Review of 2007-2010 Action Programme for the Nitrates Directive Northern Ireland

Recommendations from the Scientific Working Group

21 December 2009

CONTENTS

1.0 INTRODUCTION

The Nitrates Directive (91/676/EEC) aims to improve water quality by protecting water against pollution caused by nitrates from agricultural sources. In particular, key objectives are to promote better management of animal manures, manufactured fertilisers and other nitrogen-containing materials spread onto land. The Directive allows Member States to either designate discrete areas of land as Nitrate Vulnerable Zones (NVZs) or establish an action programme to be applicable to the whole territory.

Until 31 December 2006, Northern Ireland had designated seven NVZs on the basis of elevated nitrate levels in groundwaters. These NVZs were very small and covered less than 1% of Northern Ireland's area. However, Northern Ireland also has a widespread problem of eutrophication of surface waters and a large proportion of this nutrient enrichment is attributable to agriculture. Following extensive consultation, the total territory of Northern Ireland was established as the area to which an action programme would be applied under the Protection of Water Against Agricultural Nitrate Pollution Regulations (Northern Ireland) 2004 with effect from 29 October 2004.

On 1 January 2007 the Nitrates Action Programme Regulations (Northern Ireland) 2006 (the NAP Regulations) (**Annex 1)** came into operation. These Regulations apply to all farmers across Northern Ireland from that date, apart from some transitional arrangements on closed spreading periods and manure storage requirements. The Regulations require farmers to observe rules to reduce nitrate pollution, with measures on storing manure and periods when spreading manure and manufactured fertiliser to land is not allowed. Under the Directive, Action Programme(s) must be reviewed and if necessary revised at least every four years.

The NAP Regulations cover the period 2007-2010 and are therefore subject to review before the end of 2010.

A Scientific Working Group (SWG) (**Annex 2**: Terms of Reference) was tasked with a review and, if required, proposals for revision of the measures in the existing Action Programme (2007-2010). This report summarises that review and puts forward options in order to continue to:

(i) meet the legal obligations laid down in the Directive; and
(ii) ensure implementation of an effective Action Programme to prevent and/or reduce nitrate pollution from agriculture.

The SWG assessed the effectiveness of the Action Programme to date through the results of water quality monitoring and the evaluation of changes in farming practice up to and including 2008.

During the development of the Action Programme (2007-2010) the authorities in Northern Ireland also agreed to undertake the following four areas of research to underpin the measures:

1. impact of spreading organic manures in October and February;
2. options to better manage dirty water;
3. minimising phosphorus losses; and

4. improving manure N efficiency and minimising nitrous oxide losses to the atmosphere.

This research is described in **Annex 3** and has also been considered in relation to the review of relevant measures. In addition, the Northern Ireland authorities have put in place a number of additional research projects designed to provide additional information as to how soils and water quality are responding to the measures. Relevant research projects have already been described in the "2007 and 2008 Derogation Report for Northern Ireland".

2.0 EVOLUTION OF WATER QUALITY

The following section provides information on the measured nitrate levels and evolution of water quality in surface freshwaters and groundwaters over the period 2001-2008. The NAP Regulations have only been operational on a two-year transitional basis and it is recognised that there are weaknesses in using data for comparisons for 2 years, i.e. 2007-2008 due to the relatively low numbers of samples involved. For this reason it is proposed for the purposes of this Report that comparison will be made of monitoring results from 2005-2008 with the previous four-year data set, i.e. 2001-2004. Using four-year data sets also complies with the requirements of Article 10 reporting. In order to examine trends of nutrients over a longer time frame, data sets from 1995-2008 have been used. Nitrate data for 2009 are not currently available but will be provided in early 2010.

Since the adoption of the Water Framework Directive (WFD) (2000/60/EC), new methodologies and criteria for the assessment of trophic status in rivers, lakes and marine waters have been developed. The first trophic assessments using these methodologies and criteria are also presented below.

2.1 Nitrate Concentrations in Surface Freshwaters

In the period 2001-2004 the Northern Ireland Environment Agency (NIEA) monitored nitrate concentrations at 439 surface freshwater stations across Northern Ireland (Table 1). The average nitrate concentration at these sites was 5.77 mg NO_3/l. In the period 2005-2008 nitrate monitoring was carried out at 542 surface freshwater stations. The average nitrate concentration at these sites was 6.44 mg NO_3/l. Summary data collected monthly from the surface water monitoring network during the two periods, 2001-2004 and 2005-2008 includes, for each sampling station, the average nitrate concentration and the winter average nitrate concentration in rivers, streams and surface drinking waters. In each period data were only included where sufficient number[1] of samples over the four years were available.

Table 1: Number of surface freshwater monitoring stations sampled for nitrate concentrations (mg NO_3/l) in Northern Ireland in 2001-2004 and 2005-2008

	2001-04	2005-08	Common points
No of surface freshwaters sites for annual average nitrate	439	542	414
No of surface freshwater sites for Winter average nitrate	257	506	238

Results presented in Figure 1 show that nitrate concentrations for the period 2001-2004 are well below the critical level of 50 mg NO_3/l. Results indicate that 99.8% of surface freshwater sites had annual average concentrations of less than 25 mg NO_3/l with 88% of sites having concentrations below 10 mg NO_3/l. All sites monitored over the winter period, of October to March each year, had concentrations less than 25 mg NO_3/l.

[1] For surface freshwaters, data are included from sites which are considered to have sufficient numbers of samples in each 4-year period. When presenting figures, sites which had >=24 samples were included. For winter averages, sites which had >=12 samples were included.

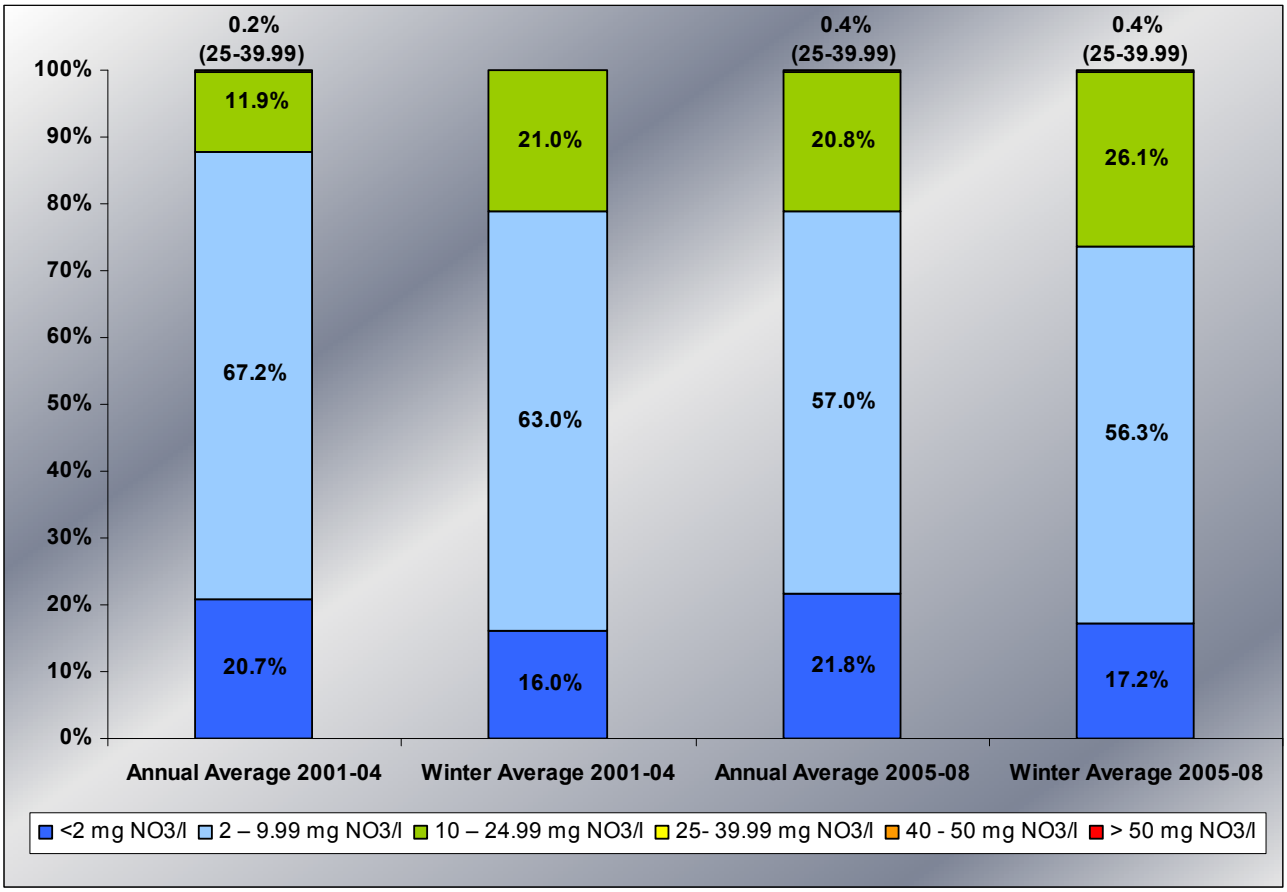

Figure 1: Annual average nitrate concentrations (mg NO_3/l) in surface freshwater stations, 2001-2004 and 2005-2008 *(% of stations)*

Data presented in Figure 1 show that, as with the previous period, the majority (99.6%) of surface water sites have an average nitrate concentration below 25 mg NO_3/l with 79% being below 10 mg NO_3/l. The majority (99.6%) of sites monitored over the winter period, of October to March each year, had concentrations less than 25 mg NO_3/l.

Data presented in Table 2 and Figure 2 show the trend or evolution of the average nitrate concentrations for 414 common monitoring stations across Northern Ireland. When comparing trends of winter average nitrate concentrations between 2001-2004 and 2005-2008, 238 common monitoring stations were considered. The data indicates that 71% of sites appear to be stable in surface freshwater annual average nitrate concentrations between the two periods. In addition, 68% of sites are showing stabilisation in winter average concentrations. It is difficult to draw any further conclusions from this assessment as the NAP Regulations have only been operational on a transitional basis for the last two years of the 2005-2008 dataset and subject to possible climatic influences as described in Section 2.3.1 below.

Table 2: Trends in surface freshwater nitrate concentrations (mg NO_3/l) based on annual and winter average values for 2001-2004 and 2005-2008 *(% of stations)*

	% of stations (based on mg/l difference)				
Change between previous and current periods	**≤ - 5 Strong decrease**	**>-5 to ≤ - 1 Weak decrease**	**>-1 to ≤ + 1 Stable**	**>+1 to ≤ +5 Weak increase**	**> +5 Strong increase**
Surface freshwaters annual average (mg NO_3/l)	1.4	2.4	71.3	23.7	1.2
Surface freshwaters winter average (mg NO_3/l)	0	1.3	67.6	29.8	1.3

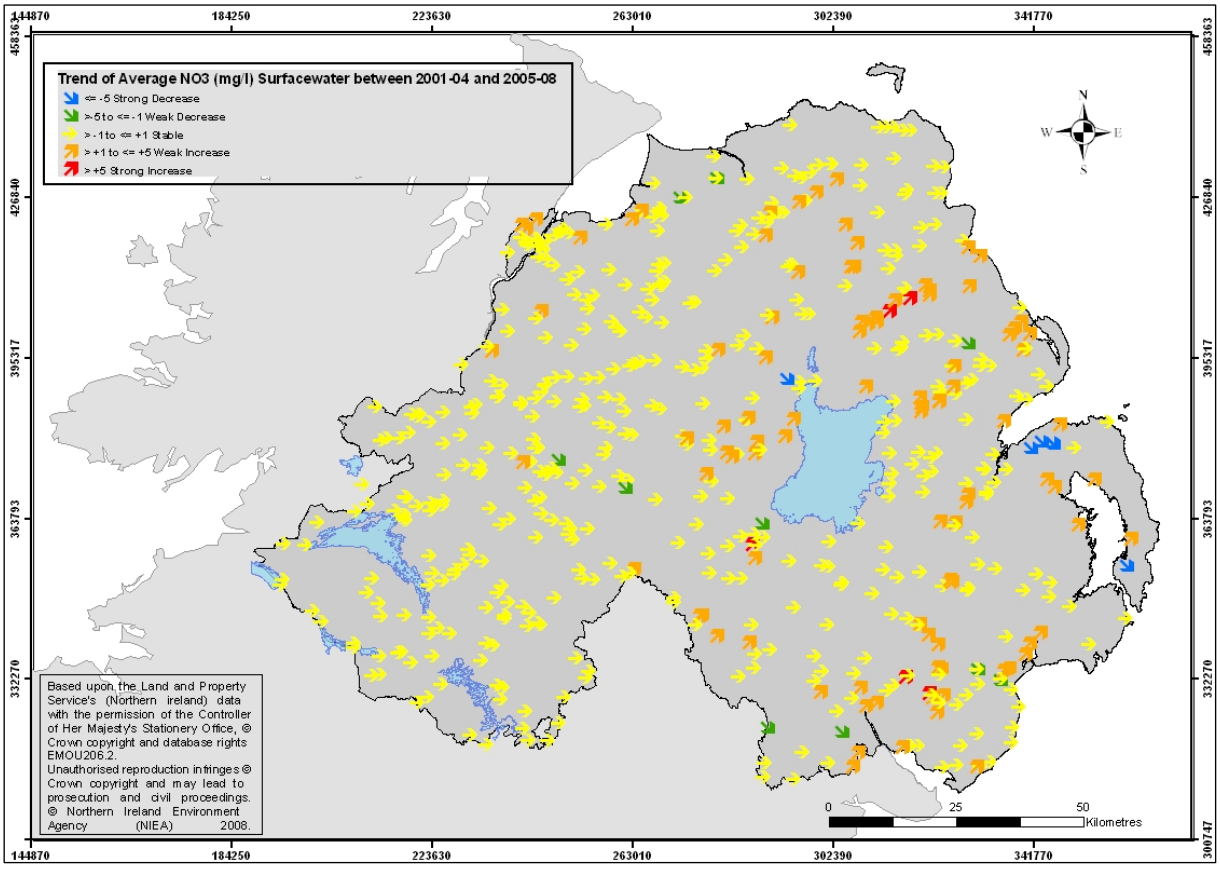

Figure 2: Average nitrate trends in surface water stations between 2001-2004 and 2005-2008 across Northern Ireland

2.2 Nitrate Concentrations in Groundwaters

Northern Ireland, compared with most of the rest of the UK has a particularly diverse and complex geology. The nature of the rocks and their associated geological 'history' is such that associated groundwater flow is predominately through fractures, concentrated in the upper part of the aquifer and discharges locally. These factors produce generally small, compartmentalised aquifers with fast groundwater through-flow which have, for the most part, only limited-to-moderate productivity with respect to water abstraction. The bedrock

aquifers in Northern Ireland can be locally confined by glacial deposits. Superficial aquifers are also found in Northern Ireland, mostly in the form of sand and gravel or alluvial deposits which are generally restricted in their extent. For these reasons, groundwater monitoring points have not been sub-divided for the purposes of this Report.

In 2000 a regional groundwater network was finalised for Northern Ireland. This network comprised private sources including farm boreholes, industrial sources and public water supplies. Over the seven year period 2001-2008, monitoring at some sources has been discontinued and new sources added for various reasons including; deterioration of the borehole headworks, access refusal by well owners and boreholes which have been taken out of service due to pump failure. As sites are discontinued, new replacement sites have been added in similar areas. However the number of boreholes monitored in 2008 has dropped significantly. Following 2006, alterations to the groundwater monitoring network were initiated to ensure that the requirements of the WFD would be met. The modifications to the network have also taken into account the need to ensure long-term reporting of nitrate concentrations in groundwater across Northern Ireland.

In the period 2001-2004, NIEA monitored nitrate concentrations at 81 groundwater sites across Northern Ireland. In the period 2005-2008, nitrate concentrations were monitored at 84 groundwater sites across Northern Ireland. Of these, 73 are common with those monitored in 2001-2004. In both periods data is presented from sites which have 5 or more samples in the four-year period and sampling frequency is variable. Summary data collected includes, for each borehole, the average nitrate concentration.

Data presented in Figure 3 show that for the most part monitored nitrate concentrations for the period 2001-2004 in groundwater in Northern Ireland are generally low with few exceeding 50 mg $N0_3$/l. The results show that 89% of points had an annual average of less than 40 mg NO_3/l and 82% less than 25 mg NO_3/l. Data presented in Figure 3 also show that in the period 2005-2008 nitrate concentrations are similar to those in 2001-2004 with 87% of sites showing an annual average of less than 40 mg NO_3/l and 79% less than 25 mg NO_3/l. Sites with average concentrations greater than 50 mg NO_3/l are situated in areas which were previously designated in 1999 and 2003 as NVZs.

Nitrate concentrations vary for a range of factors including land use type and intensity, rainfall rates, soil types, the presence of glacial deposits providing some protection to the underlying water table and the small compartmentalised nature of the aquifers, as described above. Northern Ireland is dominated by relatively poorly draining soils and low permeability glacial deposits which combine to reduce infiltration and offer opportunities for denitrification. Relatively high rainfall rates (mean annual rainfall 1113 mm/ a; Betts, 1997) also act to reduce nitrate concentrations. Where nitrate concentrations are locally elevated this can coincide with superficial and bedrock aquifers which have some primary porosity potentially resulting in delayed release of nitrates to the water table via the unsaturated zone.

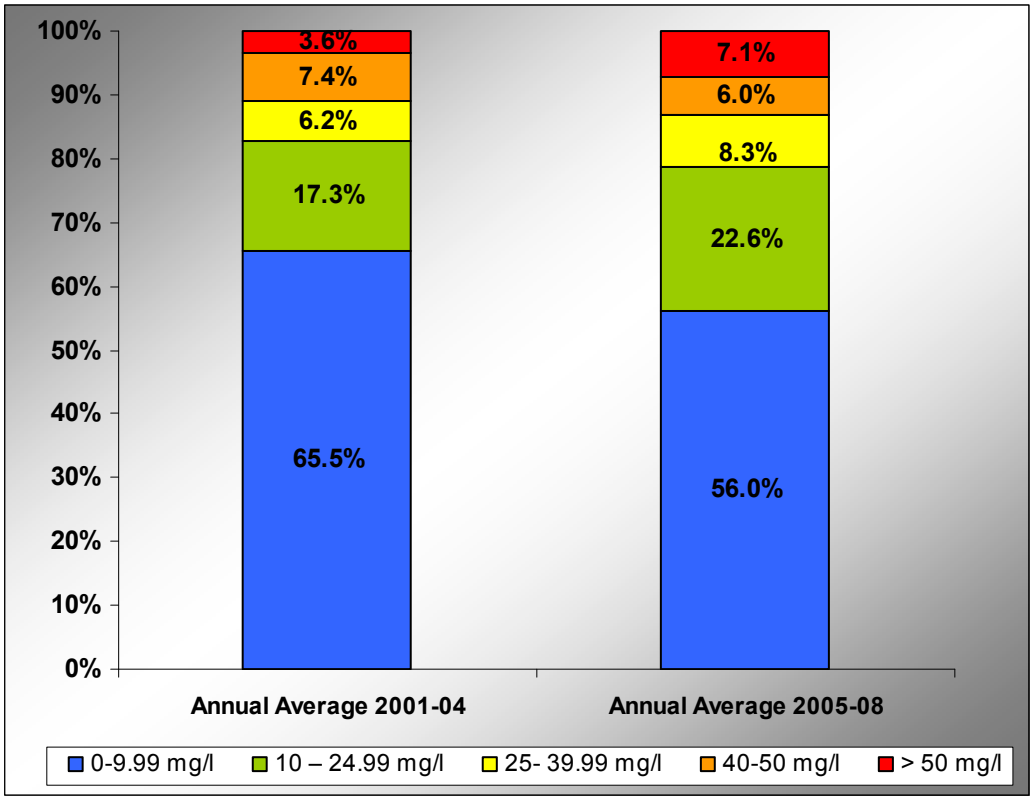

Figure 3: Annual average nitrate concentrations (mg NO_3/l) in groundwater stations, 2001-2004 and 2005-2008 *(% of stations)*

Data presented in Table 3 and Figure 4 show the trend or evolution of the average nitrate concentrations between 2001-2004 and 2005-2008 for the 73 commonly monitored boreholes across Northern Ireland. Data indicates that 48% of sites are showing a stabilisation in groundwater annual average nitrate concentrations. There is an almost similar increase and decrease in the other 52% of sites. It is difficult to draw any further conclusions from this assessment as the NAP Regulations have only been operational on a transitional basis for the last two years of the 2005-2008 dataset.

