requires landowners to bear the extra costs of complying with the Action Programme.

Adoption of the targeted approach would mean an increase in the total area designated from 2.4% to approximately 8% which includes those areas newly identified by NRW. A description of the methodology is included in Annex 1 and on our website <http://lle.gov.wales/apps/nvz>.

Option 2 – Whole Wales NVZ designation.

We also have the option to introduce a whole Wales approach to designating NVZs and apply the Action Programme throughout Wales.

A ‘Whole Wales’ designation would provide an opportunity to develop an integrated approach to a number of different, though related issues. As well as providing a baseline to tackle agricultural pollution, it could also help us to meet other key objectives on air quality and reducing greenhouse gas emissions. Using a single legal instrument to set a baseline level of farm nutrient management would give us the opportunity to coordinate action aimed at achieving our objectives and make the baseline rules as simple as possible.

All landowners would be subject to the same rules throughout Wales which would help to avoid potential tensions between landowners at the boundaries of NVZ’s through a possible perception of inequality between neighbouring farms. It also avoids (real or perceived) competitive variations e.g. in relation to farm production costs or agricultural land values.

It would avoid the continuing uncertainty associated with the non-designation of areas as NVZs. These excluded areas could easily be designated in future years and advanced planning could be hindered by such uncertainty.

Such an approach however would make it difficult to determine the costs to the agriculture industry attributable to implementation of the regulations. It may appear that costs would be higher than with discrete NVZs though being able to coordinate basic measures within one instrument would facilitate minimising the costs on the industry overall by ensuring that measures were fully integrated.

There is a risk that due to the levels of investment required, landowners may resort to conscious non-compliance. This would undermine our objectives of improving water quality.

<p>Q1 - Do you prefer Option 1 (continuing with discrete NVZ designations), or Option 2 (applying the Action Programme to a ‘Whole Wales’ NVZ designation)?</p>
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8. Appeals

If a whole Wales approach (option 2) is not the preferred option and we continue to designate discrete areas, we will notify those landowners who will be affected by the new regulations following the conclusion of the consultation process.

Affected landowners will be able to appeal against the designation.

This section is intended to help you understand the timing and opportunity for those appeals. We are not seeking or accepting appeals at this stage as the maps we have included here are the areas we are minded to designate subject to the outcome of this consultation.

Appeals can be made on either or both of the following grounds:

- **The land to be designated does not drain into water which the Welsh Ministers are minded to identify or continue to identify as being polluted; or**
- **The land drains into water that the Welsh Ministers should not identify or continue to identify, as polluted.**

These two grounds for appeal are established through the Regulations. Appeals will be limited to factual matters in relation to the way in which land drains into water bodies and the level of pollution in water bodies. If you wish to appeal, you will need to provide appropriate evidence to support your case.

The appeals will be handled by the Planning Inspectorate Wales and they will issue full details of the appeal process (including guidance, forms and appeal deadline) prior to the appeals window opening. A 35 day window for making appeals will be advertised in the Government's response document.

The appeal mechanism is currently fully funded by the Welsh Government. We estimate the total cost of hearing appeals at this review to be £120,000 based on the proportion of appeals that took place during the last review, although we appreciate that this estimate could change dependant on the number of appeals.

We suggest introducing a provision to share that cost between the Welsh Government and individual appellants and propose an appeal fee. If the appeal is successful, the fee will be refunded to the applicant. This will be done through changes to the current regulations following this consultation. Based on the costs outlined above, we propose to charge a fee of £250 for each individual appeal.

Q2 - Do you agree that a refundable fee of £250 is an appropriate amount to charge?

If you don't agree, how much do you suggest the charge should be?

9. Approaches to tackling the issue

The Action Programme measures proposed in this consultation document are underpinned by detailed scientific evidence generated through research commissioned by the Department for Environment, Food and Rural Affairs (Defra) to inform the implementation of the Nitrates Directive in the UK.

We are aware however that there are alternative approaches to those outlined in the action programme below which could deliver the same outcome. We would therefore welcome your views on the actions outlined below, as well as possible alternative interventions.

10. Action programme

Existing Action Programme Measures

The proposals in this consultation for changes to the Action Programme reflect developments in our understanding of agricultural pollution pathways and key inputs from research commissioned by Defra to inform the implementation of the Nitrates Directive in the UK.

Research undertaken to date indicates losses of nitrogen to water will be most effectively addressed by the existing Action Programme measures. However, additional measures are proposed or explored within this consultation, which have the potential to further reduce nitrogen pollution from agriculture and promote the sustainable use of resources.

Some of the key Action Programme measures, such as the manure and slurry storage requirements have only recently come into force and are likely to take a number of years before they have full effect. There are also wider trends in agriculture that are not driven by the NVZ Action Programme but may contribute significantly to the reduction or increase of water pollution, such as changes in total livestock numbers and application rates of manufactured fertilisers.

The relationships between nutrient use, nutrient delivery, biological response and ecosystem resilience, water and sediment residence times, and confounding factors, such as rainfall, connectivity, catchment functioning and other sources of pollutants mean that forecasting water quality changes is particularly challenging.

As a result, the Welsh Government considers it too early to meaningfully analyse the success of the existing Action Programme. Therefore, the proposals contained within this consultation document are mainly focused on areas where new evidence has been generated.

Proposals for the NVZ Action Programme

This section outlines the proposed changes to the existing Action programme together with other changes that may be considered in the context of this review. Most aspects of the Action Programme will remain unchanged, but where there is evidence that existing measures can be improved upon we have developed proposals for further consideration. In selecting a final package of measures we will be looking for the best suite of proposals that will support an economically viable farming industry whilst achieving the following goals:

- reductions in losses of nitrogen from agriculture (with associated benefits of improving water quality and enhancing biodiversity);
- improving the efficiency with which all sources of nitrogen are used on farms;
- minimising pollution swapping (i.e. reducing losses of one pollutant that results in increasing the losses of another pollutant);
- delivering coherent interventions to support agriculture whilst improving the environment; and
- reducing the burden of reporting for landowners.

When commenting on the proposals you should be aware that the Nitrates Directive specifically lists measures that must be implemented by the Welsh Government within an Action Programme. It is not within the scope of this review to remove the basic measures.

In summary, the basic measures include:

- periods when the land application of certain types of fertilizer is prohibited;
- the capacity of storage vessels for livestock manure;
- the limitation of the land application of fertilisers, consistent with good agricultural practice, accounting for:
 - soil conditions, soil type and slope;
 - climatic conditions, rainfall and irrigation;
 - land use and agricultural practices, including crop rotation systems;
 - the foreseeable nitrogen requirements of the crops;
 - the nitrogen supply to the crops from the soil and from fertilization;
 - the amount of livestock manure applied to the land each year must not exceed the amount of manure containing 170 kg of nitrogen per hectare, unless a derogation has been granted.

The proposed measures are based on research and evidence. However we have presented options or alternatives for consultation purposes and responses to these proposals will inform the Welsh Government in developing the best 'package' of proposals to achieve the above listed goals.

The consultation proposals address the following issues:

- soil cover
- closed periods
- manure field heaps
- manure efficiency values and other manure values
- application of fertilisers on slopes
- holdings partially within an NVZ
- natural Resource Planning and Management

Nitrate pollution of water is harmful to the aquatic environment, adversely affecting natural and semi-natural habitats and has detrimental knock-on effects for the food chain which supports Wales' terrestrial wildlife. However, nitrate water pollution is not only an environmental issue but it is also a threat to the economy and human health. The annual costs for nitrate water treatment in the UK are around £16 million.

The following proposals aim to reduce nitrate pollution from agriculture to protect Wales' natural resources, without compromising the viability of sustainable businesses.

Soil Cover - crops, stubbles, residues or other vegetation

We consulted on the use of cover crops throughout NVZs in 2007 and 2012 but consultees rejected the idea, and Ministers agreed. However, the most recent evidence indicates that when used in the right way they can be a significant and cost-effective measure for tackling diffuse water pollution from arable land. The most recent evidence suggests that the presence of soil cover can reduce the concentration of nitrate in leachate by 30-60% and phosphorus losses by 20-80%.

In addition, autumn soil cultivation stimulates the mineralisation of nitrogen from organic matter at a time when there is little uptake by the crop, increasing the potential for nitrate leaching during the winter. By retaining stubbles over winter, there will be less leaching of nitrogen and less risk of sediment and phosphorus losses in surface runoff. The retention of stubbles has the potential to reduce nitrate leaching losses by 20-50% and sediment and phosphorus losses by 20-80% compared with ploughing.