Table 3: Trends in groundwater nitrate concentrations (mg NO_3/l) based on annual average values between 2001-2004 and 2005-2008 *(% of stations)*

	% of stations (based on mg/l difference)				
Change between 2001-2004 and 2005-2008	**≤ - 5 Strong decrease**	**>-5 to ≤ -1 Weak decrease**	**>-1 to ≤ + 1 Stable**	**>+1 to ≤ +5 Weak increase**	**> +5 Strong increase**
Groundwater annual average (mg NO_3/l)	6.9	15.1	47.9	17.8	12.3

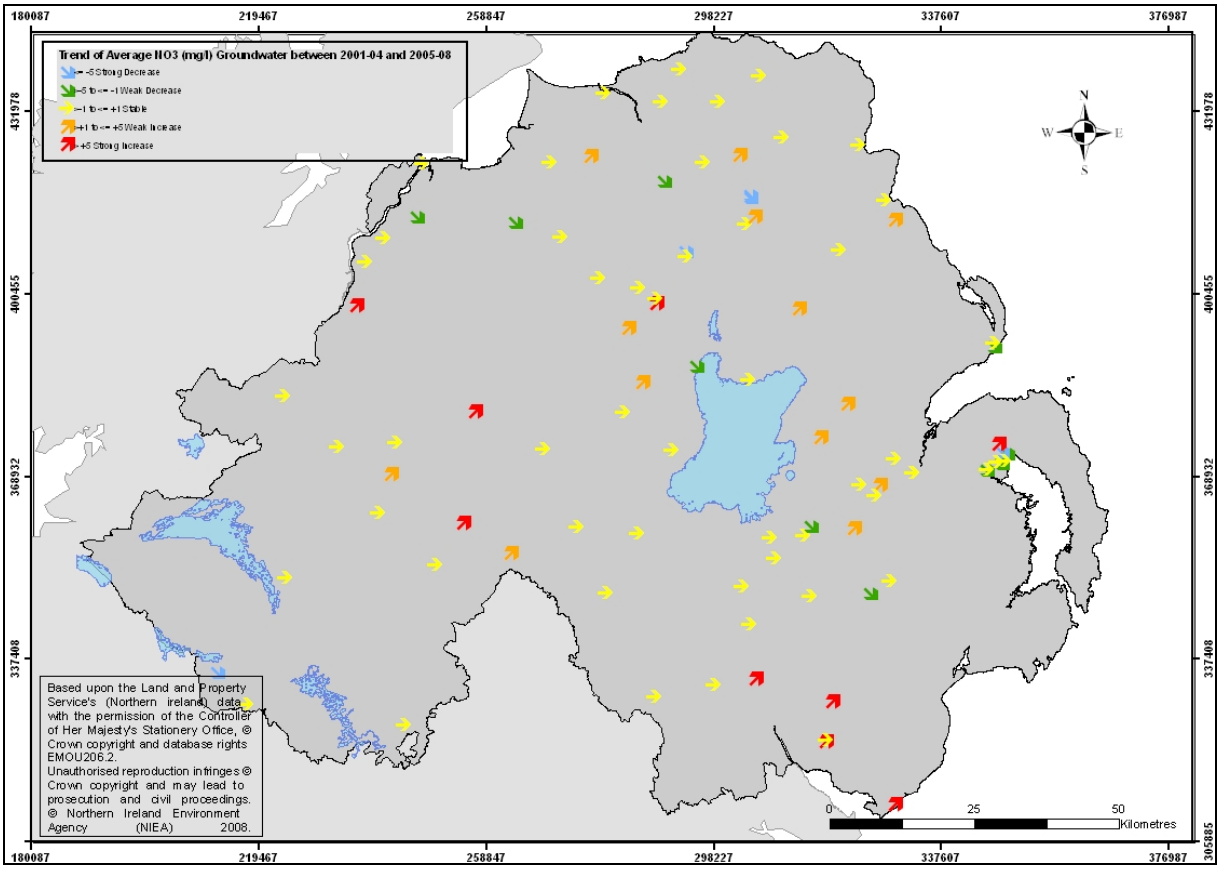

Figure 4: Average nitrate trends in groundwater stations between 2001-2004 and 2005-2008 across Northern Ireland

2.3 Long-Term Trend in Nitrate and Phosphorus

NIEA carried out a statistical analysis to enable an assessment of long-term temporal trend of measured nitrate concentrations in monitored rivers and streams in Northern Ireland between October 1994 and March 2009. The non-parametric Seasonal Kendall Tau (SKT) test (Hirsch *et al.,* 1982) was used to determine trends and provided a measure of the overall trend as well as trends for individual seasons (or months). This trend analysis was also carried out for soluble reactive phosphorus (SRP) on data collected between July 1999 and March 2009. This data set was over a shorter time period due to a change in the laboratory limit of detection for SRP from 0.05 to 0.01 mg/l in 1998 and as some sites would have previously had values less than the limit of detection. Monthly data throughout the study period were therefore available for 238 sites for nitrate and 245 sites for SRP.

2.3.1Trends in Nitrate

Seasonal trend analysis showed that the monthly trends in average nitrate concentrations in 238 rivers in Northern Ireland were decreasing or stable over the 15-year period, 1994-2009 (226 sites or 95% of sites). The most significant decreasing trends occurred in the winter months December to March. Only 12 sites (5% of sites) showed a significant increasing trend (Tables 4 and 5; Figures 5 and 6a). The overall rate of change calculated by determining slope, shown in Figure 6b, demonstrates that the magnitude of change for sites which have decreasing trends is smaller than those which have increasing trends. Figure 7 shows the distribution of long-term nitrate trends across Northern Ireland.

Table 4: Summary of the number of monitoring sites with decreases, increases or stable time series for nitrate overall and for each month. *(Significance levels were p<0.05 and were determined by the SKT)*

Time Period	NO_3 (n=238): 1994-2009		
	Decrease	Stable	Increase
Overall	***83***	***143***	***12***
Jan	25	213	0
Feb	6	231	1
Mar	35	202	1
Apr	10	226	2
May	15	218	5
Jun	8	218	12
Jul	11	222	5
Aug	6	228	4
Sep	7	226	5
Oct	5	227	6
Nov	7	231	0
Dec	13	225	0

Table 5: Summary of trend of average nitrate concentration October 1994 – March 2009 *(based on number of sites)*

	No Sites (NO_3 mg/l)	% Sites (NO_3 mg/l)
Decrease (p<0.01)	64	26.9
Decrease (p<0.05)	19	8
Stable	143	60.1
Increase (p<0.05)	6	2.5
Increase (p<0.01)	6	2.5
TOTAL	**238**	**100**

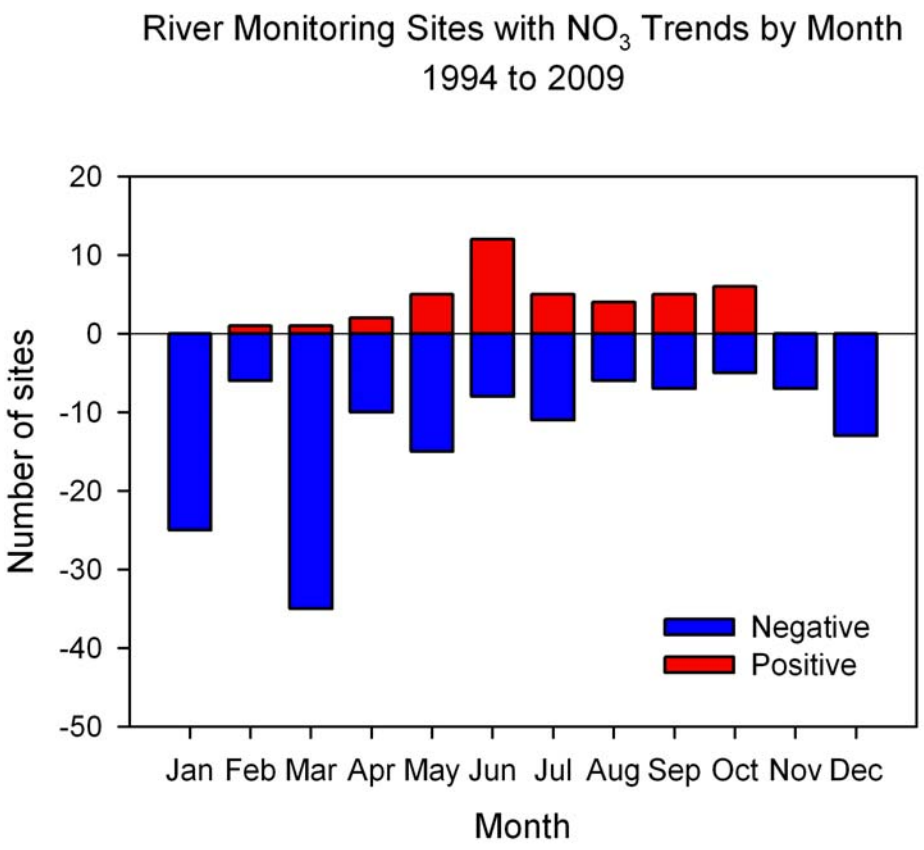

Figure 5: Number of monitoring sites showing decreasing and increasing trends for nitrate by month

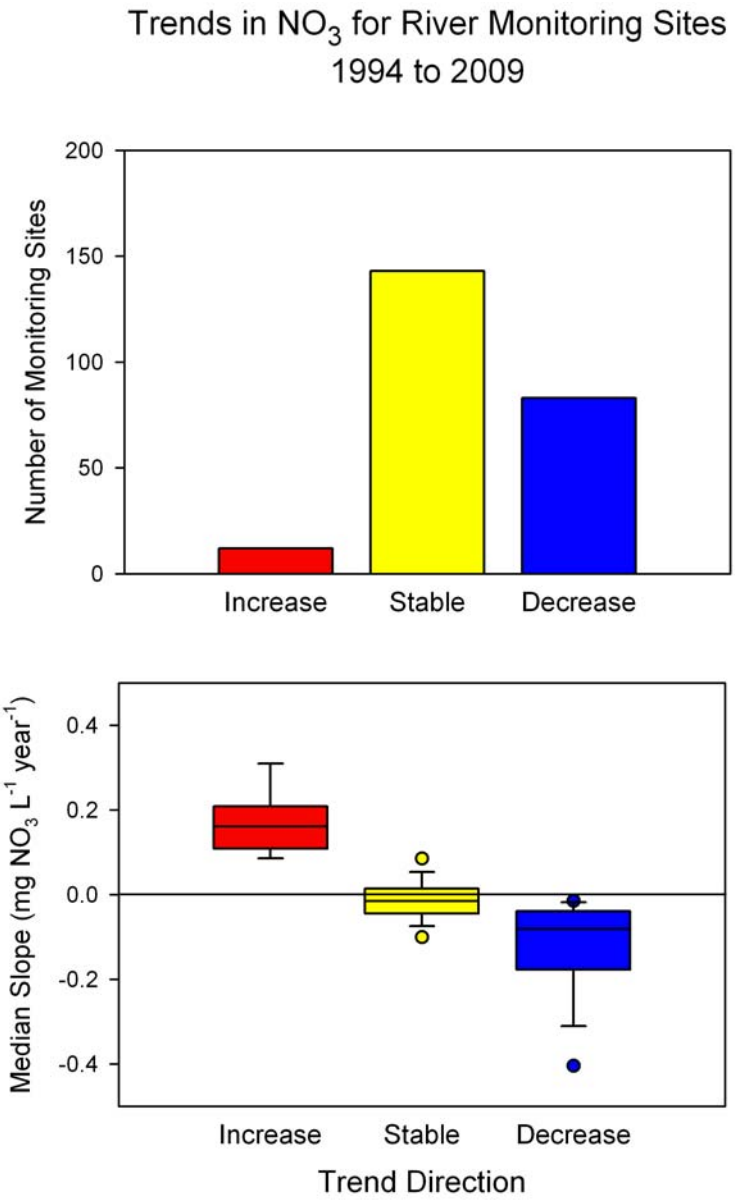

Figure 6: Upper plot (a) Number of monitoring sites showing increases, decreases or remaining stable. Lower plot (b) Boxplots of median slopes for each group of sites.

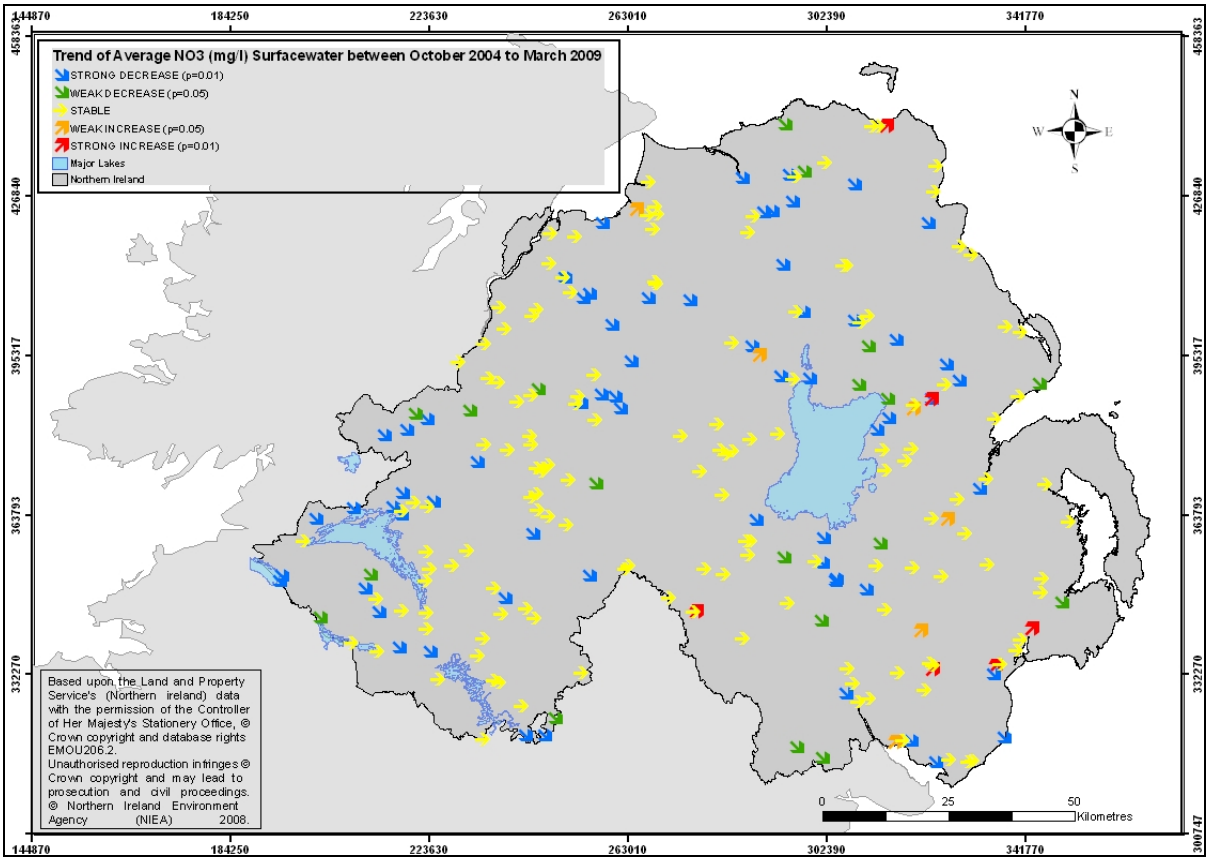

Figure 7: Trend of average nitrate (mg NO_3/l) in rivers across Northern Ireland in the period October 1994 to March 2009

The SKT test was also used to examine the directional trend across all the rivers sites for each month whereby the mean nitrate concentrations were calculated from the 15-year data set (Figure 8). Further, the test accounts for seasonality in the data, which tended to have peak values in rivers in the winter months. However the SKT tests for increasing or decreasing trends, are not necessarily linear over time (i.e. a consistent rate of change over the entire sampling period). It is recognised that climatic factors may have a significant impact on trends in Northern Ireland's rivers (DARD-DOE, 2002). In a large proportion of rivers, peaks in nitrate concentrations since the 1970s have occurred quite regularly at intervals of approximately six years following exceptionally dry summers. This series may reflect a climatic signal in low summer rainfall detected at Armagh Observatory and extending back to 1840 (Butler *et al.,* 1998). In the period 1994-2009 a strong cyclical peak can be seen in the years 1996-1997 and again in 2006-2007 although nitrate concentrations were generally lower in the latter years.

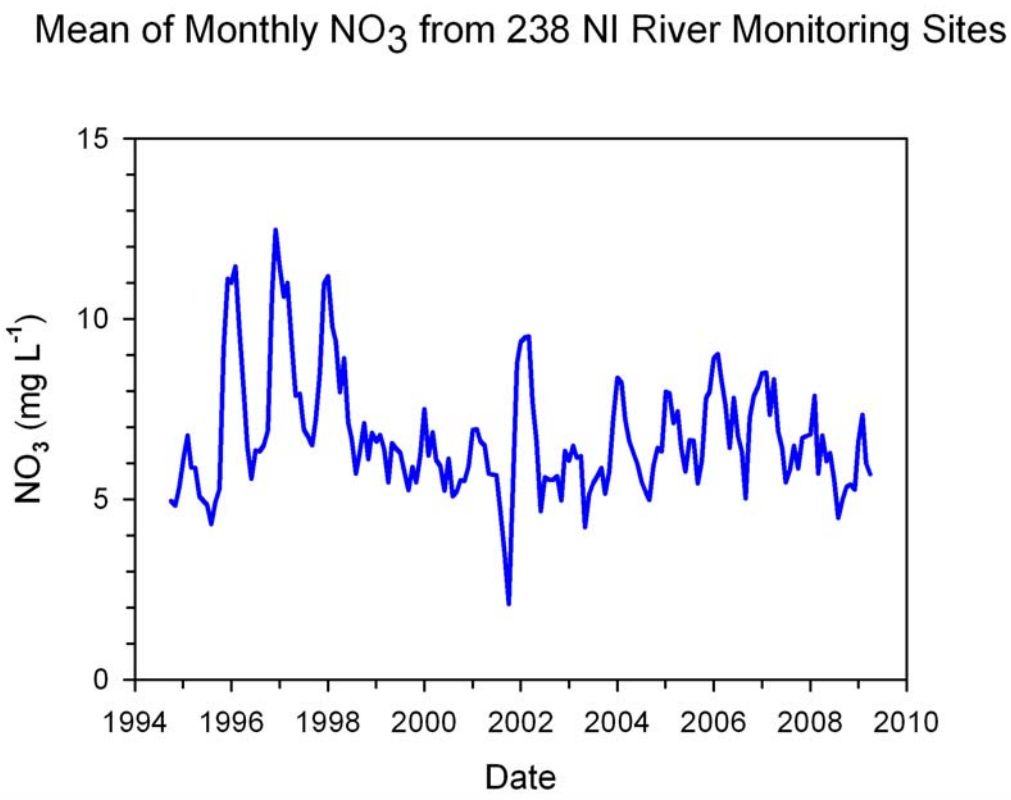

Figure 8: Nitrate concentrations in 238 river monitoring sites summarized by month into annual mean values of the site population

2.3.2 Trends in Phosphorus

Seasonal trend analysis showed that the direction of monthly trends of average phosphorus concentrations in 245 monitored rivers in Northern Ireland was predominantly decreasing or stable over the nine year period, 1999-2009 (243 sites or 99.2% of sites). The most significant decreasing trends occurred between April and September. Only two sites (0.8% of sites) showed a significant increasing trend (Tables 6 and 7; Figures 9 and 10a). These two sites showed increasing SRP concentrations in the months of January, February, May and September across all years. The overall rate of change calculated by determining slope, shown in Figure 10b, demonstrates that the rate of change for sites which have decreasing trends is small. For the two sites which had increased, there was very little magnitude of change. Figure 11 shows the distribution of phosphorus trends across Northern Ireland.

Table 6: Summary of the number of monitoring sites with decreases, increases or stable time series for soluble reactive phosphorus overall and for each month *(Significance levels were p<0.05 and were determined by the SKT)*

Time Period	SRP (n=245): 1999-2009		
	Decrease	Stable	Increase
Overall	***182***	***61***	***2***
Jan	12	231	2
Feb	29	215	1
Mar	28	217	0
Apr	35	210	0
May	28	215	2
Jun	34	211	0
Jul	55	190	0
Aug	43	202	0
Sep	39	206	0
Oct	13	231	1
Nov	10	235	0
Dec	26	219	0

Table 7: Summary of trend of average soluble reactive phosphorus concentration July 1999 – March 2009 *(based on number of sites)*

	No Sites (SRP mg/l)	% Sites (SRP mg/l)
Decrease (p<0.01)	158	64.5
Decrease (p<0.05)	24	9.8
Stable	61	24.9
Increase (p<0.05)	0	0
Increase (p<0.01)	2	0.8
TOTAL	**245**	**100**

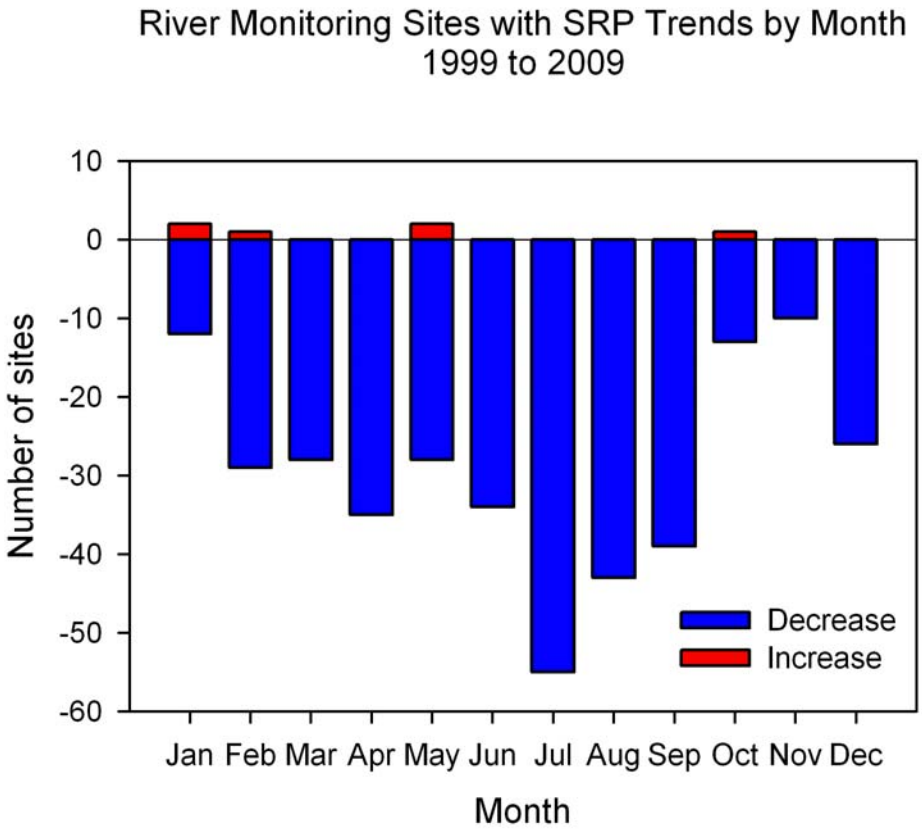

Figure 9: Number of monitoring sites showing decreasing and increasing trends for soluble reactive phosphorus by month