Allowing volunteers and natural regrowth and sowing other crops to establish a cover following harvest can be as effective in reducing nitrate leaching as purpose sown cover. In practice, it would be possible to minimise cost by using minimum tillage methods, cheap seed and, where appropriate, using the harvested crop to feed livestock.

Consideration should also be given to securing secondary benefits. As the cost of removing nitrate from drinking water is high, preventing nitrate leaching into drinking water sources is particularly cost effective. Soil cover would also reduce sedimentation of water courses which is damaging to biodiversity, including fish spawning grounds which impacts upon tourism, and increases phosphate pollution and water purification costs. Soil and sediment losses account for 7% of agricultural pollution incidents in Wales.

The inclusion of soil cover within the Action Programme would therefore also contribute to achieving our Well-Being for Future Generations goals. Soils:

- are necessary for food production;
- support ecological habitats and biodiversity;
- act as a filter and immobilises substances and takes up, stores and releases atmospheric gases;
- regulate water flow from rainfall to vegetation and groundwater, and influence river flows and flooding;
- holds billions of cubic metres of water and is a direct source of minerals and resources, peat and topsoil; and
- stores and protects much of our cultural heritage, including archaeological remains.

We are, therefore, proposing to include soil cover measures in the Action Programme. To ensure that this measure does not increase the complexity of rules applying across Wales we intend to replicate the rules already implemented in cross compliance. However, the soil cover requirements in cross compliance allow rough cover where a soils assessment has been undertaken to reduce the risk of soil erosion. The soil cover requirements in cross compliance are primarily designed to prevent soil erosion and nitrogen losses are a secondary consideration. Rough cover is not a justifiable alternative to soil cover as a method to prevent nitrogen loss to water. As such, we do not intend to include the rough cover option in the NVZ areas.

The cost per hectare of a soil cover requirement is expected to be as detailed below, which includes the costs of increased cultivation, seed, broadcast, rolling, subsoiling, cover crop destruction and potential yield loss where applicable:

- Early harvested crops: £110-230/ha;
- Late harvested crops: £170-300/ha;
- Stubble following early harvested crops on heavy soils: £79-156/ha;
- Stubble following early harvested crops on light soils: £48-114/ha;
- Stubble following late harvested crops: £2-10/ha.

The proposal is as follows:

You must ensure that all land is covered by crops, stubbles, residues or other vegetation at all times, unless field operations would need to be carried out on waterlogged soil. The crop or temporary cover crop should then be sown as soon as is practical after it ceases to be waterlogged.

Where land that has been harvested with a combine harvester, forage harvester or mower, to comply with requirements, one of the following conditions should be met at all times between the day after harvest to the 1 March:

(a) the stubble of the harvested crop remains in the land; or

(b) the land is prepared as a seedbed within 14 days for a crop and the crop is sown within a period of 10 days beginning with the day after final seedbed preparation.

Advantages

- The available evidence suggests that the use of soil cover under these circumstances would take up significant quantities of nitrate over the autumn and winter period.
- This would be a cost-effective measure to reduce nitrate pollution from arable land.
- The presence of soil cover can also help reduce soil erosion and phosphorus losses.
- Soil cover can provide biodiversity and soil protection benefits.

Disadvantages

- The presence of soil cover could interfere with operations such as de-stoning of potato land, and preparation of a quality seedbed could be difficult in wet years.
- Increased costs, time and practicality constraints

Q3 - Do you think cover crops should be included in the Action Programme?

Q4 - If so, have we identified the correct circumstances for their use?

Q5 - Are the suggested dates appropriate? If not, what dates would you suggest?

Q6 - What actions do you consider should be defined to show compliance with the cover crop requirement ?

Storage of solid livestock manures in field heaps

Temporary field heaps of solid manure are an important part of farming practice in Wales. To ensure that any risk to the environment from the storage of field heaps is minimised the rules on manure field heaps were revised in 2013.

The current NVZ Action Programme includes measures on what types of manure may be stored in field heaps, the location of these heaps and the maximum storage time.

The current rules are as follows:

A temporary field heap must not be:

- in a field liable to flooding or becoming waterlogged;
- located within 30m of a watercourse on land identified on the risk map as having an incline of greater than 12°;
- within 50m of a spring, well or borehole or within 10m of surface water or a land drain (other than a sealed impermeable pipe);
- located in any single position for more than 12 consecutive months; or
- located in the same place as an earlier one constructed within the last two years.
- solid poultry manure that does not have bedding mixed into it and is stored on a temporary field site must be covered with an impermeable material.
- topsoil must not be removed from the ground upon which a temporary field site is to be constructed;
- the surface area of a temporary field site should be as small as reasonably practicable to minimise the leaching effect of rainfall.

Since the last review of the Action Programme, further research has been carried out on solid manure heaps, although field trials on the effectiveness of measures to mitigate nutrient losses have not yet been completed. Your views on the treatment of field heaps will help determine whether the rules in place are sufficient or whether additional requirements would be beneficial for the management of manure field heaps.

The rules enabling the storage of livestock manure in field heaps are designed to ensure that the practice can be carried out as a temporary measure. However, the rules currently require that temporary field heaps must not be located in any single position for more than 12 consecutive months. We would welcome your view on whether the rules make it clear that field heaps should be a temporary measure and whether the maximum length of time a field heap should be maintained should be reduced.

Q7 – Do you think the existing rules on the storage of solid livestock manures sufficient to reduce the risk of pollution?

Q8 – If not, what additional rules do you think should be established?

Closed Periods

The existing NVZ Action Programme prohibits the spreading of nitrogen fertiliser at specified times. This is because nitrogen in the soil in its readily available form will be leached at a higher level during the over-winter drainage period. Currently the closed period only applies

to organic manure in which more than 30% of the total nitrogen content is available to the crop at the time of spreading. There is no closed period for the spreading of farmyard manure, which contains less nitrogen in its readily available form, yet research shows that it presents a risk of nitrate leaching, particularly when spread in the autumn.

Slurry and poultry manures contain high levels of readily available nitrogen. Farmyard manure is lower in readily available nitrogen. The risk of nitrate leaching from farmyard manure will be lower than that from organic manure with high readily available nitrogen. The risk is much lower on grassland, where the crop uptake is sufficient to reduce the risk to a minimum. Research also shows that a closed period for farmyard manure on medium and heavy soils used for winter sown arable crops is likely to lead to increased ammonia loss and reduced nutrient efficiency to the detriment of crop yields.

The most significant risk of nitrate leaching losses following farmyard manure applications is following early autumn applications to sandy soils in arable production in high rainfall areas. This is because of low uptake of nitrogen by immature arable crops in the period between manure application and the start of drainage and increase rainfall after the manure is applied. A closed period will promote good practice, by ensuring on farm nutrients are recycled efficiently rather than released into the environment.

We therefore propose that an autumn closed period should be introduced but restricted to sandy soil on tillage land, where nitrate leaching reductions would be greatest. We propose to introduce a closed period for farmyard manure from 1 August to 30 September, in addition to the existing closed periods. As with the existing closed periods, we would expect to introduce an exemption where a crop is sown which would take up the applied nutrients.

Extending the closed period to include farmyard manure will mean that the time period during which organic fertilisers can be applied would be shorter. This may result in a higher reliance on synthetic fertilisers, which come at a higher cost to the farmer. If land is available for storage in temporary field sites then the cost of this measure will be low. The cost of constructing storage facilities with an impermeable base and effluent collection facilities would be significant though this is unlikely to be the necessary in the majority of cases. There may be increased labour costs associated with the need to spread manure at busy times. However, the size of the costs associated with this proposal is too small to be accurately estimated without a disproportionate level of additional research.

Q9 - Should there be a closed period for farmyard manure?

Q10 - If so, have we identified the correct circumstances in which a closed period should apply?

Q11 – Should a closed period apply to all other organic fertilisers?

Livestock manure values

The current Regulations require landowners to establish the total amount of nitrogen available for crop uptake in organic manure that contributes towards the Nmax limit (the permitted maximum amount of nitrogen that can be applied to a crop).

The amount of nitrogen available for crop uptake in organic manure is established using minimum manure nitrogen efficiency standard values. These values represent the percentage of the manure total nitrogen content that has the same effectiveness as manufactured nitrogen fertiliser.

The table below sets out the current standard values in Wales. These are some of the lowest standard values in the EU.

Table 1

Manure type Current	Current NVZ Action Programme %
Cattle slurry	40
Pig slurry	50
Poultry manures	30
Farm Yard Manure	10

In the last NVZ review, revised values were introduced for cattle and pig slurry. Research is ongoing on the values for poultry and farmyard manure.