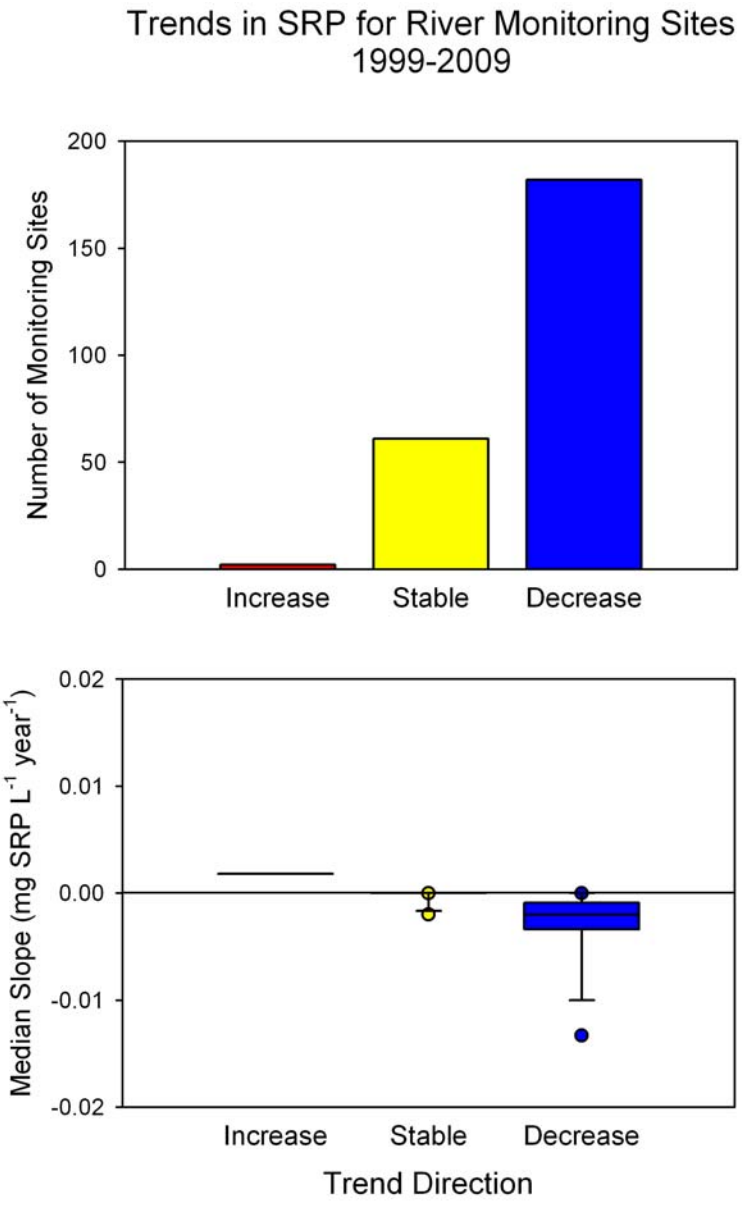

Figure 10: Upper plot (a) Number of monitoring sites showing increases, decreases or remaining stable for soluble reactive phosphorus. Lower plot (b) Boxplots of median slopes for each group of sites

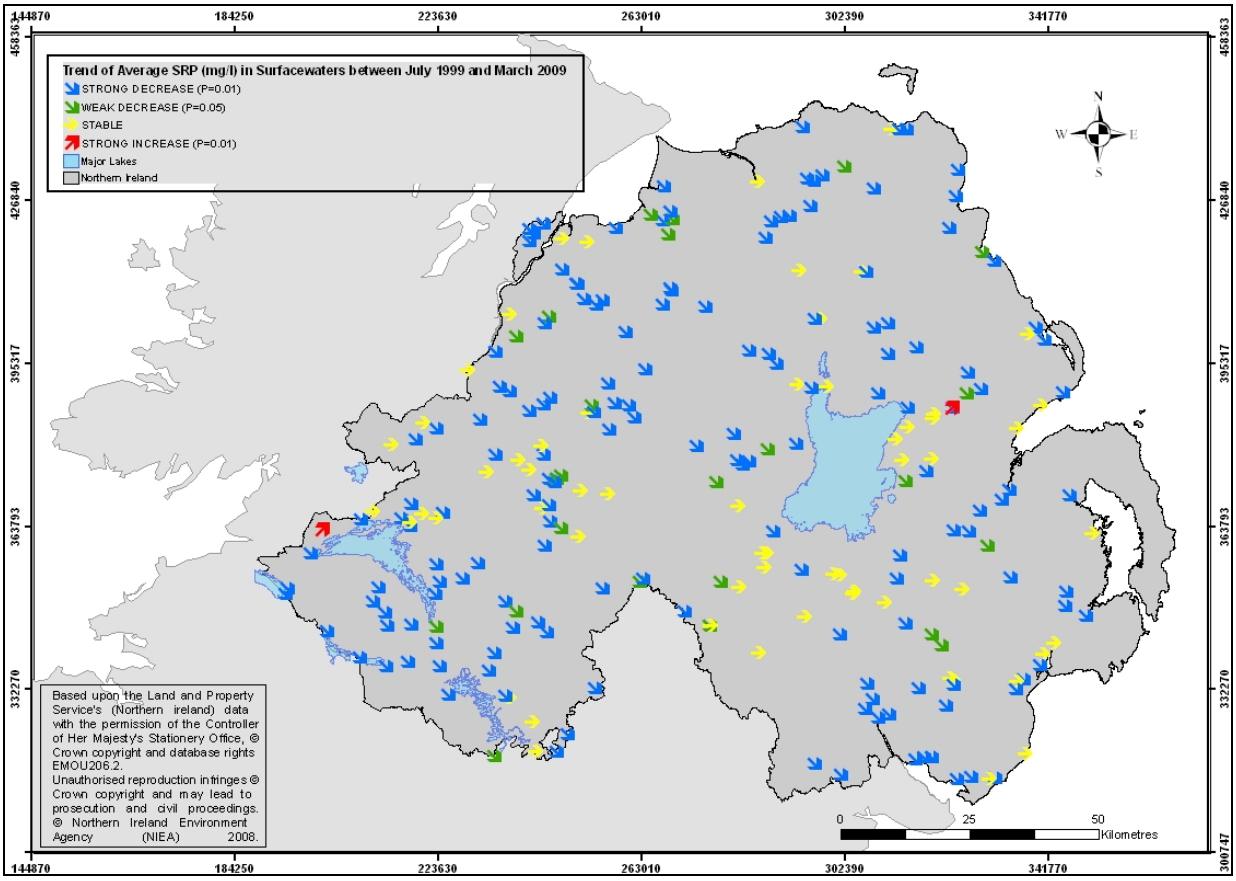

Figure 11: Trend of average soluble reactive phosphorus (mg SRP/l) in rivers across Northern Ireland: July 1999 - March 2009

The SKT test was also used to examine the directional and seasonal trend of phosphorus across all the rivers sites for each month mean SRP concentrations were calculated from the 10-year data set 1999-2009 (Figure 12). The test accounts for seasonality in the data, which tended to have peak values in rivers in the summer months across all years.

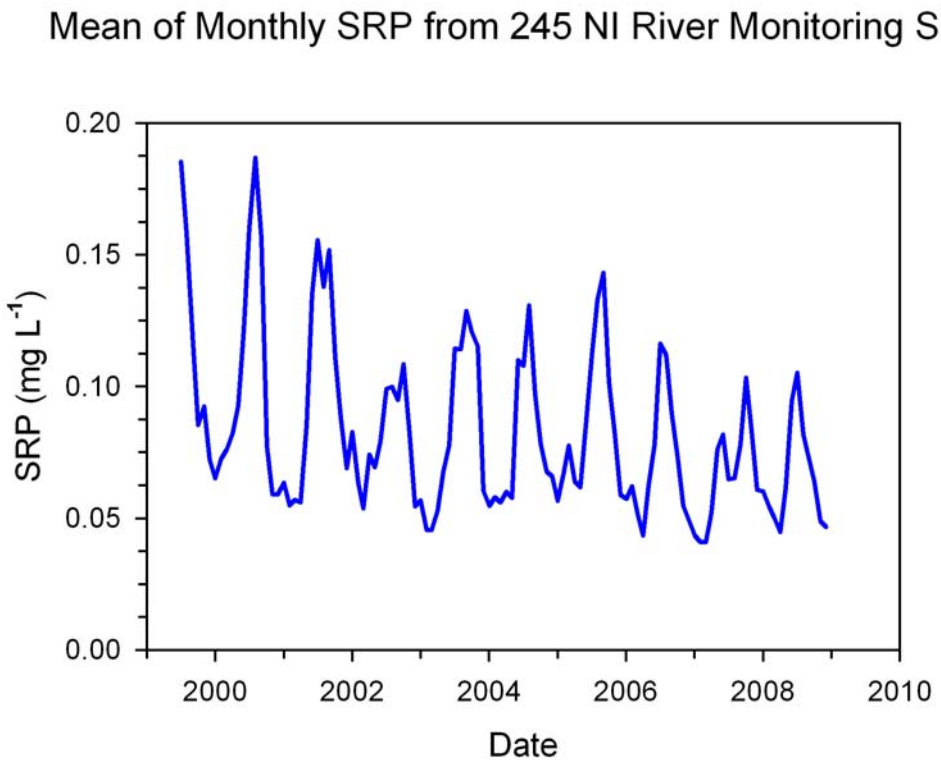

Figure 12: Soluble reactive phosphorus concentrations (mg SRP/l) in 245 river monitoring sites summarized by month into annual mean values of the site population

2.4 Trophic Status Assessments

2.4.1 Sensitive Area Review, 2005

Historically, under the Nitrates Directive and Urban Waste Water Treatment (UWWT) Directive (91/271/EEC) trophic status was assessed by determining the concentrations of nutrients in a water body, either phosphorus in rivers or nitrogen in coastal or marine waters. In addition, the occurrence of undesirable effects, i.e. the growth of algae or plants, due to these nutrient inputs was considered.

In March 1993 the Northern Ireland authorities issued guidance for the identification of sensitive areas (eutrophic) under the UWWT Directive outlining both biological and chemical parameters used as indicators of the eutrophication process in all surface waters (DOENI, 1993). For assessment of coastal and marine waters this guidance was used alongside the Comprehensive Studies Task Team guidance issued by the UK authorities in 1997 (MPMMG, 1997). In Northern Ireland these documents along with further guidance produced for the implementation of the UWWT Directive (DOENI, 1999)) and supplementary guidance produced by the UK (DEFRA, 2002), aligning closely with OSPAR Common Assessment Criteria for Eutrophication, have formed the basis for all trophic assessments to date.

A review of the trophic status of coastal, estuarine and freshwaters was carried out in 2005 as required by the UWWT and the Nitrates Directives. The objective was to identify waters as eutrophic or likely to become eutrophic in the absence of protective action.

For freshwaters the review focused on areas not already identified as sensitive areas (eutrophic) under UWWT Directive. The two largest freshwater loughs in Northern Ireland, Lough Neagh and Lough Erne were already identified in 1994 as eutrophic. In addition to these lakes, three transitional and coastal waters had also been identified in 2001, i.e. the Quoile pondage, the Tidal Lagan and Inner Belfast Lough (Figure 13).

In 2006 following the review 11 new sensitive areas (eutrophic) were identified; eight freshwater and one coastal water bringing to 84% of the total area of land draining to water bodies that are 'eutrophic' or 'showing the potential to become eutrophic if protective action is not taken' (Figure 13).

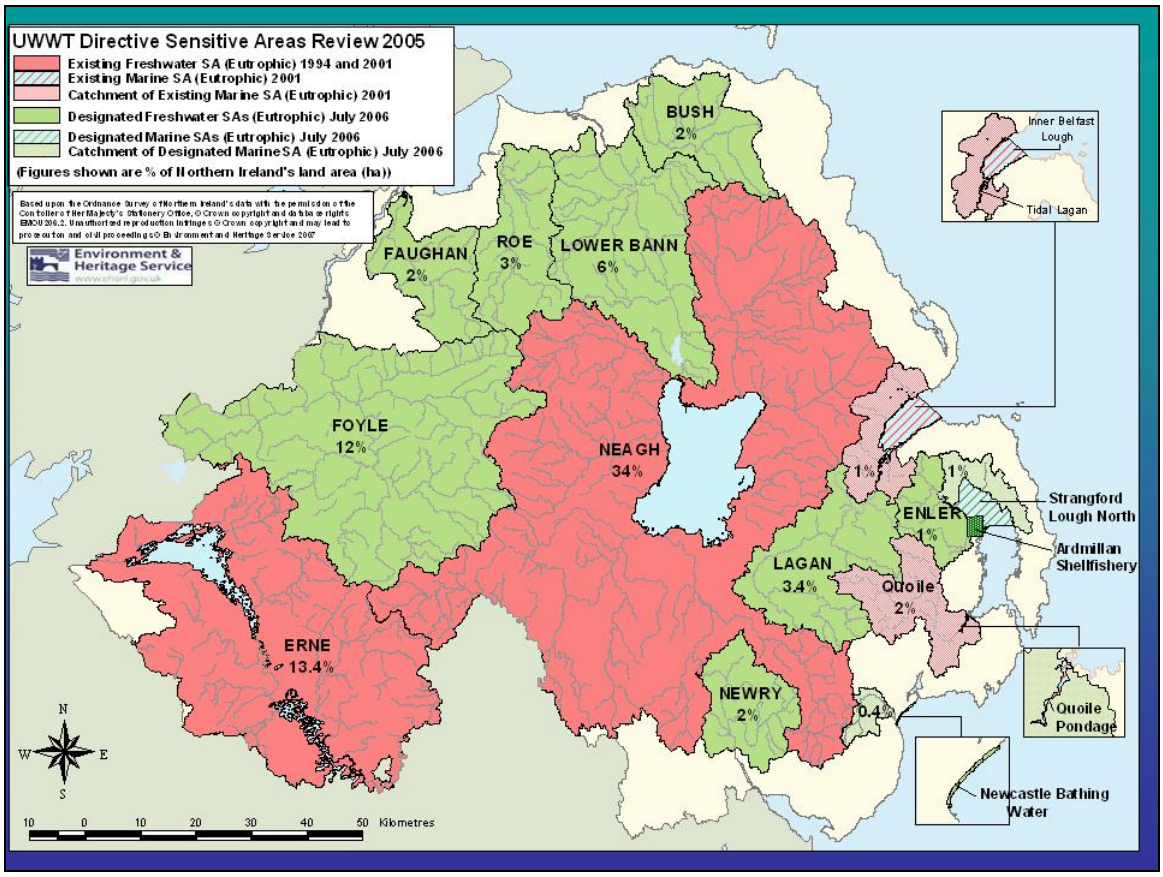

Figure 13: **Sensitive areas designated under the UWWT Directive; 1994, 2001 and 2006**

2.4.2 WFD Trophic Assessment

Since the adoption of the WFD in 2000, new methodologies and criteria for assessment of eutrophication in rivers, lakes and coastal/transitional waters have been developed. The WFD requires Member States to classify the ecological status of type-specific surface water bodies based on a number of biological, hydromorphological, chemical and physio-chemical quality elements. Ecological status is based on one of five ecological status classes; High, Good, Moderate, Poor and Bad. These classes describe the extent to which biological quality elements (i.e. nutrient conditions as well as composition, abundance and biomass of phytoplankton and macrophytes) may differ in that class compared to their reference, or High status conditions as a result of the effects of human activity.

One other difference between WFD classification and previous systems is that it is based on water bodies. Water bodies are discrete areas and there are a range of possibilities for the number of monitoring stations they contain.

NIEA monitors a number of quality elements and parameters when considering eutrophication pressures for WFD on all water body types which are outlined in Table 8 below.

Table 8: WFD quality elements and parameters relevant to eutrophication

Quality Element	Rivers	Freshwater Lakes	Transitional Waters	Coastal Waters
General Conditions	Soluble Reactive Phosphorus	Total Phosphorus	Dissolved Inorganic Nitrogen	Dissolved Inorganic Nitrogen
Phytoplankton	-	Chlorophyll	Chlorophyll-a Phytoplankton	Chlorophyll-a Phytoplankton
Macrophytes & Phytobenthos	Diatoms Macrophytes	Diatoms Macrophytes	-	-
Macroalgae & Angiosperms	n/a	n/a	Macroalgae: (Blooming tool) (FSL and RSL) Seagrass	Macroalgae: (Blooming tool) (FSL and RSL) Seagrass

NIEA uses information collected on the above indicators and assesses them against the three elements of 'eutrophication' as set out in guidance (DOENI, 1993 and DEFRA, 2002). Assessment of the indicators is used to determine whether a water body is eutrophic or may become eutrophic in the near future if protective action is not taken. The three elements are:

1. the water body is enriched by nitrogen and/or phosphorus;
2. this enrichment causes or is likely to cause an accelerated growth of algae and higher forms of plant life; and
3. this accelerated growth produces an undesirable disturbance to the balance of organisms present in the water and to the quality of the water concerned.

This Report considers the trophic status of Northern Ireland's river water bodies using previous trophic assessments up to 2005 and compares these with the current trophic status (2006-2009) using WFD methodologies and since the adoption of the NAP Regulations to its whole territory in January 2007.

The WFD eutrophication assessments for 2006-2009 for each waterbody type are based only on elements shown in Table 8 above. Overall status in the context of this Report refers to overall trophic state only and therefore differs from what Northern Ireland will be submitting to the Commission in the River Basin Management Plans for overall WFD classification in 2008 incorporating all physio-chemical, morphological and biological elements.

2.5 Trophic Status of Northern Ireland Rivers

2.5.1 Chemical Indicators in Rivers

Soluble Reactive Phosphorus

The importance of phosphorus is recognised by the inclusion of SRP in WFD classification. Increasing nutrient concentrations are capable of changing the biomass and composition of biological communities with the most obvious primary impact being enhanced plant and algal production. Secondary impacts can include reduced dissolved oxygen levels caused by the overnight respiration of macrophytes which can lead to problems for fish. Elevated nutrient levels can also cause toxic blooms of blue-green algae leading to potential problems for livestock and other animals as well as overgrowth of other species.

Under previous guidance (DOENI, 1993 & 1999; DEFRA, 2002), phosphorus concentrations in the UK were assessed using 100 µg SRP/l (0.10 mg SRP/l) as the threshold above which waters were considered eutrophic and above 20 µg SRP/l (0.02 mg SRP/l) waters were considered 'at risk' of becoming eutrophic (Table 9). These limits did not take account of the current condition of the river compared to a reference condition for that type of river and were most likely applicable to large lowland rivers.

Table 9: UWWT Directive threshold values for SRP used in Northern Ireland for assessment of eutrophication in rivers, 1999-2005

SRP (mg/l)	Status
0 – 0.02	Oligotrophic
>0.02 – 0.10	Mesotrophic
>0.10	Eutrophic

Under the WFD, freshwater bodies are now classified for phosphorus using standards determined by typology (alkalinity and altitude) (UKTAG, 2008). Currently there are four typologies operating in the UK for rivers as shown in Table 10 which create suitable levels of sensitivity to pressures from nutrients.

Table 10: Environmental characteristics of the four 'types' of rivers/streams

Type	Total alkalinity (mg l^{-1} $CaCO_3$)	Altitude (m)
1n	≤ 50	≤ 80
2n	≤ 50	> 80
3n	> 50	≤ 80
4n	> 50	> 80

Waters which are not considered to be eutrophic are classed as 'High' or 'Good' according to the standards in Table 11, and waters considered to be eutrophic are classed as 'Moderate', 'Poor' or 'Bad' status. Waters which fall into 'Moderate' class equate to 'indicative of unacceptable or worsening eutrophic conditions'. Classification provides a way of comparing waters and a way of looking at changes over time. Where the trend of phosphorus deteriorates from 'Good' status to 'Moderate' status the water body would be considered to be 'at risk of eutrophication'.

Table 11: WFD standards for phosphorus in rivers

Soluble Reactive Phosphorus (mg/l) (annual mean)				
Type	**High**	**Good**	**Moderate**	**Poor/Bad**
1n	>=0.03	>=0.05	>=0.15	>=0.50
2n	>=0.02	>=0.04	>=0.15	>=0.50
3n + 4n	>=0.05	>= 0.12	>=0.25	>=1.00

2.5.2 Biological Indicators in Rivers

In recent years, with the increased interest in aquatic eutrophication, assessment methods for rivers based on both macrophytes and algae have been developed in several European countries, leading to the development of European standards (BS EN 14184; BS EN 13946; BS EN14407; CEN, 2003a & b, 2004). In the UK, two methods, the macrophyte-based Mean Trophic Rank (MTR) (Holmes, 1995; Holmes *et al*., 1999) and the Trophic Diatom Index (TDI: Kelly & Whitton, 1995; Kelly *et al.*, 2001) have both been in use for a number of years. However, the mode of assessment required for the WFD (i.e. focusing on a holistic concept of 'ecological status' rather than on the impact of individual pressures such as eutrophication) means that almost all existing approaches have been refined or replaced entirely in order to provide guidance appropriate to the WFD.

Macrophytes in rivers

The standardised monitoring of macrophytes in UK rivers, for the purpose of determining trophic status has been based on the 3-band MTR system. This methodology, widely used by the UK regulatory agencies, produces information on the composition and abundance of aquatic macrophyte flora. Stretches of river are surveyed to determine their species composition, and an estimate of their individual abundance is recorded. This can then be collated into a MTR score from which subsequent classifications can be derived as described in Table 12.

Table 12: Macrophyte classifications based on MTR

Class	Class Descriptor	Trophic Ranking Score Values
1	Waters that are unlikely to be enriched	>65
2	Waters that are enriched or are showing the potential to become enriched	25 – 65
3	Waters already enriched with a degraded macrophyte flora	<25

The WFD classification tool now used is known as the Macrophyte Prediction and Classification System (LEAFPACS) developed by Willby *et al* (2009) and it considers species sensitivity to pollution and the actual abundance of plants represented in a waterbody which are then collated into a 5-band classification system. The LEAFPACS classification method uses three key aspects of the aquatic plant community to assess the ecological status of rivers, namely, species composition, diversity and abundance based on the response of these characteristics to nutrient and hydromorphological pressures (Table

13). The method is designed to distinguish the anthropogenic effects of nutrient enrichment from a natural nutrient gradient, and to take into account the impact of changes in river hydromorphology on the macrophyte community. Each of the observed characteristics is compared with a reference value, and expressed as a calculated ecological quality ratio (EQR). Reference values specific to each river water body are determined from a set of environmental predictors, including geographical location, altitude, slope, distance from source and alkalinity. EQRs for each of the metrics are adjusted to a common scale and combined using weighted averaging to give an overall status class.

Table 13: WFD boundaries for LEAFPACS classification

WFD Class	EQR Range	Class Boundary
High	> 0.80	
Good	0.60 – 0.80	H/G = 0.80
Moderate	0.40 – 0.60	G/M = 0.60
Poor	0.20 – 0.40	M/P = 0.40
Bad	<0.20	P/B = 0.20

In addition to allocating a classification for survey sites, the LEAFPACS river calculator also calculates a confidence of class for that particular site. All LEAFPACS classifications in this Report were calculated using Version 1.4 (January 2009) of the programme.

The principal refinements to the original MTR method are in an extended list of scoring taxa and the scores applied to these taxa to obtain a site-based metric. Macrophyte surveys are undertaken once between May and September and are not normally repeated within three years. More often surveys in Northern Ireland are carried out over six years.

Diatoms in rivers

Diatoms are being used in most EU Member States as one of the biological elements that are required by the WFD in ecological status assessments. In the UK, the TDI, which was previously used in Northern Ireland for the UWWT Directive sensitive area (eutrophic) review in 2005 (Table 14), has been refined and extended to provide WFD-compatible metrics for rivers and lakes .