The evidence from the last review showed that significantly more of the original nitrogen content is available for crop uptake with spring and summer applications than with autumn and winter applications.

Increasing the manure nitrogen efficiency values can ensure that all crop available nitrogen is taken into account when considering fertilisation plans and encourages the uptake of good practice.

Advantages

- Updating the manure nitrogen efficiency standard values will help ensure the Action Programme is based on the most up-to-date evidence.
- Recognising the full nitrogen contribution that organic manures make to meeting crop demand will reduce the need for additional manufactured nitrogen fertiliser and should increase farming efficiency.
- This proposal should also encourage a move to best practice in the handling and timing of applying organic manures to land, which will reduce nitrate pollution and manufactured fertiliser bills.

Disadvantages

- Changing the nitrogen efficiency standards so soon after the introduction of the January 2014 standard values may cause some confusion

The Welsh Government also seeks to update the other manure values established by the regulations. These include the values in Schedule 3, used to calculate the amount of nitrogen in organic manure and Schedule 1, used to determine the amount of manure, nitrogen and phosphate produced daily by grazing and non-grazing livestock.

Q12 - Do you agree with increases to the nitrogen efficiency standard values used in Nmax or should they remain the same?

Q13 - What concerns or benefits do you think increasing the values may raise?

Q14 – If you think the values should be increased, what values should be used?

Q15 – Do you think that the manure values of Schedules 1 and 3 – would be useful to reference the regs here and add a link so people know what to look for - should

Application of fertiliser on slopes

The regulations already provide that the slope of the land must be taken into account when assessing the risk of nitrogen getting into water, alongside other factors, such as ground cover, weather conditions and soil type.

To assess whether the rules address the risk of slopes sufficiently to minimise the risk of run-off and nitrate loss, further work was commissioned by Defra. The research showed that the effectiveness of measures to mitigate run-off and nitrate loss is, in the main, independent of slope and soil type and rainfall levels were more significant factors

The Welsh Government believes that the rules on slopes are sufficient to address the risk of slopes and so no changes to the rules are proposed in this consultation.

Q16 – Do you agree that the current rules on slopes sufficiently address the risks of pollution?

Q17 - If not, why not and what rules do you think should be implemented to address the risk?

Frozen Ground

The existing regulations are intended to prevent the spreading of manure on frozen ground to prevent run-off to water. The regulations specify that no person may spread nitrogen fertiliser if the soil is snow covered, or has been frozen for more than 12 hours in the previous 24 hours.

The Welsh Government intends to clarify the rules on spreading when the ground is frozen. We intend to adopt the wording 'nitrogen fertiliser must not be spread on soil that is frozen at or below the surface'.

Q18 - Do you agree with the proposal to clarify the wording of the regulations?

Farms partially within an NVZ

The Welsh Government recognises there is scope to clarify how the regulations apply to agricultural holdings that cross the NVZ boundary, which have land both inside and outside

the NVZ areas. As land outside of the NVZ areas is not subject to the NVZ rules, calculations can be undertaken on a pro-rata basis to establish the minimum storage requirement for livestock manure and the total nitrogen farm limit (170kg/N/ha).

It has also been observed that there are unintended consequences of designating discrete NVZs, with some farms spreading excessive amounts of livestock manure on the land outside of the NVZ in order to remain compliant with the 170kg/N/ha limit which applies to the land within the NVZ. This increases the risk of pollution outside of the NVZs, particularly where the 250kg/N/ha limit, as recommended in the Code of Good Agricultural Practice, is exceeded.

The risks include declines in water quality in areas outside of the NVZs, including that of bathing waters which are so important for tourism in Wales, and the deterioration of important habitats and biodiversity in these areas. The redistribution of manures may also lead to the designation of additional catchments as NVZs in the future.

We therefore intend to establish a whole farm limit for farms which are partially in an NVZ, as currently recommended in the NVZ Workbook to determine the manure capacity of the farm. The following calculation will be used to determine the whole farm limit for part NVZ farms, which must not be exceeded:

NVZ land area (ha) x 170kg	+	Non NVZ land area (ha) x 250kg	=	Whole farm limit
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For the storage of slurry to be determined for farms partly within an NVZ, we propose to clarify that the storage requirement should be proportional, based on the agricultural area. For example, where 70% of the agricultural area is within the NVZ, 70% of the storage capacity calculated for the whole farm using the existing NVZ calculation methodology will be required and the remaining 30% would need to meet the requirements of the Water Resources (Control of Pollution) (Silage, Slurry and Agricultural Fuel Oil) (Wales) Regulations 2010 (SSAFO).

The recent SSAFO consultation proposed a simplification of the regulations governing the storage of slurry across Wales by the adoption of the NVZ storage calculation methodology for slurry stores. An alternative option to the proportional approach detailed above would be to apply the NVZ storage requirement to the whole farm. This would be significantly more straightforward and easier to understand. However, the Welsh Government believes this should be established as an alternative option to the proportional calculation as there would be additional costs to farming businesses if made mandatory.

Q19 – Do you agree with the adoption of a whole farm limit?

Q20 – If you do, have we identified the correct method of establishing the limit?

Q21 – If you do not agree, do you think an alternative approach should be taken?

Q22 – Do you agree with the proportional approach described for calculating slurry storage?

Q23 - If not, how do you propose the rules should be clarified?

Further questions

Q24 - How do you think the proposed Action Programme changes will impact on the practical management of typical farm enterprises in the new or existing zones?

Natural Resource Management

The Welsh Government aims to ensure our natural resources are managed in a way and at a rate that can maintain and enhance the resilience of our ecosystems, whilst meeting the needs of present generations and without compromising the ability of future generations to meet their needs.

The Environment (Wales) Act 2016 has been developed to join-up the existing statutory frameworks for natural resource planning and management in Wales. It also aims to ensure Natural Resources Wales has the legislative tools to help enable them to implement integrated natural resource management. The regulations are enforced by NRW and so potentially form part of the legislative framework enabling them to do so.

Sustainable management of natural resources is defined in the Environment Act as using natural resources in a way and at a rate that maintains and enhances the resilience of ecosystems and the benefits they provide. By managing our natural resources in this way, the needs of present generations of people will be met without compromising the ability of future generations to meet their needs,

Further information on Natural Resource Management can be found on the Welsh Government website at:

<http://gov.wales/topics/environmentcountryside/consmanagement/natural-resources-management/?lang=en>

The Welsh Government wishes to explore natural resource planning and management in dealing with pollution and we therefore welcome your views on how natural resource planning and management can be used to tackle nitrate pollution in Wales.

Q25 – In the future, how could natural resource planning and management be considered as an alternative and complementary solution to tackling nitrate pollution in water?

Q26 - We do not believe that this policy affects opportunities for people to use Welsh or treats the language less favourably than English, or that it could be reformulated or revised to have positive effects. If you disagree, we would welcome your comments on this issue.

11. Summary of Questions:

Q1	Do you prefer Option 1 (continuing with discrete NVZ designations), or Option 2 (applying the Action Programme to a 'Whole Wales' NVZ designation)?
Q2	Do you agree with the proposal to charge a refundable fee of £250 per appeal?
Q3	Do you think cover crops should be included in the Action Programme?
Q4	If so, have we identified the correct circumstances for their use?
Q5	Are the suggested dates appropriate? If not, what dates would you suggest?
Q6	What actions do you consider should be defined to show compliance?
Q7	Do you think the existing rules on the storage of solid livestock manures sufficient to reduce the risk of pollution?
Q8	If not, what additional rules do you think should be established?
Q9	Should there be a closed period for farmyard manure?
Q10	If so, have we identified the correct circumstances in which a closed period should apply?
Q11	Should the closed period apply to all other organic fertilisers?
Q12	Do you agree with increases to the nitrogen efficiency standard values used in Nmax or should they remain the same?
Q13	What concerns or benefits do you think increasing the values may raise?
Q14	If you think the values should be increased, what values should be used?
Q15	Do you think that the manure values of Schedules 1 and 3 should be updated, where there is sufficient evidence to support that change?
Q16	Do you agree that the current rules on slopes sufficiently address the risks of pollution?
Q17	If not, why not and what rules do you think should be implemented to address the risk?
Q18	Do you agree with the proposal to clarify the wording of the regulations?
Q19	Do you agree with the adoption of a whole farm limit?
Q20	If you do, have we identified the correct method of establishing the limit?
Q21	If you do not agree, do you think an alternative approach should be taken?
Q22	Do you agree with the proportional approach described for calculating slurry storage?
Q23	If not, how do you propose the rules should be clarified?
Q24	How do you think the proposed Action Programme changes will impact on the practical management of typical farm enterprises in the new or existing zones?
Q25	In the future, how should natural resource planning and management be considered as an alternative solution to tackling nitrate pollution?
Q26	We do not believe that this policy affects opportunities for people to use Welsh or treats the language less favourably than English, or that it could be reformulated or revised to have positive effects. If you disagree, we would welcome your comments on this issue.