Table 14: Environmental characteristics of the four 'types' of stream, along with threshold TDI values (*Kelly & Whitton, 1995 & 2001*)

Type	Total alkalinity (mg l^{-1} $CaCO_3$)	Altitude (m)	Threshold TDI
1n	≤ 50	≤ 80	45
2n	≤ 50	> 80	38
3n	> 50	≤ 80	60
4n	> 50	> 80	66

The old four-band TDI assessment has been replaced by Diatoms Assessment for Rivers and Lakes Ecological Quality (DARLEQ) which takes into account species presence and their relative abundance to produce a classification, weighted by degradation indicator

species (Kelly *et al*., 2006 & 2008). The DARLEQ tool implements a classification algorithm using a metric based on a revised TDI (Table 15).

Table 15: Provisional WFD Diatom Status (DARLEQ) Class boundaries for UK rivers

WFD Class	EQR Range	Class Boundary
High	> 0.93	
Good	0.78 – 0.93	H/G = 0.93
Moderate	0.52 – 0.78	G/M = 0.78
Poor	0.26 – 0.52	M/P = 0.52
Bad	<0.26	P/B = 0.26

Diatom monitoring is relatively new in Northern Ireland with most sites having been sampled once or twice and in a few cases sampling having been carried out three or four times since 2006. The developing WFD classification requires a minimum of three and ideally six repeat samples at the same station over several years and this is why the number of water bodies classified for diatoms is relatively low. However diatom sampling frequency has been increased to support future classification.

2.5.3 Trophic assessments of Rivers, 1999-2005

Data presented in Table 16 shows that there was evidence of elevated annual average SRP concentrations in excess of the indicator value of 0.02 mg SRP/l for waters at risk of eutrophication in 63% of river length surveyed between 1999 and 2004. In addition 13% of rivers surveyed had concentrations in excess of 0.1 mg SRP/l which indicated nutrient enrichment. Compared with phosphorus concentrations in 2000 (DARD-DOE, 2002), levels for the period 1999–2004 appeared to have remained stable.

Table 16: Classification of rivers in Northern Ireland based on SRP concentration in the period 1999-2004

SRP (mg/l)	Status	% River length
0 – 0.02	Oligotrophic	13.4
>0.02 – 0.1	Mesotrophic	62.9
>0.1	Eutrophic	23.7

Data presented in Table 17 show there is evidence of disturbance to the balance of macrophyte assemblages in 94% of rivers surveyed between 2002 and 2005 in rivers where the phosphorus concentrations were elevated, i.e. 76% of rivers.

Table 17: Classification of rivers in Northern Ireland based on MTR scores in the period 2002-05

	MTR Score	% River length
Class 1 – Unlikely to be enriched	>65	6.2
Class 2 – Enriched or showing potential to become enriched	>25 - 65	89.5
Class 3 – Already enriched	<25	4.3

The overall trophic status for rivers in the period 1999-2005 shows the majority of rivers being eutrophic or at risk of being eutrophic, showing evidence of changes to the macrophyte communities in response to increased nutrient concentrations.

2.5.4 WFD Trophic Status of Rivers, 2006-2009

Over the period 2006-2008, NIEA monitored phosphorus concentrations at 540 surface freshwater stations across Northern Ireland. Macrophyte surveys were carried out on a catchment basis at 428 river sites over the period 2006-2009 and benthic diatoms samples were collected at 144 selected river sites over the 3-year period 2007-2009. Results for each of the parameters are considered in turn and each one was assessed using the new WFD classification systems described previously. The results of each parameter are then put together using the WFD overall classification criterion of deferring to the lowest class in each case to give an overall WFD Trophic Class for a river water body. To date Northern Ireland have identified 575 water bodies for WFD classification so one overall class is given to each water body.

Results in Table 22 show that in 2006-2009, 280 (49%) river water bodies in Northern Ireland are considered to be High/Good trophic status. No river water bodies are considered to be Bad status equating to hyper-eutrophic. However 41% of river water bodies are classed as Moderate/Poor status which is indicative of eutrophic conditions. Data were not available for 57 (10%) of river water bodies. The distribution of water body classes across Northern Ireland is shown in Figure 14.

Table 18: WFD classification of trophic indicator quality elements for 575 river water bodies in Northern Ireland in the period 2006-2009 (based on SRP, macrophytes and diatoms)

	No. Water Bodies	% Water Bodies
HIGH	143	24.9
GOOD	137	23.8
MODERATE	166	28.9
POOR	72	12.5
BAD	0	0.0
NO DATA	57	9.9

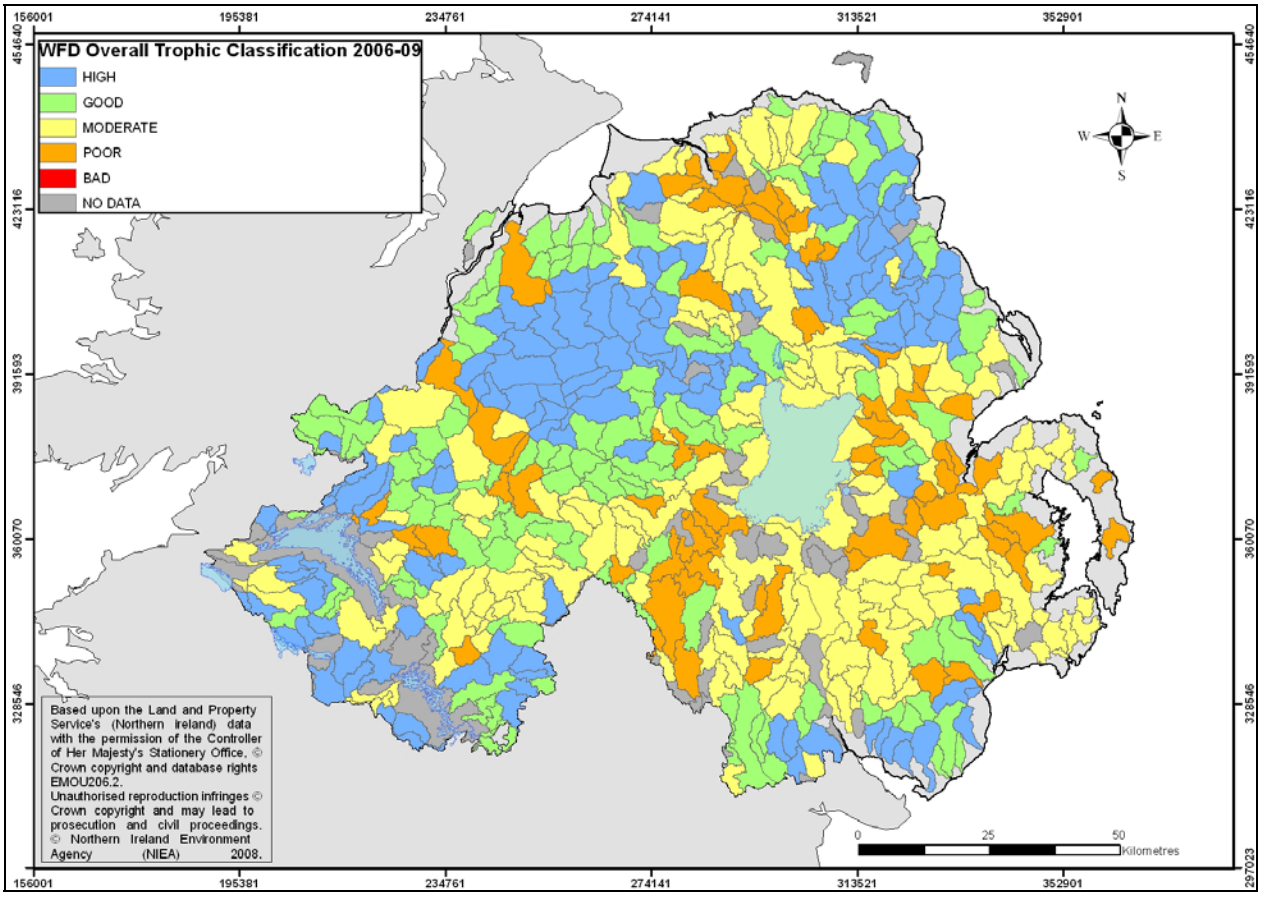

Figure 14: Distribution of overall WFD trophic classes across Northern Ireland 575 river water bodies in the period 2006-2009 *(based on SRP, macrophytes and diatoms)*

When SRP is considered in isolation, 74% (422) of river water bodies across Northern Ireland were classed as High/Good status and 14% (81) were classed as Moderate/Poor trophic status (Table 19). There were no river water bodies classed as Bad status. SRP data was not assessed at 72 (12.5%) water bodies. The distribution of SRP classes across Northern Ireland can be seen in Figure 15. Water bodies which were classed as High/Good were largely situated in the north and west. Water bodies considered to be of poorer quality occurred more in the central and eastern parts.

Table 19: WFD classification of soluble reactive phosphorus for 575 river water bodies in Northern Ireland in the period 2006-2008

	No. Water Bodies	% Water Bodies
HIGH	237	41.2
GOOD	185	32.2
MODERATE	66	11.5
POOR	15	2.6
BAD	0	0.0
NO DATA	72	12.5

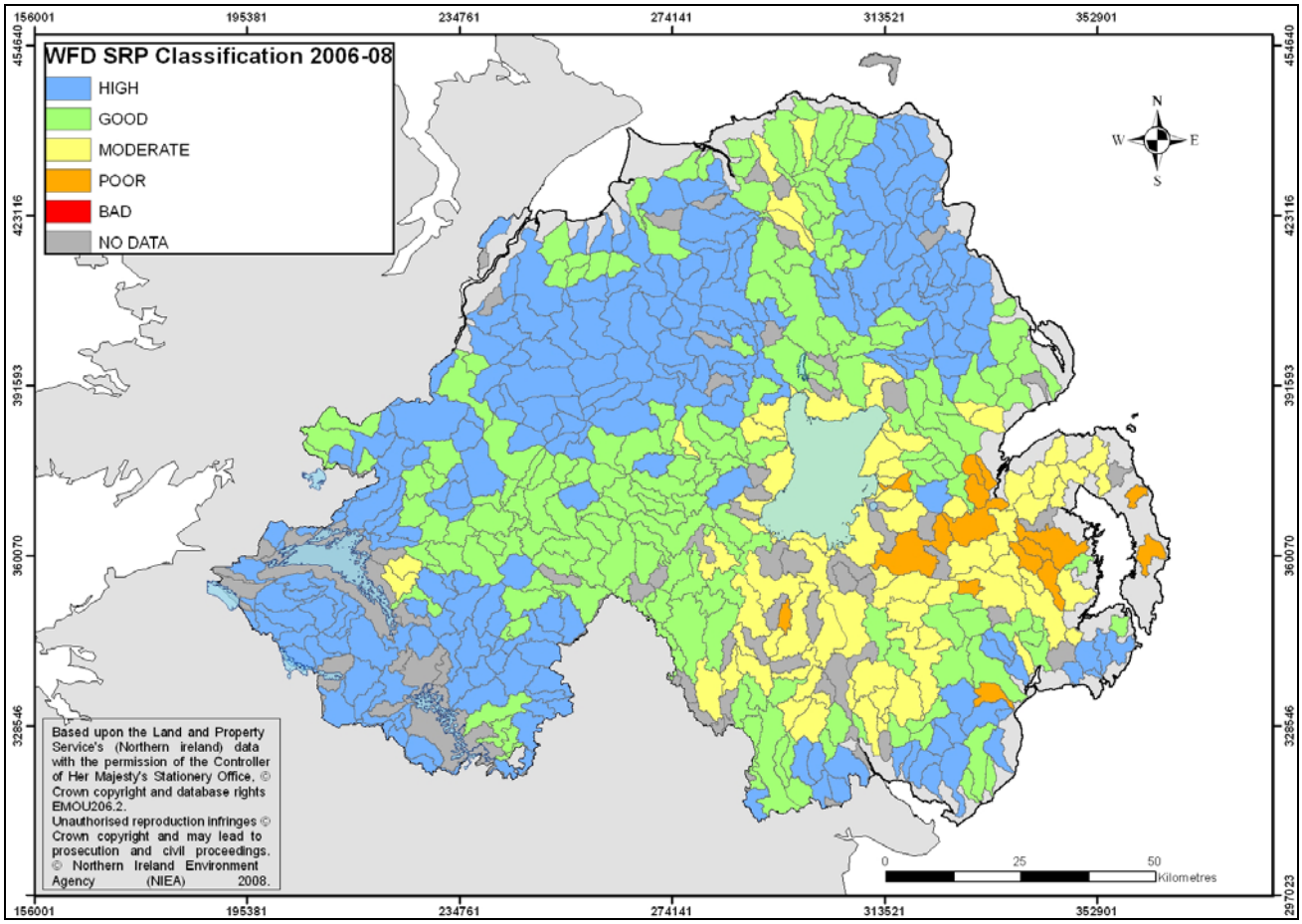

Figure 15: WFD soluble reactive phosphorus classification in the period 2006-2008

2.6 Trophic Status of Northern Ireland Lakes

The WFD introduces a formal classification system for lakes. Lakes over 50 hectares (ha) in size are water bodies in themselves, but lakes <50ha are subsumed under river water bodies. Methodologies for assessment of phosphorus in lakes have also changed since the adoption of the WFD. Until fairly recently lake classification had most commonly used the Organisation for Economic Co-operation & Development (OECD, 1982) classification scheme to evaluate lake water quality but this was not WFD compliant and took no account of natural variation between lake types. This system divided lakes into three trophic categories: oligotrophic (nutrient poor), mesotrophic (moderately enriched) and eutrophic (enriched) as shown in Table 20. A further 'boundary category' of hypertrophic was defined as an extreme state of eutrophy. The biological response to changes in nutrient enrichment was assessed by chlorophyll *a* concentration, which is an index of the amount of algae suspended in the water. High levels of algae, and hence high levels of chlorophyll *a*, will also lower water transparency. The Secchi disc measurement, which measures water transparency, was also used to assess lake response to nutrient inputs. However Secchi disc has proved to be a less satisfactory index of enrichment in Northern Irish lakes because other factors, such as pigments from peat, also lower water transparency.

Table 20: OECD (1982) trophic state classification for lakes

Trophic Category	Total Phosphorus (μg P/l)	Chlorophyll *a* Average	Chlorophyll *a* Maximum (μg/l)	Secchi Disc Average Minimum (m)	
Oligotrophic	≤ 10	≤ 2.5	≤ 8	≥ 6	≥ 3
Mesotrophic	10-35	2.5-8	8-25	6-3	3-1.5
Eutrophic	35-100	8-25	25-75	3-1.5	1.5-0.7
Hypertrophic	≥ 100	≥ 25	≥ 75	≤ 1.5	≤ 0.7

2.6.1 Trophic Status of Lakes, 2002-2005

In 2002, the trophic status of Northern Irelands's largest lakes, Lough Neagh, Lough Erne and Lough Melvin was assessed and reported using the OECD classification system, based on concentrations of chlorophyll *a* and total phosphorus (TP), (DARD-DOE, 2002), The classification system placed Lough Neagh within the hypertrophic category (Table 21). Water transparency values, measured by Secchi disc, were also typical of hypertrophic or eutrophic lakes and based on maximum chlorophyll *a* concentrations, Lough Neagh is the most eutrophic of the larger lakes in Northern Ireland.

Table 21: OECD trophic state classification and designation for larger lakes in Northern Ireland

Lough	Sampling Station	Total Phosphorus (μg P / L)	Chlorophyll *a* Average (μg / L)	Chlorophyll *a* Maximum (μg / L)	Secchi Disc Average Minimum (Metres)	
Lough Neagh		145 (H)	59 (H)	95 (H)	1.1 (H)	0.8 (E)
Upper Lough Erne	Lady Craigavon Bridge	78.0 (E)	12.2 (E)	29.6 (E)	-	-
Lower Lough Erne	Portora	77.0 (E)	4.7 (M)	23.4 (M)	1.8 (E)	0.8 (E)
	Friars Leap	78.6 (E)	4.2 (M)	15.7 (M)	1.7 (E)	0.8 (E)
	Rossahilly	80.4 (E)	7.9 (M)	10.9 (M)	1.4 (E)	0.7 (E)
	Killadeas	70.8 (E)	6.3 (M)	16.1 (M)	1.7 (E)	1.2 (E)
	Broad Lough	62.7 (E)	3.4 (M)	19.0 (M)	2.4 (E)	1.4 (E)
Lough Melvin		36 (E)	10 (E)			

TP concentrations in Upper and Lower Lough Erne in 2001 were also indicative of eutrophic conditions (Table 30). In previous assessments of the Lough in 1994-1999 frequent algal blooms had ensured maximum chlorophyll *a* concentrations that were typical of hypertrophic or eutrophic conditions. However with the introduction to the Lough in 1995-1996 of the zebra mussel (*Dreissena polymorpha*), which feeds by filtering and removing algae and other particulate matter from the water, average chlorophyll-a concentrations were more typical of mesotrophic conditions although TP concentrations remained typical of

strongly eutrophic conditions. A secondary impact of this has been increased water clarity and the growth of macrophytic plants in shallower waters.

Based on a six-month sampling programme from July 2001 in Lough Melvin, mean concentrations of TP (36 µg TP/l) and chlorophyll *a* (10 µg/l) indicated eutrophic status. During 2005 the 27 largest lakes and reservoirs were monitored on a monthly basis for chlorophyll *a* and TP from which lake trophic status was determined according to the OECD classification. On this basis 64% of lakes and reservoirs were eutrophic or hypertrophic (Figure 16a). Only one reservoir fell into the oligotrophic category.

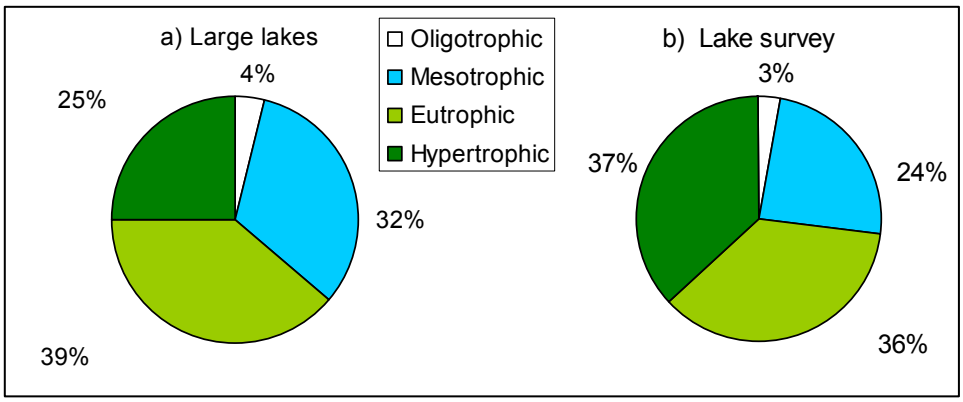

Figure 16: Trophic status of lakes and reservoirs in Northern Ireland a) the 27 largest lakes and reservoirs and b) based on TP in 134 smaller lakes

In addition to the lake and reservoir monitoring programme above, two synoptic lake surveys were carried out in 2002 and 2003. During these surveys 111 and 134 lakes respectively in the size range of 0.4 to 66ha were sampled (Gibson and Jordan, 2004). Each lake was sampled in late February before algal growth would be expected to deplete phosphorus from the water. Trophic classes based on concentrations of TP produced a trophic status categorisation that was similar to that obtained for the larger lakes and reservoirs as 73% of lakes fell into the eutrophic and hypertrophic categories (Figure 16b).

2.6.2 WFD Trophic Status of Lakes, 2006-2008

Total Phosphorus

The importance of phosphorus is recognised by the inclusion of TP in WFD lake classification. TP is the chosen parameter as it includes available phosphorus, that bound to particulate material and that contained in phytoplankton. It is a well established measure and is deeply rooted in limnological literature.

Under the WFD, lakes are now classified for TP using standards determined by typology (altitude, alkalinity and mean depth) (Table 22). The natural nutrient levels in a lake will vary and the impact of additional phosphorus depends on the sensitivity of the lake. As a result it was decided to use standards specific to individual lakes. A site specific model is used to predict the reference level of phosphorus for each individual lake. This reference value of phosphorus is derived from the Morpho Edaphic Index (MEI) which uses the typology factors of alkalinity and mean depth, (Vighi *et al*, 1985) reflecting both the physical environment and the water chemistry. It can be used to classify lakes according to their natural status and identify lakes which have been impacted by anthropogenic influences. In other words, it predicts the TP reference concentrations for a particular lake and also calculates deviation from this reference condition. In addition NIEA have used site specific

humic and non-humic MEI models developed by Cardoso (2007) to produce the reference lake TP values for each individual lakes (Table 23).

Table 22: WFD typologies for surveillance lakes in Northern Ireland

Alkalinity (mg/l CaCo3)	Low (LA) = < 10 Moderate (MA) = 10 - 50 High (HA) = >50
Depth (m)	Very Shallow (VS) <3 Shallow (S) 3 – 15 Deep (D) >15

Table 23: WFD type specific standards for TP for lakes

	Class Boundaries	
	High	**Good**
	Annual Mean (ug TP/l)	
High Alkalinity - shallow	20	34
High Alkalinity – very shallow	28	43
Moderate Alkalinity – deep	7	13
Moderate Alkalinity – shallow	12	17
Moderate Alkalinity–very shallow	20	28
Low Alkalinity – deep	5	9
Low Alkalinity – shallow	7	10
Low Alkalinity –very shallow	11	15

If the typology data required by the model is not available type specific standards can be applied. The UK Technical Advisory Group (UKTAG) has defined these as the median of the range of site specific standards. For Moderate, Poor and Bad status UKTAG doubled the boundary values i.e. the boundary between Moderate/Poor status is twice the boundary between Good/Moderate and the boundary between Bad/Poor is double that for the Moderate/Poor boundary.

Lakes which are not considered to be eutrophic are classed as High or Good, and lakes considered to be eutrophic/hypereutrophic are classed as Moderate, Poor or Bad status. Lakes which fall into Moderate class equate to 'indicative of unacceptable or worsening eutrophic conditions'. Similar to rivers classification this provides a way of comparing the trophic status of lakes and a way of looking at changes over time. Where the trend of phosphorus deteriorates from Good status to Moderate status the lake water body would be considered to be 'at risk of becoming eutrophic'.

Phytoplankton

Classification of lake phytoplankton is based on two metrics that have been developed and intercalibrated separately:

- phytoplankton biomass is represented by chlorophyll (based on monthly samples); and
- phytoplankton taxonomic composition and abundance is represented by the percentage of nuisance cyanobacteria (blue-green algae) as measured by biovolume.

Environmental quality ratios (EQRs) for chlorophyll are calculated as a ratio of the observed values to the expected values at Reference condition (Table 24).

Phytoplankton are sampled three times (spring, summer and late summer) in the selected survey year corresponding to the natural growth optima of a range of species groups. The measured value of percentage by biovolume of nuisance cyanobacteria, is the percentage of the total biovolume of the sample made up of cyanobacteria against the total biovolume of all phytoplankton taxa present in each sample. The overall classification for the lake, based on phytoplankton, is whichever is the lower of the chlorophyll and % cyanobacteria classifications

Table 24: WFD class boundary EQR values for chlorophyll for each lake type

Lake Type*	High/Good Boundary EQR	Good/Moderate boundary EQR	Moderate/Poor boundary EQR	Poor/Bad boundary EQR
HA, S	0.55	0.32	0.16	0.05
HA, VS	0.63	0.30	0.15	0.05
MA, D	0.50	0.33	0.17	0.05
MA, S	0.50	0.33	0.17	0.05
MA, VS	0.63	0.34	0.17	0.06
LA, D	0.50	0.33	0.17	0.05
LA, S	0.50	0.29	0.15	0.05
LA, VS	0.63	0.33	0.17	0.05

* see table 23 above for type abbreviations

Macrophytes

Macrophyte surveys in lakes in Northern Ireland are carried out once between June and September (summer) and the classification is based on the data from the most recent survey year. NIEA have used the FREE Index (Free *et al.*, 2007) developed by the Environmental Protection Agency in the Republic of Ireland to classify lakes as this gives the advantage of using the same tool to classify macrophytes throughout Ecoregion 17. The FREE index uses the relative frequency of macrophytes found in each quadrant from all sites surveyed. It uses a combination of metrics to produce an overall FREE index for an individual lake. Boundaries are set using points of ecological change along a TP gradient based on reference sites from the IN-SIGHT[1] paleoliminology work (Table 325). The FREE index is applicable across all lake types.

Table 25: WFD class boundary EQR values for macrophytes for each lake type

WFD Class	EQR Range
High	>0.90
Good	>0.68 – 0.90
Moderate	>0.42 – 0.68
Poor	>0.33 – 0.42
Bad	<0.33

[1] **I**dentification of refere**N**ce-**S**tatus for **I**rish lake typolo**G**ies using palaeolimnological met**H**ods and **T**echniques

Diatoms

DARLEQ is a benthic diatom-based tool developed to fulfil the obligation to include phytobenthos in the assessment of ecological status of freshwaters. Separate tools have been developed for lakes and rivers, although they share a common approach. The tools are based on changes in the species composition and abundance of the benthic diatom flora (the bio-film) in response to nutrient pressure. The dynamic nature of bio-films means they mat change over relatively short time scales. The tool is based on the TDI, which is already used by the UK statutory agencies for the assessment of eutrophication in rivers. A new index, Lake Trophic Diatom Index (LTDI), has been developed for use in lakes. Reference TDI values (or LTDI for lakes) are calculated using site-specific predictions, and compared with the observed values to produce an EQR. The High/Good status boundary was defined as the 25th percentile of the EQRs of all sites considered to be at reference condition; the Good/Moderate boundary is the point at which the relative proportions of diatoms present belonging to nutrient-sensitive and nutrient-tolerant taxa were approximately equal (Table 26). As a consequence of the dynamic nature of bio-films there may be a considerable amount of within-site variability, although less so in lakes compared to flowing waters. Both tools include an estimation of uncertainty along with their EQR outputs. Diatoms are sampled twice a year in spring and summer in the selected survey year.

Table 26: WFD class boundary EQR values for diatoms for each lake type

WFD Class	EQR Range	
	High/Moderate Alkalinity	Low Alkalinity
High	>0.90	>0.90
Good	>0.66 – 0.90	>0.63 – 0.90
Moderate	>0.44 – 0.66	>0.44 – 0.63
Poor/Bad	<0.44	<0.44

The results of the overall trophic classification for Northern Ireland's 27 surveillance lakes in 2006-08 are shown in Tables 27 and 28. Table 27 shows that 30% of lakes and reservoirs were classed as High or Good'. A slightly higher proportion of lakes and reservoirs, (33%), were classed as Moderate (indicative of eutrophic conditions), and 37% were classed as Poor/Bad or exhibiting hypereutrophic conditions. The spatial distribution of the 27 lakes surveyed with their WFD classes is shown in Figure 17.

Table 27: WFD class based on average TP concentrations of WFD surveillance lakes and reservoirs across Northern Ireland *(based on % of sites)*

WFD Class	Northern Ireland
% of sites	2006-2008 (27 sites)
High	7.4
Good	22.2
Moderate	33.3
Poor	14.8
Bad	22.2

Table 28: WFD trophic classification for 27 surveillance lakes in Northern Ireland in the period 2006-2008

Lake Name	Overall WFD Trophic Status	TP	Phytoplankton	Diatoms	Macrophytes
Cashel Lough	High	High	High	High	High
Lough Scolban	High	High	High	No data	High
Lough Carn	Good	Good	Good	High	High
Lough Fea	Good	Good	High	No data	High
Lough Lattone	Good	Good	Good	Good	Good
Upper Lough Macnean	Good	Good	Good	Good	Good
Lough Melvin	Good	Good	High	Good	Good
Silent Valley Reservoir	Good	Good	High	No data	High
Lough Ash	Moderate	Good	High	Good	Moderate
Lower Lough Macnean	Moderate	Good	Good	Moderate	Good
Keenaghan Lough	Moderate	High	Good	Good	Moderate
Cam Lough	Moderate	Moderate	Moderate	Good	Good
Castlehume Lough	Moderate	Moderate	Good	Good	Good
Coolyermer Lough	Moderate	Moderate	Good	Good	Good
Lower Lough Erne	Moderate	Moderate	High	Moderate	Moderate
Upper Lough Erne	Moderate	Moderate	High	Moderate	Good
Lough Island Reavy	Moderate	Moderate	Moderate	No data	Good
Lough Beg	Poor	Poor	Poor	Poor	Poor
Lough Mourne	Poor	Poor	Moderate	No data	Moderate
Lough Muck	Poor	Poor	Moderate	Moderate	Moderate
Lough Ross	Poor	Poor	Moderate	No data	Moderate
Clea Lakes	Bad	Bad	Moderate	No data	Moderate
Lough Neagh	Bad	Bad	Poor	Poor	Bad
Stoneyford Reservoir	Bad	Bad	Moderate	Poor	Bad
Spelga Dam	Bad	Good	High	No data	Bad
Lough Gullion	Bad	Poor	Moderate	Poor	Bad
Portmore Lough	Bad	Poor	Moderate	Poor	Bad

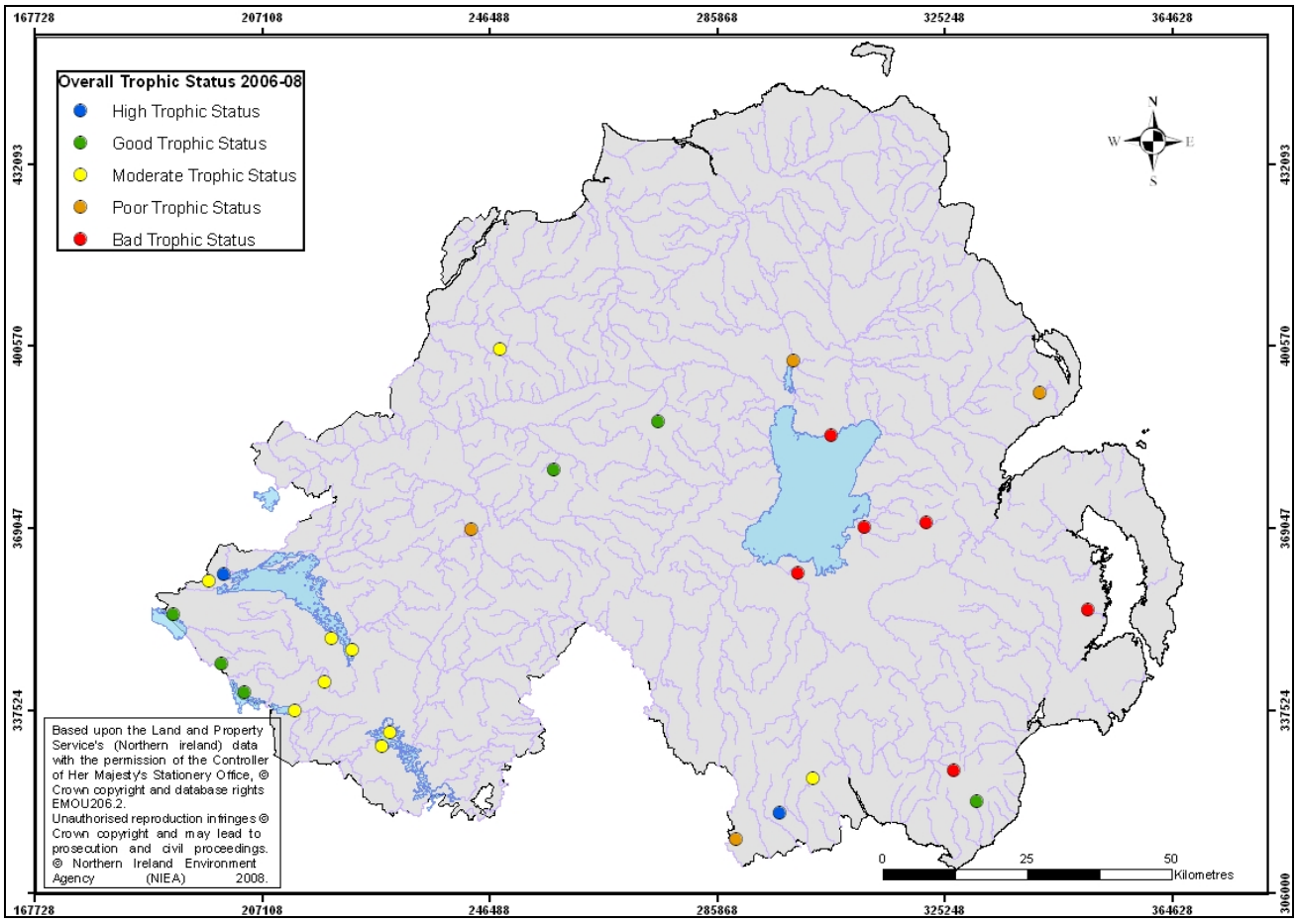

Figure 17: Distribution of 27 surveillance lakes and associated WFD trophic classifications in 2006-2008

2.7 Trophic Status of Northern Ireland Coastal and Transitional Waters

2.7.1 Trophic Status of Northern Ireland Sea Loughs, 2001-2005

The key criteria used in 2001 to assess the trophic status of estuarine and coastal waters in Northern Ireland were based on the guidance produced for implementation of the UWWT Directive (DOENI, 1999).

On behalf of NIEA, the then Department of Agriculture and Rural Development (DARD) Science Service carried out surveys of trophic status of the five major sea loughs of Northern Ireland (Foyle, Larne, Belfast, Carlingford and Strangford) and of the Quoile Pondage (Service *et al.,* 1996; Service*, 2000,* Taylor *et al., 2001,* Charlesworth*, et al 2001*). Inner Belfast Lough (including Belfast Harbour and the Connswater estuary), the Tidal Lagan and the Quoile Pondage were assessed and designated as sensitive areas (eutrophic) in 2001. Inner Belfast Lough received the majority of its total nitrogen loading from an industrial point source and the waste water treatment works (WWTWs) discharging directly into the Inner Lough. It had high nutrient levels and sporadic algal blooms, including toxic species of algae. The tidal reaches of the River Lagan were also impacted significantly by the nutrient inputs to Inner Belfast Lough and the River Lagan.

In 2006 following the 2005 Sensitive Area Review, Strangford Lough North was also identified as a sensitive area (eutrophic).

2.7.2 WFD Assessment, 2007-2009

Northern Ireland Marine Winter Nutrient Status.

Northern Ireland marine waters (both coastal and transitional) are now assessed for ecological status under the WFD classification tools. The nutrient tool is based on the OSPAR criteria which were previously used.

Marine nutrients are one of the key environmental variables controlling the growth of phytoplankton in coastal waters. In temperate regions, coastal waters nutrient concentrations are highest in winter, when agricultural run-off is highest due to increased rainfall, and algal growth is lowest due to lack of light and lower temperatures. Monitoring studies done in the UK indicate that nutrients tend to accumulate in coastal waters during the winter months (November to February). Dissolved inorganic nitrogen (DIN) includes nitrate, nitrite and ammonium and is an important indicator of marine nutrient status, as nitrogen is the most important nutrient in limiting marine algal growth. Recent monitoring has shown that winter concentrations of DIN each year in Northern Ireland's five sea loughs are either reducing or stable. Sustained reductions in DIN in Belfast Lough are due to significant reductions in nutrient inputs from both WWTWs and industry.

NIEA have used the UK WFD classification tools to place water bodies in High, Good or Moderate Status using the boundaries in Table 29.

Table 29: DIN thresholds for coastal and transitional waters

Area	Salinity range	DIN (uM) HIGH	DIN (uM) GOOD	DIN (uM) MODERATE	DIN (uM) POOR	DIN (uM) BAD
Coastal (at salinity 32)	30-34.5	<12	≥12 ≤18	>18 ≤30	>30 ≤40.5	>40.5
Transitional (at salinity 25)	<30	<20	≥20 ≤30	≥30 ≤45	≥45 ≤67.5	>67.5

The assessment shown in Figure 18 is based solely on the winter mean of DIN and is not a complete assessment of ecological status, which also incorporates biological and hydromorphological quality elements.

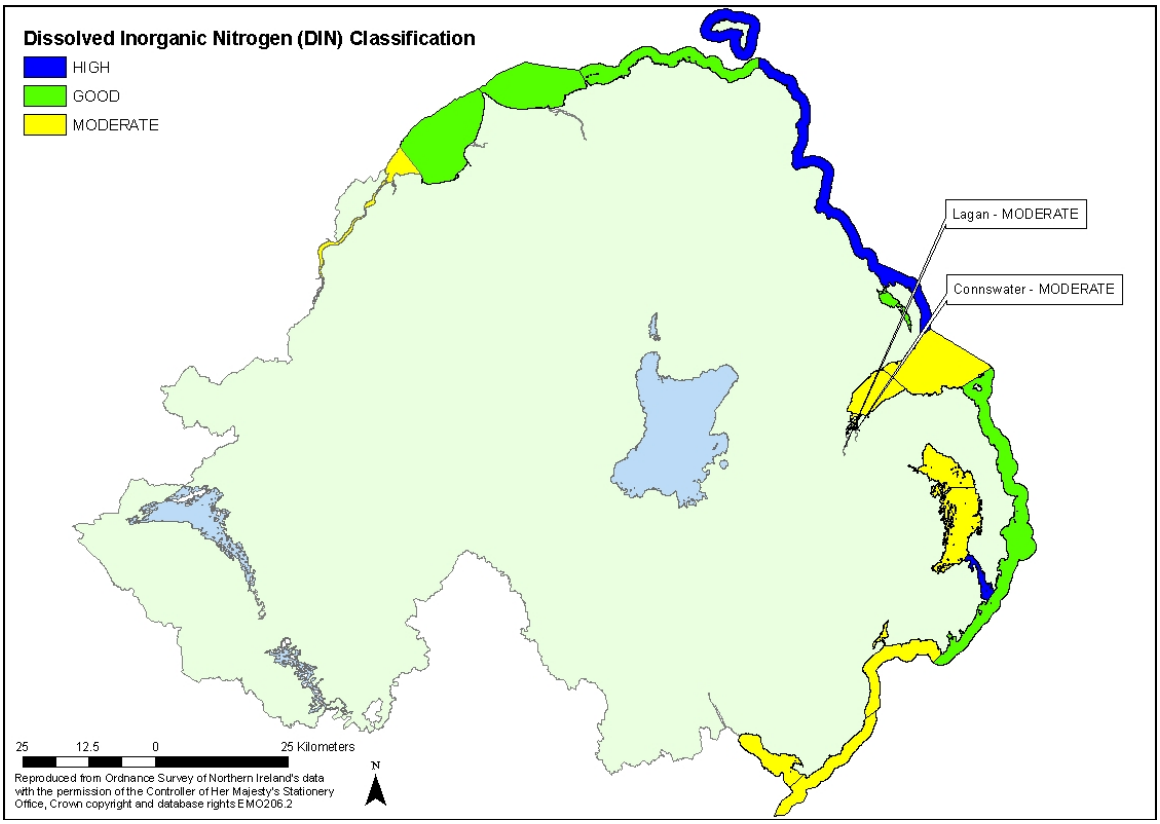

Figure 18: Northern Ireland water body classification based on the DIN tool in the period 2007-2009 Small transitional water bodies difficult to identify at this scale are labelled.

In addition to the DIN status, and the thresholds given in Table 29, a biological assessment is also made as part of ecological status (Table 30). This would take into account factors such as potential productivity, and the evidence of elevated chlorophyll and dissolved oxygen. The DIN thresholds are useful for targeting and prioritising biological monitoring. The biological tools can also be used to help show in general terms if water bodies worse than Good are improving.

Table 30: **WFD classification from direct and secondary eutrophication parameters**

Water body name	DIN	DO	Chl a	MBT	RSL
Rathlin	High	High	High	TNA	High
North Channel	High	High	High	TNA	High
Strangford Lough Narrows	High	High	High	High	Good
Portstewart Bay	Good	High	High	TNA	Good
North Coast	Good	High	High	TNA	High
Larne Lough North (HMWB)	Good	High	High	TNA	High
Larne Lough Mid	Good	High	High	TNA	High
Larne Lough South	Good	High	Good	High	TNA
Ards Peninsula	Good	High	Moderate	TNA	Good
Lough Foyle	Good	High	Good	High	Good
Roe Estuary	Good	High	TNA	High	TNA
Belfast Lough Outer	Moderate	High	High	TNA	Good
Belfast Lough Inner	Moderate	High	Good	TNA	Good
Belfast Harbour (HWMB)	Moderate	High	Poor	TNA	TNA
Strangford Lough North	Moderate	High	High	Good	Good
Strangford Lough South	Moderate	High	High	TNA	Good
Dundrum Bay Outer	Moderate	High	High	TNA	High
Dundrum Bay Inner	Moderate	High	Good	Moderate	TNA
Mourne Coast	Moderate	High	High	TNA	Good
Carlingford Lough	Moderate	High	Good	TNA	Good
Lagan Estuary (HMWB)	Moderate	Moderate	TNA	TNA	TNA
Connswater (HMWB)	Moderate	Good	TNA	TNA	TNA
Foyle and Faughan (HMWB)	Moderate	Good	TNA	TNA	TNA
Maiden Islands	TNA	High	High	TNA	High
Quoile Pondage (HMWB)	TNA	Moderate	TNA	TNA	TNA
Bann Estuary (HMWB)	TNA	High	TNA	TNA	TNA
Newry Estuary (HMWB)	TNA	High	TNA	High	TNA

TNA-Tool not applied

Secondary Biological effects

The assessment methods for macroalgae and chlorophyll were developed for the WFD. Status is classified into five categories from High/Good/Moderate/Poor/Bad. Moderate to Bad classifications are indicative of pressure such as nutrient enrichment and eutrophication.

The Reduced Species List (RSL) for marine macroalgae uses basic indices to assess nutrient enrichment and disturbance pressures including:

- shore description;
- species richness;
- proportion of chlorophyta (green seaweed);
- proportion of rhodophyta (red seaweed);
- Ecological Status Group (ESG) ratio indicates shift from a pristine state (EGS1 – late successionals or perennials) to a degraded state (ESG2 – opportunistic or annuals); and

- proportion of opportunists.

The use of this tool is restricted to rocky shore environments. Results of WFD classification of coastal and transitional waters using the RSL assessment tool where applicable in the period 2007-2009 are shown in Figure 19 and Table 30.

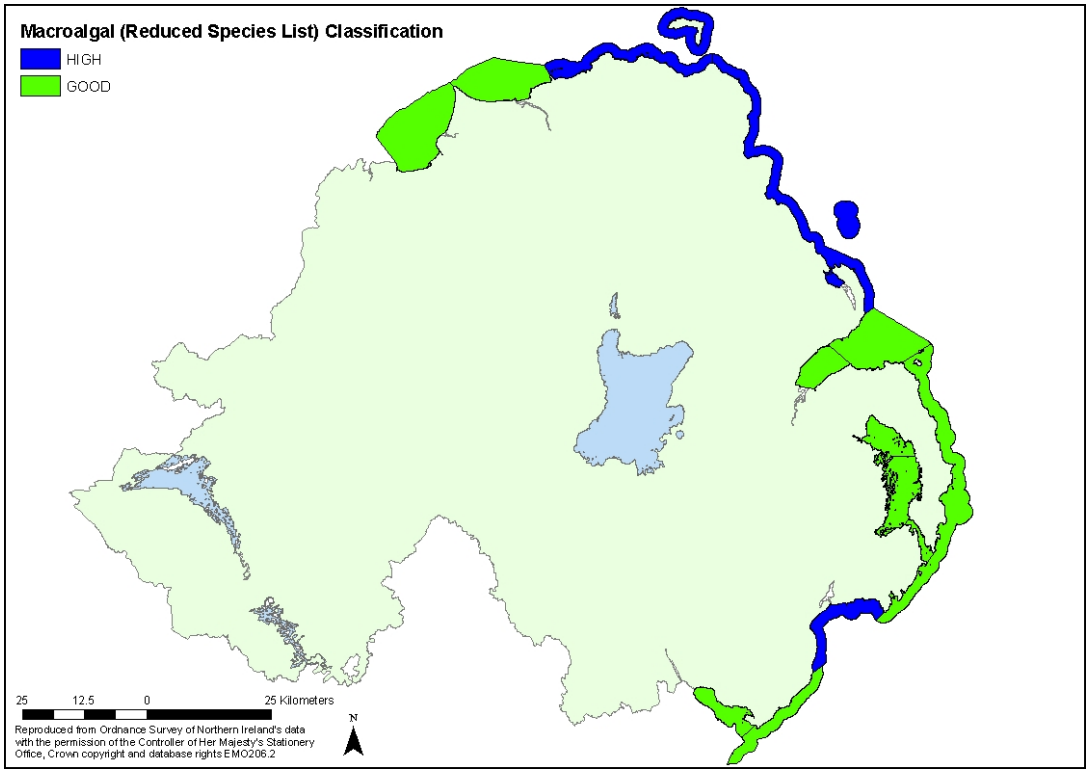

Figure 19: Northern Ireland water body classification based on the RSL tool in the period 2007-2009

The Macroalgal Blooming Tool (MBT) is designed to determine the extent of algal cover and associated biomass of green algal species which develop in response to local nutrient enrichment pressure. The use of this tool is restricted to specific sedimentary habitats which favour the growth of green algal species which form dense mats in response to localised nutrient enrichment. The indices are:

- total extent of macroalgae bed;
- percentage cover of available intertidal habitat at site (derived measure) and at quadrat level;
- biomass of opportunistic macroalgal mats (g/m^2);
- biomass over available intertidal habitat; and
- presence of entrained algae.