Annex 1: Description of the methodology for identifying individual NVZs

The areas recommended for designation are identified as land draining to and contributing to the pollution of a “polluted” water, specifically:

- a **surface water** which has, or could have if action is not taken, a nitrate concentration greater than 50 mg per litre
- a **groundwater** which has, or could have if action is not taken, a nitrate concentration greater than 50 mg per litre
- a surface water which is **eutrophic**, or in the near future may become eutrophic if action is not taken.

Methodology

The methodology used represents a robust and practical approach to the identification of polluted waters and NVZs, consistent with assessment approaches adopted for the Water Framework Directive (2000/60/EC) requirements and Groundwater protection. It makes use of all the available data; up to 20 years’ worth of monitoring in some cases.

Surface Water Methodology

Surface waters affected by nitrate pollution were identified using a series of steps. These include dividing the country into a large number of surface water catchments in which all watercourses are deemed to be ‘surface water’. The next step was analysing water quality monitoring data to find out whether the nitrate levels in the surface water were above 50mg/l. In parallel to this exercise, a modelling assessment of nitrate pollution in surface waters was undertaken which provides an additional assessment of the risk of nitrate pollution based on how the land is used. The combination of the results of these two methods provided an initial determination of whether the surface water was polluted.

Workshops were then held allowing local area Natural Resources Wales staff to comment on the preliminary results of the assessment and to highlight, for example, where others sources of pollution may have been the reason for high nitrate levels. The workshops were attended by observers from external stakeholder groups. The next and final stages were to check whether the land that drains into the ‘polluted’ waters.

Groundwater Methodology

Groundwaters affected by nitrate pollution were identified using a series of steps. Water quality monitoring data was analysed to determine the mean nitrate concentration in mid 2010 and the predicted mean nitrate concentration in 2025 to determine if the water was, or was likely to become, polluted. If the mean current or predicted nitrate concentration of a groundwater exceeds 50mg/l, it is deemed to be polluted and these areas were mapped.

The area of the ‘failed’ groundwater is then determined. In parallel, as for surface water, an assessment of nitrate leaching to groundwater using land use data was modelled. The outputs of these 2 methods were combined to provide an initial assessment of whether a ground water was polluted, and the confidence of that conclusion. As for surface water, to incorporate local knowledge and understanding, the results were reviewed and modified

where necessary by groundwater quality teams within Natural Resources Wales at local workshops, which were attended by observers from external stakeholder groups.

Land that is directly above a polluted groundwater does not necessarily drain into it and therefore the final stage was to use geology and other hydrogeological features such as surface water outflows and groundwater flow lines to delineate the catchments of the 'polluted' groundwater.

Methodology for eutrophic waters

Assessing eutrophication is complex. It describes a process of change rather than a state. It is not possible to assess whether a water is, or may become, eutrophic simply by reference to a single numeric threshold such as a nitrate concentration. Whether a water is eutrophic depends on a large number of variables in addition to the concentration of nutrients. It is necessary to consider the current condition of the water body, including its ecology, and whether undesirable effects and the growth of algae or plants are due to Nitrogen inputs. As with the surface and groundwater assessments, we are also required to consider whether such effects may occur if preventative action is not taken. All these elements are included in the methodology and conclusions are reached based on the weight of the evidence of eutrophication.

Criteria have been established for the relevant water types to decide whether waters are affected by eutrophication. Natural Resources Wales identified polluted waters if sufficient nitrate was present to promote eutrophication and the elevated nutrient concentrations were having an adverse impact on the plant life in the waters. Information on the impact on water quality and use (e.g. recreation or conservation value) of the water bodies was also considered. Therefore a number of factors were considered in order to come to a rounded judgement, taking into account the weight of evidence, as to whether an individual water was suffering from eutrophication or might do so without preventative action. Having identified candidate eutrophic water bodies Natural Resources Wales convened a panel of its own and external experts to ensure consistency in application of the assessment procedure.

External, academic experts were included on the panel because of the greater degree of expert judgement that this methodology requires (compared with the surface and groundwater processes). The final stage was that the land draining to these surface waters was identified.