Results of WFD classification of coastal and transitional waters using the MBT assessment tool where applicable in the period 2007-2009 are shown in Table 30 and Figure 20.

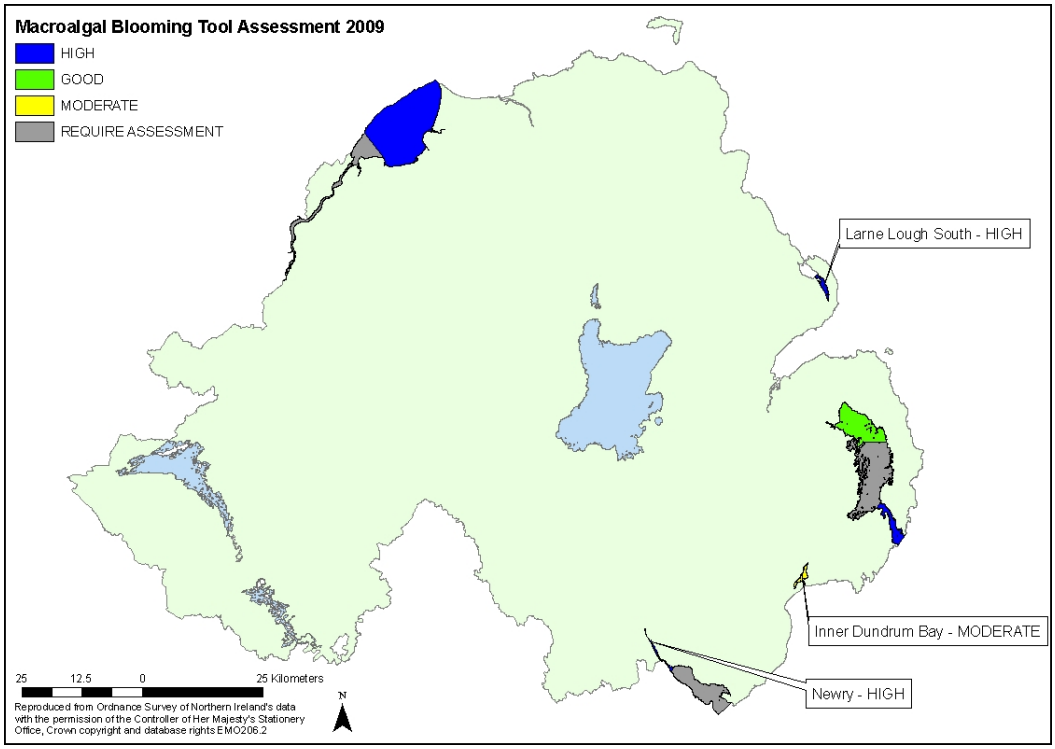

Figure 20: Northern Ireland water body classification based on the MBT in the period 2007-2009 Small waterbodies that are difficult to identify at this scale are labelled

Chlorophyll-a biomass is assessed as a 90%ile against accepted threshold standards (Table 31). Elevated chlorophyll biomass (Moderate or worse status) can be indicative of nutrient enrichment.

Table 31: Chlorophyll-a thresholds for coastal waters

Water Ref. Area		Status				
		High	Good	Moderate	Poor	Bad
North/Irish Sea	Chl µg l^{-1} 90%ile	<5	5-10	10-15	15-20	>20
	EQR	0 -1.0	1.0-0.8	0.8-0.6	0.6-0.4	0.4-0.2

Results of WFD classification of coastal and transitional waters using the chlorophyll *a* assessment tool where applicable in the period 2007-2009 are shown in Table 30 and Figure 21.

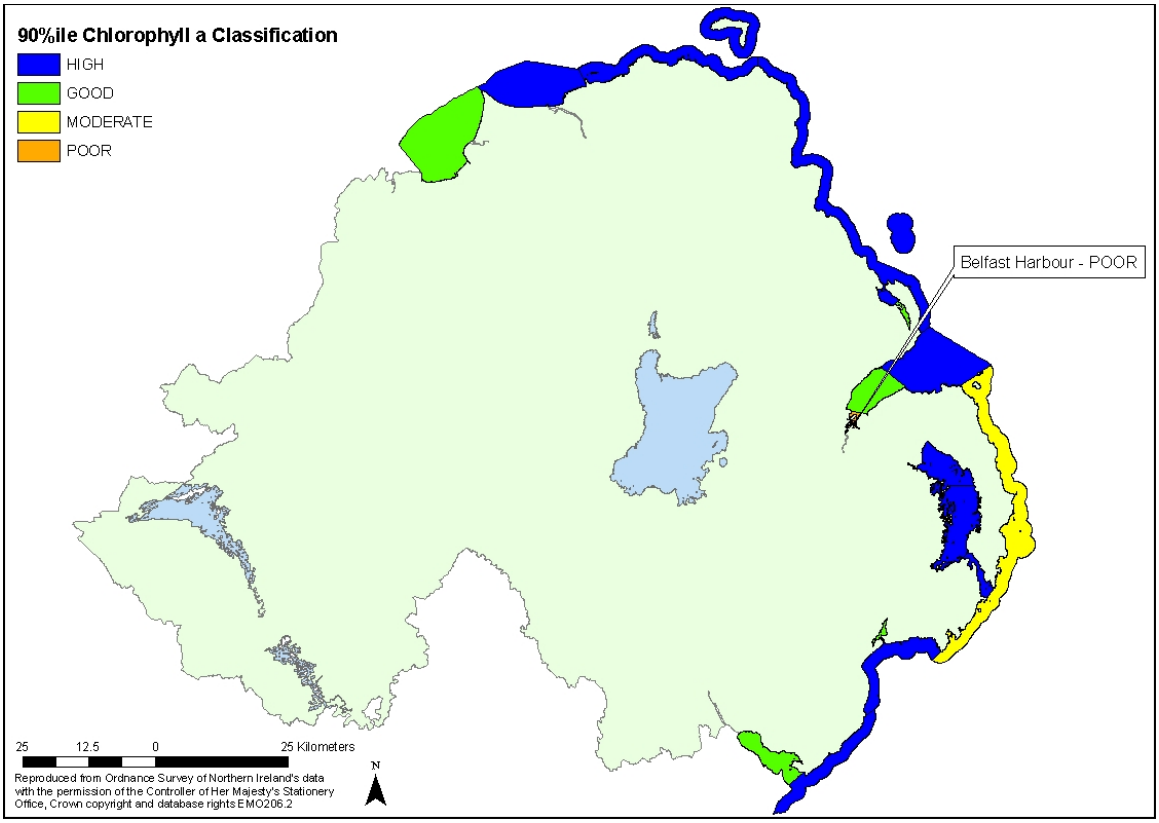

Figure 21: Northern Ireland water body classification based on the 90th Percentile chlorophyll *a* Tool in the period 2007-09 Small waterbodies difficult to identify at this scale are labelled

Dissolved oxygen (DO) is assessed as 5%ile against accepted threshold standards (Table 32). Reduced DO (Moderate or worse status) can be indicative of nutrient enrichment.

Table 32: DO thresholds for coastal and transitional waters

WFD Status	Marine 5%ile	Objectives
HIGH	≥5.7 mg/L	All life stages of salmonids and transitional fish
GOOD	≥4.0 <5.7 mg/L	Presence of salmonids and transitional fish
MODERATE	≥2.4 <4.0 mg/L	Most life stages of non-salmonid adults
POOR	≥1.6 <2.4 mg/L	Presence of non-salmonids, poor survival of salmonids
BAD	<1.6 mg/L	No salmonids present, marginal survival of resident species

Results of WFD classification of coastal and transitional waters using the DO assessment tool where applicable in the period 2007-09 are shown in Table 30 and Figure 22.

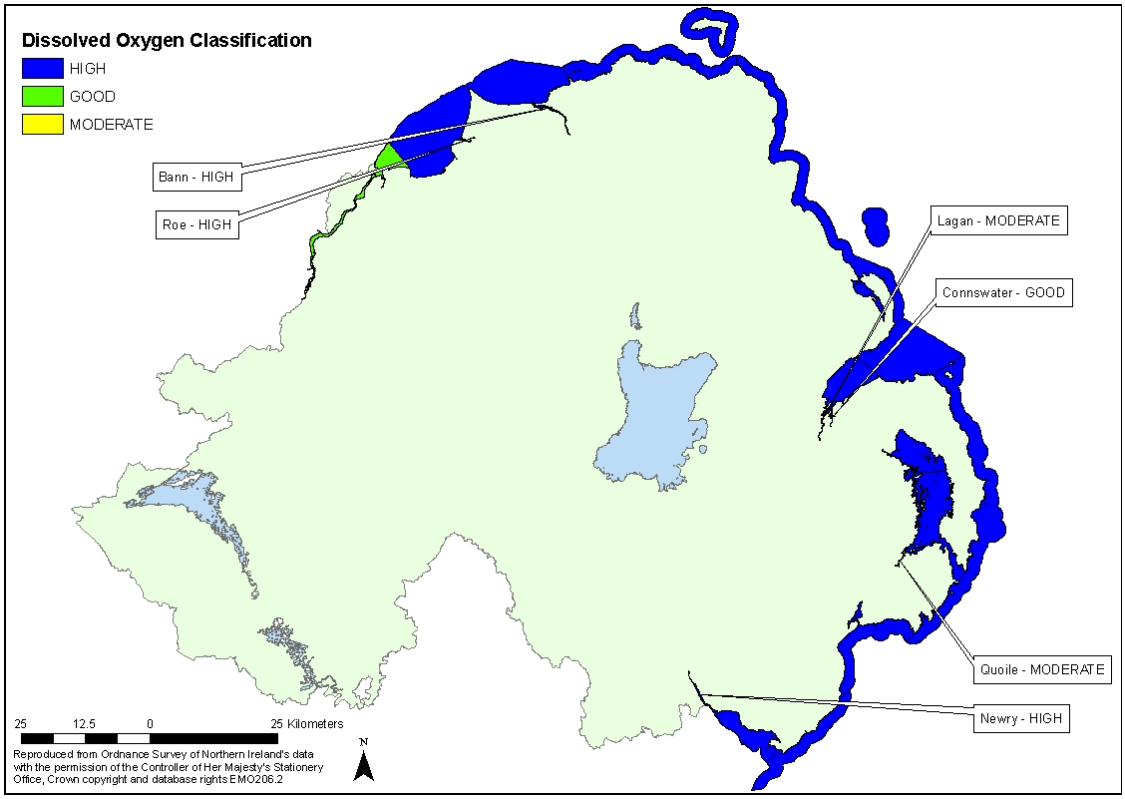

Figure 22: Northern Ireland water body classification based on the DO tool in the period 2007-2009 Small transitional waterbodies that are difficult to identify at this scale are labelled

The results of the WFD assessment broadly align with previous assessments under both the Nitrates and UWWT Directives. As the marine receiving waters are at the very end of the catchment, it is anticipated that improvements will be slowest to manifest in these areas.

Following the initial assessment of Northern Ireland water bodies using WFD tools, the sites that are definitely at Moderate or Worse status are Belfast Harbour, Quoile Pondage and the Tidal Lagan, all of which have been previously designated as eutrophic or likely to become eutrophic if preventative action is not taken (Table 30).

There are a number of water bodies that fail the DIN criteria (Moderate or worse) but that pass the biological criteria. These include, Inner Belfast Lough, Outer Belfast Lough, Strangford North and South, Dundrum Bay Inner and Outer, Mourne Coast, Carlingford Lough, Connswater, Foyle and Faughan. Of these sites, Inner Belfast Lough and Strangford North are designated as eutrophic or likely to become eutrophic if protective action is not taken. Under the European Eutrophication guidance, sites that fail the supporting determinands but pass the biology require a 'checking procedure'. This involves a more extensive biological assessment to ensure that the ranges set for the supporting determinands are correct, and not too strict. The checking procedure will be invoked in all water bodies in this category to ensure that the correct classification has been assigned. Further measures to those already in place are not yet recommended at these sites.

There is little nutrient data at the Newry and Bann Estuaries and these areas will be a priority for future monitoring. Both catchments are already designated under UWWT Directive.

One water body (Ards Peninsula), fails on one biological determinand only, but passes on all other determinands. This area will be targeted for further monitoring.

Portstewart Bay, North Coast, Larne Lough North, Mid and South and Lough Foyle all achieve Good status on WFD eutrophication criteria, with Rathlin, Maidens, North Channel, and Strangford Narrows achieving High status.

3.0 OVERVIEW OF NORTHERN IRELAND AGRICULTURE

Agriculture plays an important role in the Northern Ireland economy. It accounts for 1.2% of gross value added (GVA) and is responsible for 2.9% of civil employment in Northern Ireland. This makes the economic contribution of the industry proportionately twice that compared to the overall UK level. When food processing is included, the shares of GVA and employment in Northern Ireland rise to 1.9% and 5.5% respectively.

It is estimated that approximately 49,000 people were engaged in some form of agricultural activity in 2008, although the majority do so on a casual or part-time basis. The size of the agricultural labour force has been reducing at an annual average rate of 2.0% over the past 10 years.

In Northern Ireland there are approximately 37,700 claimants of direct aid of which 25,950 are active farm businesses. Only 23% (5,970) of farm businesses are regarded as large enough to provide full-time employment for one or more persons (based on a standardised labour requirement). The number of farms has been reducing at an annual average rate of 1.6% over the past five years and 1.8% over the past 10 years (Figure 23).

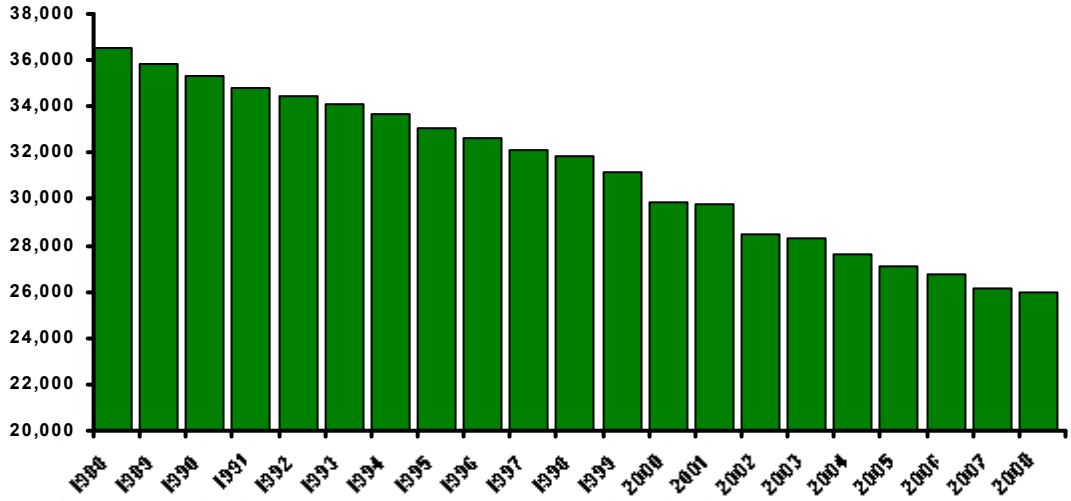

Figure 23: Trends in farm numbers in Northern Ireland (1988-2008)

Farms in Northern Ireland are almost entirely owner-occupied and are small by UK standards. However, the average area of farm businesses in Northern Ireland (39.2 ha) is almost 1.5 times larger than the EU-15 countries (26.9 ha). In 1990 the average farm size in Northern Ireland was 30.4 ha. Since 1990 the average area farmed has increased by almost 9 ha (29%). Although the quantity of land sold annually on the open market is small, seasonal leasing of land (conacre) is common and facilitates both farm business expansion and contraction.

3.1 Land Use

The area of agricultural holdings accounts for 1.02 million (m) ha (75%) of Northern Ireland's 1.35m ha. This compares with 40% of total area in the EU-15 countries. About 70% of Northern Ireland's agricultural land has been designated by the EU as a Less Favoured Area (LFA). In the UK as a whole 45% of the agricultural area is designated as LFA compared to 61% in the EU-15 countries. Almost 40% of the land is under an agri-environment scheme.

Northern Ireland is almost all under grass with approximately 93% grassland and only 6% of the area farmed as arable or horticulture.

3.2 Farming Systems

Farms have increasingly become more grass-based over the last 28 years. In 1980, cattle were found on 70% of farms, with the figure for 2008 being 81%, and sheep flocks are more common (Table 33). There has been a marked decline in the incidence of farms with pigs, from 16% in 1980 to 2% in 2008, and cereal crops were grown on only 12% of farms in 2008.

Table 33: Percentage of Farms with Enterprises in 1980, 1990, 2000 and 2008

% farms with:	1980	1990	2000	2008
Dairy cows	20	23	18	15
Beef cows	42	55	56	65
Cattle	70	87	84	81
Sheep	18	38	36	34
Pigs	16	9	3	2
Cereals	21	19	13	12

Dairy Sector

In 2008 there were 3,975 dairy herds with the average dairy herd having 73 cows. This was more than double the EU-15 average. Fifty three per cent of dairy cows were in herds of 100 or more cows. Total milk output was over 1.9 billion litres. These enterprises were grass-based systems characterised by a moderate output, of 6700 litres per cow with the calving pattern typically spread from early autumn to late spring. Economically the dairy sector is the most important, producing a sector gross margin of £343.9m which is 58.2% of the total agricultural gross margin in 2008.

Beef Sector

A range of production systems exist to breed, rear and fatten beef cattle and are generally extensive in nature. In 2008 there were 265,700 beef cows with the average beef breeding herd comprising 16 cows with only 6% in herds of 100 or more cows. This sector generated a sector gross margin of £80.7m or 13.7% the total agricultural gross margin.

Sheep Sector

In 2008 total sheep numbers were almost 2m with the breeding ewe numbers at approximately 940,000. The average sheep flock comprised 109 ewes. There were relatively few large flocks with only 28 having 1,000 or more ewes. The economic contribution of this sector was modest with a sector gross margin of £16.0m or 2.7% of the total agricultural gross margin in 2008.

Poultry Sector

In 2008 there were approximately 2.4m layers and 11.5m broilers, with 60% of commercial layer producers having 1,000 or more laying birds and 95% of commercial broiler producers having 1,000 or more broilers. Over 40% of laying birds were farmed by 14% of commercial producers. A similar situation occurs with broiler flocks where over 80% of the birds were farmed in just over half of the businesses. Northern Ireland's commercial egg-laying and broiler flocks are very large by EU standards – the average broiler flock has 39,000 birds compared with 1,200 birds in the EU-15. Average poultry flock sizes are also well above UK values with Northern Ireland having an average of 13,600 laying hens per business

compared to an average of 1,000 in the UK. This sector contributed 3.1% of the total agricultural gross margin or £18.1m in 2008.

Pig Sector

The size of the pig herd contracted significantly between 1997 and 2001 when pig numbers fell by 45%. The number of pig herds has declined to 438 in 2005 and has shown a gradual recovery in herd numbers to 488 in 2008. Almost one-third (151 herds) have fewer than 10 sows. This sector generated a gross margin of £9.4m, 1.6% of the total agricultural gross margin in 2008.

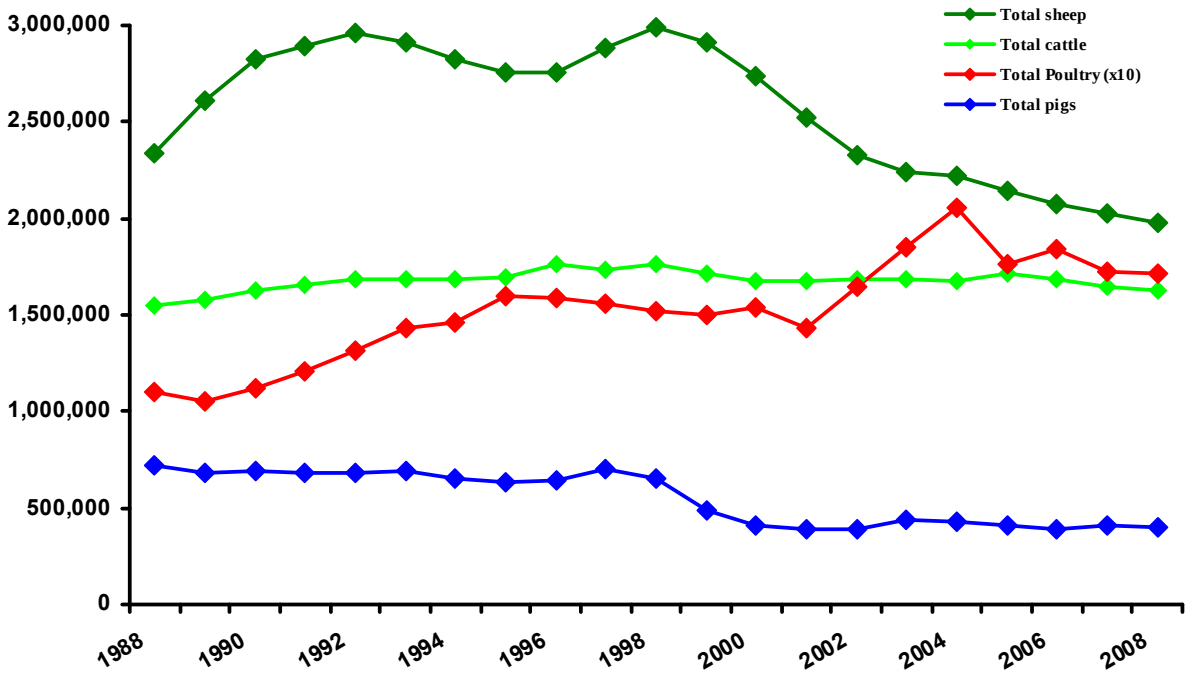

Figure 24: Livestock Trends in Northern Ireland 1988-2008

3.3 Fertiliser Purchase Trends

Fertiliser purchases in Northern Ireland have significantly declined in recent years. There has been a 42% reduction in chemical nitrogen (N) fertiliser purchases (Figure 25) and an 80% reduction in chemical phosphate (P_2O_5) fertiliser purchases (Figure 26) over the period 1995 to 2008.

The six-year (2003-2008) average for chemical N fertiliser purchase of 87.5 kt was applied to 848,000 ha of grassland and crops (excluding rough grazing). This equates to an average chemical N fertiliser application of 103 kg/ha. The average for P_2O_5 and potash was 17kg/ha and 24kg/ha respectively.

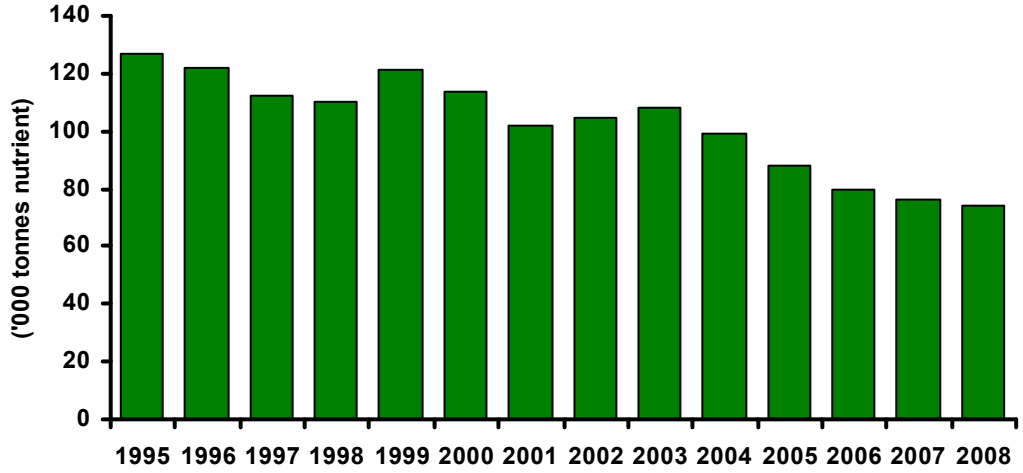

Figure 25: Trends in purchases of chemical Nitrogen (N) fertiliser ('000t/year)

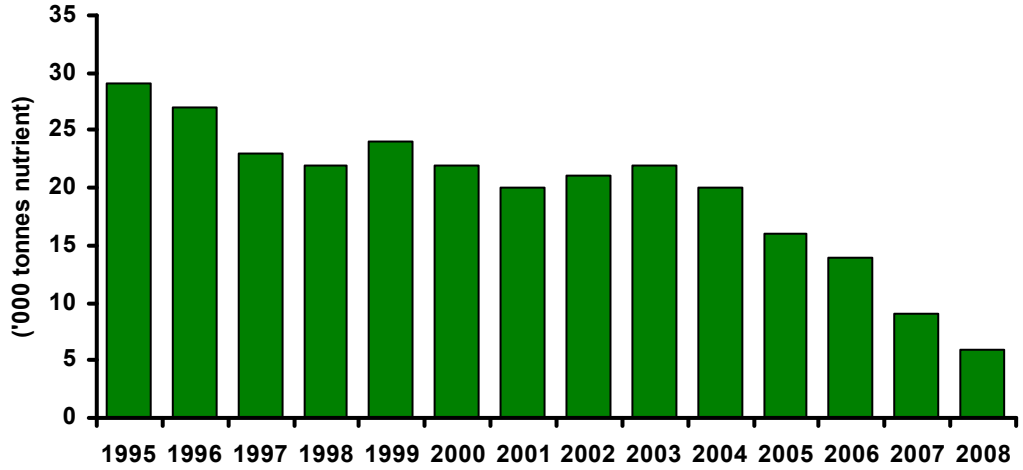

Figure 26: Trend in purchases of chemical Phosphate (P_2O_5) fertiliser ('000t/year)

3.4 Trends in Nitrogen Use and Efficiency in Northern Ireland

To sustain production agriculture in Northern Ireland imports nutrients in the form of chemical fertilisers and animal feedstuffs. Outputs of nutrients are contained in the agricultural outputs sold from farms as milk, meat, eggs, cereals, fruit and vegetables. Of these, animal products dominate nutrient outputs (>80%) as the arable sector is small, accounting for less that 5% of the agricultural area.

Within Northern Ireland the difference between inputs and outputs of nutrients has been positive and the resulting nutrient surplus is potentially available to be lost to the wider environment and/or accumulates within the soil profile. Lowering nutrient surpluses is therefore environmentally desirable and in 2008 DARD set a specific government target to ensure that farm nutrient balances are maintained at levels below 145kg N/ha and reduced to 10kg P/ha by 2011.

DARD monitors purchases of chemical fertilisers, imported feedstuffs and agricultural outputs in Northern Ireland. A methodology for translating these data into nutrient inputs and outputs has been developed and is used to monitor changes in the nutrient surplus calculated as the difference between inputs less outputs (Foy *et al.,* 2002). The data can also be used to provide an estimate of nutrient efficiency as the ratio of outputs to inputs. This efficiency statistic is of interest as the NAP Regulations specify improvements in the efficiency with which N in animal manures is utilised in crop and grass production. On this basis the maximum permitted use of chemical fertilisers (and organic manures not being

livestock manure) on grass on dairy farms and other farms is being progressively lowered from 289 or 239 kg N/ha/year in 2007 to 272 or 222 kg N/ha/year in 2010 respectively.

In 2005 the potential for lower use of chemical N fertilisers that could arise from improvements in N efficiency of manure utilisation was estimated (Bailey, 2005). On the basis that 33% of cattle and pig manure would be spread by band spreading (in order to lower losses to the atmosphere) and the operation of the closed period, a reduction in the use of chemical N fertiliser of 15500 tonnes N/year could be expected. This represented 15% of the average annual use of chemical nitrogen fertiliser in the period 2000-2004.

Changes in the use of N fertiliser and N nutrient efficiency are set out below. P fertilisation rates are included because of the role of P as a driver of freshwater eutrophication and the fact that eutrophication was the dominant reason why a total territory approach was taken to implement the Nitrates Directive within Northern Ireland. Additional to the measures in the NAP Regulations, Northern Ireland introduced the Phosphorus (Use in Agriculture) Regulations (Northern Ireland) 2006 (P Regulations). These Regulations require the use of chemical P fertilisers to proven crop need as defined by recommended rates and soil test P and the availability of nutrients in manures. Given the prevalence of high P soils in many areas of Northern Ireland it was expected that this would lower the use of P fertilisers on farms

Chemical Fertiliser Use

The average rate of application of chemical N fertiliser in 2008 was 82 kg N/ha (Figure 27). It was the lowest recorded since 1975 and 45% lower that the maximum rate recorded in 1995. The rate in 2006 was 94 kg N/ha. Compared to the average for 2004-2006 of 102 kg N/ha/year, the reduction was 20 kg N/ha or 19.3%. Between 2004-2006 and 2008 there was a slight contraction of 2.6% in the area of crops and grass, so the amount of chemical fertiliser used in 2008 of 69650 tonnes N was 21.7% lower when compared to the average rate of 89000 tonnes/year from 2004-2006. Therefore the reduction in chemical N fertiliser 2008 of 19350 tonnes N/year exceeded the potential reduction of 15000 tonne N/year computed from introducing the NAP Regulations and adoption of low emission spreading techniques.

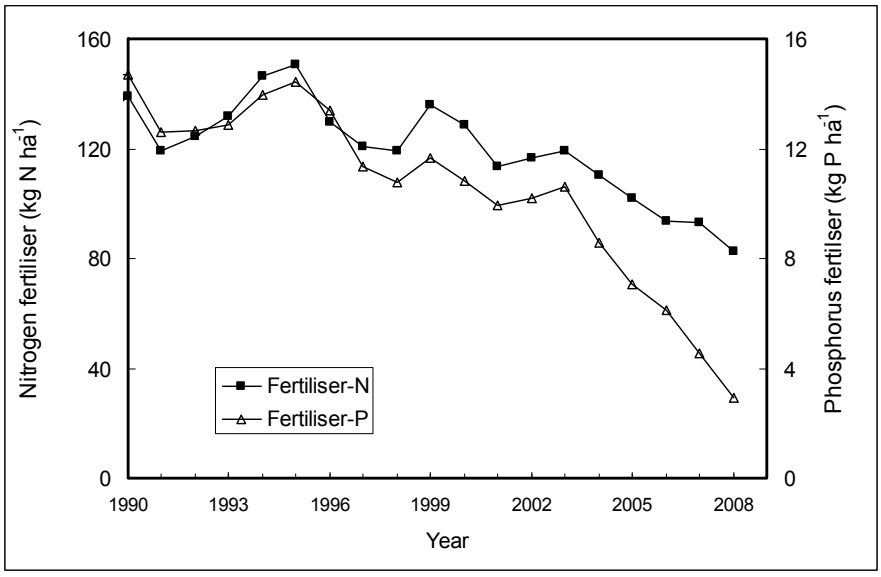

Figure 27: Trends in rates of chemical N and P fertiliser use in Northern Ireland from 1995-2008 *Rates have been normalised to the area of crops and grass in Northern Ireland*

Trends in applications of chemical P fertilisers in Figure 27 show a dramatic reduction in recent years. The rate for 2008 of 2.9 kg P/ha was unprecedented for modern agriculture in Northern Ireland as it was the lowest since 1938. When the rate for 2008 is compared to the average for the period 2004-2006, the reduction of 59% in P applied was considerably larger than that observed for N, indicating that the P Regulations (along with economic factors) had a significant impact.

Nitrogen efficiency

Taking the period 2004-2006 as a baseline for comparison with 2008, the total inputs of N to agriculture, in the form of chemical fertiliser and imported animal feedstuffs, decreased by 10.9% from 158 to 141 kg N/ha (Figure 28). This decline of 17 kg N/ha was slightly less than the decline of 20 kg N/ha in the use of N chemical fertiliser. The difference reflects an increase in the amount of N contained in imported feedstuffs for livestock. Despite the decreased input of N, outputs of N in agricultural products increased, albeit slightly, by 3.5% giving a net lowering of the N surplus of 15% (124 vs 105 kg N/ha).

As N inputs decreased while N outputs increased, the gross efficiency of N usage (the ratio of output N to input N) increased. The efficiency in 2008 was 25.3% compared to 21.7% in the 2004-2006 period. This increase may be modest but historically it is large given that throughout the period 1975-2000 the gross N efficiency remained within the range 15% to 19%.

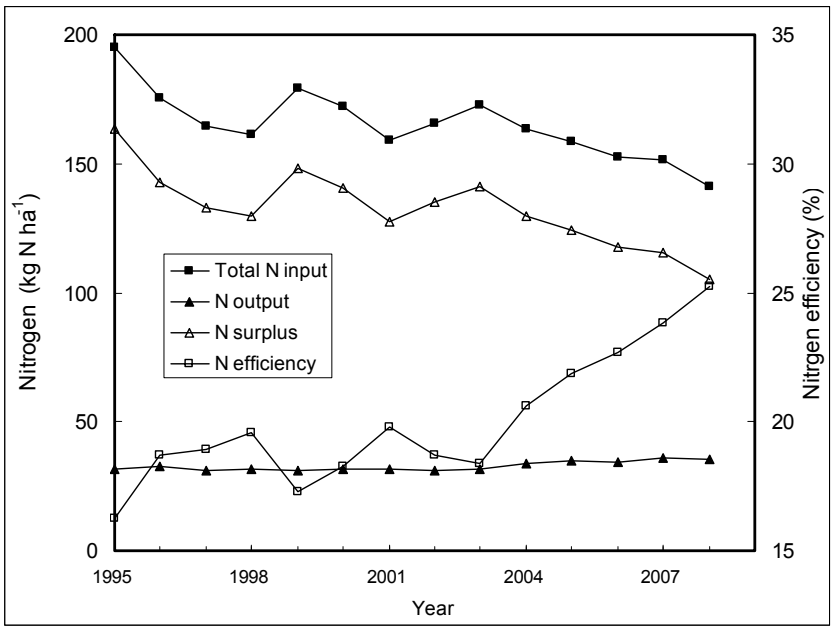

Figure 28: Time series of N inputs, outputs and surplus for agriculture in Northern Ireland *The N efficiency is plotted as the ratio of N output to N input-rates have been normalised to the areas of crops and grass in Northern Ireland*

4. IMPLEMENTATION OF 2007-2010 ACTION PROGRAMME

Following an extensive consultation the NAP Regulations, applying to all farmers across Northern Ireland, came into operation on 1 January 2007. Given that eutrophication of Northern Ireland's surface waters occurs primarily in freshwaters where phosphorus is the main contributor, the P Regulations also came into operation on 1 January 2007. These Regulations limit the application of chemical phosphorus fertiliser to crop requirement, based upon a soil analysis, and introduce land application restrictions similar to those for nitrates.

4.1 Guidance

Throughout 2006, prior to the operational date of the Regulations, press releases were placed in local industry journals explaining the impact of different elements of the new legislation. This was further supplemented in December 2006 with the issue to all farmers of a summary document covering both sets of Regulations (**Annex 4**). In early 2007 a comprehensive guidance booklet and workbook were issued to all farmers in Northern Ireland explaining the requirements of the Regulations and what action was needed to comply (**Annex 4**).

Code of Good Agricultural Practice

In Northern Ireland, the Code of Good Agricultural Practice for the Prevention of Pollution of Water, Soil and Air (the Code) was developed prior to the first designation of Nitrate Vulnerable Zones in 1999. It outlined management practices for preventing pollution of water, air and soil. The Code was first revised and updated in 2002, comprising two booklets, one of which applied specifically to water. DARD issued this 'Code' to all farmers in Northern Ireland in 2003.

Since 2003, various pieces of legislation have been introduced and implemented to protect the environment, including the NAP Regulations. DARD published a fully revised Code of Good Agricultural Practice for the prevention of pollution of water, air and soil in August 2008. Promotion included an official launch with press release, associated press articles dealing with various themes contained in the Code as well as radio interviews. Additional press articles are published on an ongoing basis to coincide with seasonal concerns such as slurry spreading and management of silage effluent. The Code is available to farmers in print, online and in CD format.

4.2 Training, Information and Advice

A wide range of training and information events on the NAP Regulations were provided for farmers in Northern Ireland.

Mid-Term Review Information Events-October 2004

In October 2004 DARD hosted 14 Mid-Term Review information events across Northern Ireland. The events were attended by about 3,000 farmer and information provided on the Single Farm Payment, Cross Compliance and specifically the requirements of the Nitrates Directive. These information events helped farmers to prepare in advance for the requirements of the NAP Regulations.

Alternative slurry spreading demonstration AFBI, Hillsborough 2006

A demonstration of alternative slurry spreading systems to the traditional splash plate was jointly organized by the Agri-Food and Biosciences Institute (AFBI) and the College of Agriculture, Food and Rural Enterprise (CAFRE) within DARD in June 2006 at AFBI Hillsborough. Trailing shoe, shallow injection, and band spreading systems were

demonstrated alongside the traditional splash plate system both on grass stubble and on two-week grass re-growths. Demonstration plots also showed the extra grass grown using trailing shoe compared to splash plate spreading systems. There were 490 attendees at this event.

Seminar for Fertiliser Suppliers and Merchants on the Nitrates and Phosphorus Regulations
This event took place at the DARD Greenmount Campus on Thursday 1st February 2007 and was attended by 51 fertiliser suppliers and merchants from across Northern Ireland. An AFBI scientist outlined the need for controls on farm nutrients and especially phosphorus. A DARD adviser explained the requirements of the NAP Regulations and the P Regulations.

Nitrates Information Meetings – Spring 2007
These meetings were held from 5th March 2007 to 10th May 2007 following the issue of the Nitrates Guidance booklets to farmers. DARD advisers delivered presentations at 151 workshops or events across Northern Ireland and these were attended by 2781 farmers.

Evaluation of the meetings showed that farmers found them to be:
Excellent 25% Very good 51% Good 21% Fair 3% Poor 1%

Nitrates Information Meetings - April 2008
These meetings were held with farmers and farmers groups who had previously indicated they were interested in this topic (1122 farmers). DARD advisers delivered presentations at 21 workshops or events and these were attended by 373 farmers.

Evaluation of the meetings showed that farmers found them to be:
Excellent 24% Very good 52% Good 22% Fair 2%

Nutrient Management Planning – Winter 2008/9
This training was delivered over two sessions by DARD advisers to farmers who applied through the reply paid postcard that was sent with the "Helping You Comply Bulletin" and also farmers who applied directly to the College. A total of 2536 farmers were invited. Advisers delivered 96 events or workshops and 1017 farmers attended.

Session 1 covered the background to nutrient management planning, soil analysis, value of manures and context in relation to the NAP Regulations. In Session 2 farmers got hands-on use on the Crop Nutrient Recommendation Calculator so they could see how they could plan phosphorus fertiliser applications for grass and nitrogen and phosphorus fertiliser for crops.

Evaluation of these sessions showed that farmers found them to be:
Excellent 24% Very good 57% Good 17% Fair 1%

Trailing Shoe Slurry Spreading Demonstrations 2007 and 2008
At the request of the Ulster Farmer's Union, a series of 25 local demonstrations of the trailing shoe slurry spreading technology were held across Northern Ireland during 2007 and 2008. Both dairying and beef farmers (1050 farmers) attended the events which featured live demonstrations and discussions on the management and economic benefits of alternative slurry spreading systems.

Nitrates Information Meetings - April 2009
These meetings were held with farmers and farmers groups who had previously indicated they were interested in this topic (210 farmers). DARD advisers delivered presentations at 7 workshops or events and these were attended by 108 farmers.

FNMS Farm Planning Consultations
In addition, DARD advisers supported the implementation of the Farm Nutrient Management Capital Grant Scheme (FNMS) which was designed to help farmers to become compliant with the livestock manure storage element of the Regulations.

Guidance on the FNMS was provided to farmers by DARD advisers both at the pre-application stage followed up by detailed consultations prior to application approval. Pre-application consultations (2830) focused on the future direction and viability of the business. Post-application consultations (2000) focused on slurry storage capacity requirements and dirty water compliance issues.

Environmental Focus Farms:
Focus farms have been selected throughout Northern Ireland to promote good practice by example. There are currently 17 of these chosen to demonstrate best environmental practice.

Other communication methods
A series of press articles for the agricultural newspapers, industry and DARD newsletters providing guidance on compliance was undertaken throughout 2006-2009. All information and frequently asked questions regarding the NAP Regulations are placed on the DARD website http://www.dardni.gov.uk/index/faq/nitrates-and-phosphorus-regualtions-2007-questions.htm.

Both DARD and NIEA have regularly attended the annual Royal Ulster Agricultural Society Winter Fair and Balmoral Agricultural Shows since 2004 to highlight issues relating to the implementation of the NAP Regulations. NIEA also attended 13 regional agricultural shows throughout 2006 and 2007 to raise awareness of the Regulations. DARD and NIEA staff also provided an ongoing range of presentations to farmers groups to promote implementation of the legislation.

In addition, a wide range of support and training has been delivered on the Derogation Regulations for farmers in Northern Ireland and are described in the "2007 and 2008 Derogation Report for Northern Ireland".

4.3 Development of Support Tools

Development of farm nutrient management calculators
DARD advisory staff took the lead in the development of a suite of five calculators that are designed to help farmers manage their farms to comply with various aspects of the NAP Regulations. The calculators are web-based and are easy to use, available 24 hours per day, secure and confidential. The details of the five calculators and a brief description of their function is given below:

- *Livestock Manure Nitrogen Loading Calculator*
  This programme enables farmers to calculate the livestock manure nitrogen loading for their farm and check if it is below the 170kg N/ha/year limit or if operating under derogation, the 250kg N/ha/year grazing livestock manure limit.

- *N Max for Grassland Calculator*
  This calculator allows farmers to check that chemical nitrogen applications to the whole grassland area on the farm do not exceed the NAP Regulations limits.

- *Crop Nutrient Recommendation Calculator*
  This programme is designed to help farmers comply with nutrient limit requirements and draw up a nutrient management plan for their farm and has the following functions:
  - determination of the amount of nitrogen (N), phosphate (P_2O_5) and potash (K_2O) nutrients required by crops;
  - calculation of the amount of nutrients supplied by organic manures and selection of the correct chemical fertiliser and application rate to ensure nutrients are optimised;
  - retention of information required for record keeping; and
  - help to reduce chemical fertiliser costs;
  - is demonstrated to and used by farmers in CAFRE's Nutrient Management Planning training courses.

- *Phosphorus Balance Calculator*
  Farms operating under the Nitrates Derogation are required to have their phosphorus (P) Balance below 10kg P/ha/year. This programme is designed to help farmers calculate the P balance for their farm and so help them manage P inputs and outputs to meet the limit.

- *Livestock Manure Storage Calculator*
  This programme will calculate the weekly slurry, dirty water, manure production and current storage capacity for the farm. It will also allow the farmer to check if they have the required 22 or 26 weeks storage or how much additional storage is needed.

Table 34 shows the number of unique users for each of these calculators up to August 2009.

Table 34: Unique web-based users of calculators up to August 2009

Calculator	Unique users at August 2009
Livestock Manure Nitrogen Loading	1050
N Max for Grassland	411
Crop Nutrient Recommendation	560
Phosphorus Balance	543
Livestock Manure Storage	1491

Adaption of APHIS (Animal and Public Health Information System)
The APHIS Online system (AoL) allows farmers to view their herd lists and carry out various functions such as registering births and deaths and authorising animal movements online. An enhancement to the AoL enables it to calculate the numbers of various classes of cattle at agreed dates throughout the year. Subsequently these values can be used to calculate average numbers of cattle for each year for the N livestock loading and average numbers of cattle during the winter for slurry and manure storage capacity. The system will hold data for previous years (2007 onwards) and it will also calculate the average number of cattle for the current year to allow the stocking rate to be monitored during the year. Over 5000 farmers have used AoL in the year ended June 2009.

4.4 Support Schemes

Farm Nutrient Management Scheme (FNMS)
The FNMS was introduced by DARD in 2005 to enable farmers to comply with the NAP Regulations and reduce water pollution by improved storage and use of livestock manures. Increased storage facilities enable farmers to spread manures when weather, soil conditions and crop uptake of nutrients are optimum. This minimises the risk of water pollution, ensuring farmers can comply with the closed period for manure spreading required by the NAP Regulations.

The FNMS provided 60% capital grant support towards the cost of building slurry and manure storage facilities, up to a maximum grant limit of £51k. The FNMS closed to applications on 31 March 2006 and some 4500 applications were received. DARD issued grant offers to 4381 farmers and 3938 farmers completed works under the Scheme. The average investment per project was approximately £50k. Facilities are built to high standards set by the Control of Pollution (Silage, Slurry and Agricultural Fuel Oil) (Northern Ireland) Regulations 2003 (SSAFO Regulations) and have a minimum 20 year design life.

The original budget of £45m was increased to £144m in 2007 to ensure that all applicants could be funded. This represents an investment of over £200m in farm infrastructure which will lead to improved water quality.

Manure Efficiency Technical Scheme (METS)
Approximately 170 offers of grant aid for the purchase of advanced slurry spreading equipment were issued in 2009 through the METS of Northern Ireland's Farm Modernisation Programme. Uptake of this grant aid and purchase of this specialised machinery will improve nutrient efficiency on farms and help to achieve farm nutrient balance targets.

If all of the 170 offers of grant aid towards advanced slurry spreading equipment under the METS capital grant scheme are fulfilled it is estimated that trailing shoe/shallow injection spreading capacity in Northern Ireland would rise to 21% of the cattle slurry produced. This calculation assumes a consistent agricultural contractor participation in equipment purchase. At the lowest, if all the METS applicants were assumed to be farmers, spreading 4000m^3 of slurry per year, the spreading capacity would still be more than doubled to over 10%.

Agri-Environment Schemes
By the close of the Northern Ireland Rural Development Programme (NIRDP) 2000-2006 some 13,000 farmers were participants in agri-environment schemes, with approximately 455,000 hectares of land or 45% of farmed area under agreement. DARD actively

promotes the agri-environment schemes and has a target to have 50% of agricultural land under environmental enhancement agreement by 2013.

The Northern Ireland Countryside Management Scheme (NICMS) is an integral part of the NIRDP 2007–2013. NICMS further enhances the agri-environment programme's ability to reduce water pollution from agricultural sources and to improve water quality on farms. Under the DARD Farm Waste Management Initiative, all NICMS applicants receive a farm nutrient and waste management advisory visit based on the principles contained in the revised Code. In addition to drawing up obligatory farm waste management plans, participants will have the option of taking up new farm waterway and riparian zone management measures aimed at helping local agriculture meet the requirements of the WFD.

5.0 COMPLIANCE WITH THE MEASURES IN 2007 AND 2008

5.1 NAP Regulations Controls in Northern Ireland

The NIEA of the Department of the Environment (DOE) is the competent authority for enforcement of the NAP Regulations along with four other environmental Statutory Management Requirements (SMRs) under Cross Compliance.

Compliance with the Regulations is assessed through on-farm inspections of records from previous years, farm facilities and fields. At least 1% of farms claiming direct aid are selected for on-farm inspections each calendar year. Up to 25% of these farms are selected randomly and the remaining 75% are selected based on criteria relevant to the five environmental SMRs. In addition to these programmed on-farm inspections, suspected breaches can also be reported by, for example, other government bodies and the general public. All such reports are also followed up.

For each inspection the NIEA officer completes an inspection form **(Annex 5)** and advises the farmer of any compliance issues at the end of the inspection. On return to the office the inspector submits the form for administrative checks. Where any non-compliance or breaches are detected the inspector also recommends any enforcement and follow-up action to be considered by a senior officer. Enforcement action may take the form of warning letters, statutory notices or prosecution depending on a number of factors relating to the breach such as extent, severity, permanence, intent or repetition. Completed inspection forms are sent to DARD, who as the paying body, will apply any reductions to direct aid payments.

5.2 Compliance with the Controls in 2007 and 2008

Table 35 shows the findings of on-farm inspections in 2007 and 2008. Non-compliance rates in 2008 were higher in general than 2007 due partly to increased reporting of breaches and to the progressive implementation of the Regulations, such as record keeping requirements.

In 2007 a total of 59 breaches were recorded against 46 farm businesses. The most significant areas of non-compliance were inappropriate storage of farmyard manure (39% of total breaches in year), pollution of waters (19%), application of organic manures too close to waters (10%), application of slurry or dirty water using inappropriate techniques (10%) and application of fertilisers to waterlogged or frozen soil, flooded or snow covered land or when rain is forecast (8%).

In 2008 a total of 209 breaches were recorded against 153 farm businesses. The most significant areas of non-compliance were pollution of waters (22% of total breaches in year), inappropriate storage of farmyard manure (18%), inadequate recording keeping (14%), application of organic manures too close to waters (14%) and application of fertilisers to waterlogged or frozen soil, flooded or snow covered land or when rain is forecast (8%).

Table 35: Results of on-farm compliance inspections in 2007 and 2008

Regulation Number	Measure Description	Total number of inspections 2007[1]	Number of breaches 2007	Total number of inspections 2008[1]	Number of breaches 2008
6.1 & 6.2	Closed periods for chemical N fertiliser application	402 (402)	0	378 (378)	0
6.3	Closed periods for organic fertiliser application	402 (402)	0	378 (378)	0
11.1 & 11.2	Sufficient and adequate storage capacity for livestock manure to avoid water pollution, including during periods of adverse weather	402 (402)	0	378 (378)	0
11.3 & 12	Pig and poultry enterprises must have at least 26 weeks storage capacity and 22 weeks livestock manure storage capacity for all other enterprises	-	Not applicable[2]	-	Not applicable[2]
11.4	Storage facilities for livestock manure and silage effluent must be maintained free of structural defect and of a standard to prevent run-off or seepage and meet SSAFO where applicable	403 (402)	1	384 (378)	12
13	Specifications for farmyard manure storage	407 (402)	19	387 (378)	31
14	Specifications for poultry litter storage	403 (402)	7	384 (378)	14
15	Provisions for dirty water storage	403 (402)	1	384 (378)	8
7.2 (f)	Restriction on N fertiliser application on steeply sloping ground	403 (402)	1	379 (378)	1

NB All breaches are recorded in year of detection

[1]Figure represents programmed inspections and those reported inspections which resulted in a confirmed breach of this measure. Figure in brackets represents programmed inspections only

[2]Not applicable due to transitional arrangement to have storage in place by 31 December 2008

[3]Not applicable as records for 2007 not available for inspection until 1 July 2008

[4]Total number of farm businesses breached

Table 35: Continued

Regulation Number	Measure Description	Total number of inspections 2007[1]	Number of breaches 2007	Total number of inspections 2008[1]	Number of breaches 2008
7.2 (a) – (e)	Prohibition on N fertiliser application to waterlogged or frozen soil, flooded or snow-covered land, or when heavy rain is forecast	407 (402)	5	394 (378)	16
18	Restrictions on land use and agricultural practices	402 (402)	0	378 (378)	0
9.2	Restriction to N crop requirement for grassland	-	Not applicable[3]	378 (378)	0
10.1	Restriction to N crop requirement for all crops other than grassland	-	Not applicable[3]	378 (378)	2
9.1 and 10.3	Livestock manure limit of 170 kg N/ha/year (or 250 kg N/ha/year if operating under derogation)	-	Not applicable[3]	378 (378)	4
7.4	Prohibition on land application of chemical N fertiliser within 1.5 m of any waterway	402 (402)	0	378 (378)	0
7.5 and 8.3	Restriction on land application of organic manures and dirty water from waterways, boreholes, wells and springs	406 (402)	6	407 (378)	30
7.1	Accurate and uniform application of N fertilisers	402 (402)	0	386 (378)	8
7.6, 7.7 and 8.2	Maximum land application of solid manures, slurry and dirty water at any one time and period between applications	403 (402)	1	378 (378)	0

NB All breaches are recorded in year of detection

[1]Figure represents programmed inspections and those reported inspections which resulted in a confirmed breach of this measure. Figure in brackets represents programmed inspections only

[2]Not applicable due to transitional arrangement to have storage in place by 31 December 2008

[3]Not applicable as records for 2007 not available for inspection until 1 July 2008

[4]Total number of farm businesses breached

Table 35: Continued

Regulation Number	Measure Description	Total number of inspections 2007[1]	Number of breaches 2007	Total number of inspections 2008[1]	Number of breaches 2008
7.8 and 8.4	Application of slurry and dirty water close to the ground by certain techniques	402 (402)	6	384 (378)	7
17	Cover in winter	402	0	378	0
19	Record keeping	402 (402)	Not applicable[3]	378 (378)	29
4	Prohibition on the entry of N fertiliser to waterways or groundwater	408 (402)	11	417 (378)	46
7.3	Prohibition on land application of N fertiliser in a location or manner likely to enter waterways or groundwater	403 (402)	1	379 (378)	1
Total	All measures	422 (402)	59 (46)[4]	466 (378)	209 (153)[4]

NB All breaches are recorded in year of detection

[1]Figure represents programmed inspections and those reported inspections which resulted in a confirmed breach of this measure. Figure in brackets represents programmed inspections only

[2]Not applicable due to transitional arrangement to have storage in place by 31 December 2008

[3]Not applicable as records for 2007 not available for inspection until 1 July 2008

[4]Total number of farm businesses breached

6.0 EVALUATION OF 2007-2010 ACTION PROGRAMME MEASURES

The following requirements of the Nitrates Directive were considered during this review:-

Article 5.4 states:
"Action programmes shall be implemented within four years of their establishment and shall consist of the following mandatory measures:

(a) the measures in Annex III;

(b) those measures which Member States have prescribed in the code(s) of good agricultural practice established in accordance with Article 4, except those which have been superseded by the measures in Annex III.

Annex II of the Directive provides further guidance on the content of the code of good agricultural practice.

Article 5.7 states:
"Member States shall review and if necessary revise their action programmes, including any additional measures pursuant to paragraph 5, at least every four years."

Article 5.5 states:
"Member States shall moreover take, in the framework of the action programmes, such additional measures or reinforced action as they consider necessary if, at the outset or in the light of experience gained in implementing the action programmes, it becomes apparent that the measures referred to in paragraph 4 will not be sufficient for achieving the objectives of Article 1."

The following section of this report follows the sequence of the measures set out in Annex III and where appropriate Annex II of the Directive and are presented in the following format:

1. The requirements of the Directive;
2. Summary of the measures in NAP Regulations*;*
3. Comments including implementation, compliance and any new scientific evidence to review the measure; and
4. SWG Recommendation:

6.1 Prohibition Periods for Fertiliser Application

Nitrates Directive
Annex III 1.1: "periods when the land application for certain types of fertilizer is prohibited;"

NAP Regulations *Regulation 6.1: Chemical Nitrogen (N) fertiliser must not be applied to grassland between 15 September and 31 January.* *Regulation 6.2: Chemical N fertiliser must not be applied to crops other than grass between 15 September and 31 January unless there is a demonstrable crop requirement.*
Comment: The length of the closed period takes account of long-term average weather patterns for Northern Ireland and is based on scientific research which indicates little benefit from applying chemical N fertiliser in the autumn and winter because there is less crop growth to use the nutrients it contains and a higher risk of causing water pollution. There were no breaches of these requirements in 2007 or 2008.
Recommendation: No change to existing regulations.

NAP Regulations *Regulation 6.3: Organic manures, excluding farmyard manure and dirty water, must not be applied between 15 October and 31 January.*
Comment: The length of the closed period takes account of long term average weather patterns for Northern Ireland and is based on scientific research which indicates little benefit from applying slurry in the autumn and winter because there is less crop growth to use the nutrients it contains and a higher risk of causing water pollution. There was a transitional arrangement in the Regulations allowing farmers to put in place the required storage capacity by 31 December 2008. As part of this transitional arrangement any farmer with insufficient storage capacity could still apply livestock manures during the closed period as long as all other measures, including those relating to environmental conditions, were met. There were no breaches of this closed period in 2007 or 2008. From 1 January 2009 all farmers must have sufficient slurry storage capacity in place and observe this closed period. This will also allow farmers to apply organic manures at the time of year to gain maximum benefit from them as fertilisers. During the development of the NAP Regulations the authorities in Northern Ireland agreed to undertake research into the impact of spreading organic manures in October and February. Relevant research projects are described in **Annex 3**.
Recommendation: No change to existing regulation.

6.2 Storage Capacity and Construction

Nitrates Directive
Annex III 1.2: "the capacity of storage vessels for livestock manure; this capacity must exceed that required for storage throughout the longest period during which land application in the vulnerable zone is prohibited, except where it can be demonstrated to the competent authority that any quantity of manure in excess of the actual storage capacity will be disposed of in a manner which will not cause harm to the environment;"

Annex II A.5: "the capacity and construction of storage vessels for livestock manures, including measures to prevent water pollution by run-off and seepage into groundwater and surface water of liquids containing livestock manures and effluents from stored plant materials such as silage;"

NAP Regulations *Regulation 11.1: The storage capacity for livestock manure shall be sufficient and adequate for all of the livestock manure which is likely to require storage on the holding for a period as may be necessary to ensure compliance with the Regulations and avoid water pollution.* *Regulation 11.2: Due regard should be given to the storage capacity likely to be needed during periods of adverse weather conditions, such as extended periods of wet weather or frozen ground, when livestock manures cannot be applied.*
Comment: There were no breaches of these requirements in 2007 or 2008.
Recommendation: No change to existing regulations.

NAP Regulations *Regulations 11.3 and 12: Pig and poultry enterprises must have at least 26 weeks storage capacity and 22 weeks for all other enterprises.*
Comment: There was a transitional arrangement in the Regulations allowing farmers to put in place the required storage capacity by 31 December 2008. There has not therefore been any assessment in 2007 or 2008 of compliance with this requirement.
Recommendation: No change to existing regulations.

NAP Regulations

Regulation 11.4: Storage facilities for livestock manure and silage effluent must be maintained free of structural defect. They must be of a standard necessary to prevent run-off or seepage directly or indirectly to a waterway or groundwater. Where applicable they must meet the Control of Pollution (Silage, Slurry and Agricultural Fuel Oil) Regulations.

Comment: In 2007 and 2008 there were 1 and 12 breaches of this regulation respectively. All breaches were considered to be of low severity and the majority involved seepage from cracks in pre-existing structures. No breaches involved recently built structures.

This area of non-compliance needs to be addressed through increased awareness of requirements through the media and training.

Recommendation: No change to existing regulation.

NAP Regulations

Regulation 13: Farmyard manure can be stored in middens or field heaps. Middens must have adequate collection facilities. Field heaps can be stored in the field where land application will take place but for no longer than 180 days. They cannot be stored in the same location of the field year after year. Farmyard manure must be stored in a compact heap and must not be stored within:

- *50m of lakes;*
- *20m of a waterway;*
- *50m of a borehole, spring or well;*
- *250m of a borehole used for a public water supply; or*
- *50m of exposed cavernous or karstified limestone features.*

Comment: In 2007 and 2008 there were 19 and 31 breaches of this regulation respectively. In 2007, all breaches were due to middens lacking adequate effluent collection facilities. In 2008, 26 breaches were also due to middens lacking adequate effluent collection facilities, with five of these being placed on permeable hard-fill. One medium severity pollution incident was recorded. A further five breaches were due to field heaps being stored in-situ for more than the 180 days.

This is an area which would benefit from raising awareness and further advice, and this will be factored into ongoing advisory activity.

Recommendation: No change to existing regulation.

NAP Regulations

Regulation 14: Up to 31 December 2010 poultry litter can be stored in middens or field heaps where land application will take place but for no longer than 180 days. Middens must have adequate collection facilities. Field heaps cannot be stored in the same location of the field year after year. Poultry litter must be stored in a compact heap, covered with an impermeable membrane within 24 hours of placement in a field and must not be stored within:

- *50m of lakes;*
- *20m of a waterway;*
- *50m of a borehole, spring or well;*
- *250m of a borehole used for a public water supply; or*
- *50m of exposed cavernous or karstified limestone features.*

Comment: In 2007 and 2008 there were 7 and 14 breaches of this regulation respectively. There were two low severity water pollution incidents noted in 2008 arising from this source. Businesses were most frequently breached for failing to cover field heaps (3 in 2007, 8 in 2008).

During the development of the NAP Regulations it became evident that off-farm solutions as alternatives to land spreading needed to be advanced, particularly for the intensive pig and poultry industries. In 2005 an expert working group, chaired by the then Chief Scientist of DARD, was established to investigate technical solutions for alternative uses of manure other than land spreading. In respect of the poultry industry, the group reviewed and endorsed the technical approach being adopted by a consortium within the industry to develop a single poultry-litter fired generator.

Progress has not been made with the off-farm solution for poultry litter on the timescale originally envisaged. With no alternative off-farm solution, poultry farmers have continued with the practice of storing poultry litter in field heaps prior to land spreading. The NAP Regulations have been amended to extend the use of poultry litter field heaps to 31 December 2010 and to allow farmers to use the quantity of poultry litter stored in temporary field heaps or middens prior to land application to be off-set against the overall storage capacity requirement (**Annex 6).**

More recently in 2009 AFBI carried out a detailed scientific assessment of technologies for the disposal of poultry litter. The report findings were that there was no evidence or recent information that would alter the original conclusion of the original 2005 expert working group report, that a centrally located combustion plant is a viable alternative use for poultry litter in Northern Ireland. This conclusion has been endorsed by two other reports:

- A feasibility study for a CHP plant produced by Integrated Energy Systems International and supported by InvestNI; and
- A report commissioned by SNIFFER (Scottish and Northern Ireland Forum for Environmental Research) entitled “The Methods for Disposal or Processing of Waste Streams from Intensive Livestock Production in Scotland and Northern Ireland”.

However, the Northern Ireland authorities continue to monitor new technologies which are

being developed for the disposal of poultry litter.

Whilst a consortium, has submitted a planning application for a poultry litter fired generator, no decision has been made on the application to date.

Recommendation: The authorities in Northern Ireland will review proposals for the sustainable use of poultry litter following the planning decision on a poultry litter fired generator and amend this measure accordingly in support of the WFD programme of measures to be operational by December 2012.

NAP Regulations

R*egulation 15: Safe storage of dirty water should be available for periods when weather and ground conditions set out in Regulation 7.2 prevent land application.*

Comment: During the development of the NAP Regulations the authorities in Northern Ireland also agreed to undertake research into options to better manage dirty water. Relevant research projects are described in **Annex 3.**

In 2007 and 2008 there were 1 and 8 breaches of this regulation respectively. Most breaches of this regulation were detected in conjunction with other breaches related to application, in particular under regulation 7.2, spreading on water logged ground.

This is an area which would benefit from raising awareness and further advice, and this will be factored into ongoing advisory activity.

Recommendation: No change to existing regulation.

.

NAP Regulations

Regulation 16: In calculating livestock manure storage capacity the following practices can be taken into account:

- *quantity of farmyard manure;*
- *solids removed by slurry separator except for pig slurry;*
- *additional rented storage;*
- *valid contract with a manure processing facility or access to approved treatment or recovery outlets;*
- *outwintering; and*
- *poultry litter stored in a field or a midden prior to land spreading.*

Comment: As described above this regulation was amended to allow farmers to use the quantity of poultry litter stored in temporary field heaps or middens prior to land application to be off-set against the overall storage capacity requirement. This requirement will need to be revisited in light of an agreed solution to the storage and use of poultry litter.

There do not appear to be any other issues with this regulation.

Recommendation: Poultry litter aspect may need amendment.

6.3 Restrictions on the Application of Fertilisers on Steeply Sloping Ground

Nitrates Directive
Annex III.3: "limitation of the land application of fertilisers, consistent with good agricultural practice and taking into account the characteristics of the vulnerable zone concerned, in particular:

(a) soil conditions, soil type and slope;"

Annex II A.2: "the land application of fertilizer to steeply sloping ground;"

NAP Regulations *Regulation 7.2 (f): Nitrogen fertiliser must not be applied to steeply sloping land where taking into account other factors such as proximity to waterways, soil condition, ground cover and rainfall there is a significant risk of water pollution.*
Comment: There was a single breach of this regulation in both 2007 and 2008. This is an uncommon problem.
Recommendation: No change to existing regulation.

6.4 Restrictions Based on Climatic Conditions

Nitrates Directive
Annex III.3: "limitation of the land application of fertilizers, consistent with good agricultural practice and taking into account the characteristics of the vulnerable zone concerned, in particular:

(b) climatic conditions, rainfall and irrigation;"

Annex II A.3: "the land application to water saturated, flooded, frozen or snow-covered ground;"

NAP Regulations *Regulation 7.2 (a)-(e): Nitrogen fertiliser must not be applied when soil is waterlogged; land is flooded or likely to flood; soil have been frozen for 12 hours or longer in the preceding 24 hours; land is snow-covered; or heavy rain is forecast within 48 hours.*
Comment: In 2007 and 2008 there were 5 and 16 breaches of this regulation respectively. Breaches in both years related to N fertiliser being spread on waterlogged ground, with one incident in 2008 being deemed of medium severity due to slurry entering a waterway. This area of non-compliance needs to be addressed through increased awareness of requirements through the media and training.
Recommendation: No change to existing regulation.

6.5 Restrictions Based on Land Use and Agricultural Practices

Nitrates Directive
Annex III.3: "limitation of the land application of fertilizers, consistent with good agricultural practice and taking into account the characteristics of the vulnerable zone concerned, in particular:

(c) land use and agricultural practices, including crop rotation systems;"

Annex II B.7: land use management, including the use of crop rotation systems and the proportion of the land area devoted to permanent crops relative to annual tillage crops;"

NAP Regulations *Regulation 18: The following principles of crop management shall apply:* a) *residues of crops harvested late, e.g. maize and potatoes, shall be left undisturbed until immediately prior to sowing the following spring; and* b) *where grass leys are grown in rotation with arable crops the first crop should be sown as soon as possible after the grass has been ploughed.*
Comment: There were no breaches of these requirements in 2007 or 2008.
Recommendation: No change to existing regulation.

6.6 Restrictions Based on Crop Requirement

Nitrates Directive
Annex III.3: "limitation of the land application of fertilizers, consistent with good agricultural practice and taking into account the characteristics of the vulnerable zone concerned, in particular:

…and to be based on a balance between:

(i) the foreseeable nitrogen requirements of the crops, and

(ii) the nitrogen supply to the crops from the soil and from fertilization corresponding to:

- **the amount of nitrogen present in the soil at the moment when the crop starts to use it to a significant degree (outstanding amounts at the end of winter),**
- **the supply of nitrogen through net mineralization of the reserves of organic nitrogen in the soil,**
- **additions of nitrogen compounds from livestock manure,**
- **additions of nitrogen compounds from chemical and other fertilizers."**

NAP Regulations *Regulation 9.2: The total available nitrogen in organic manures and chemical fertiliser, excluding livestock manures, applied to grassland shall be in proportion to the crop requirement and not exceed the amounts in Schedule 1 Table 4 when calculated in accordance with paragraphs 5, 6 and 7.*
Comment: Assessment of compliance against this regulation can only be made in the following calendar year as records are not available for inspection until 1 July of the following calendar year. Inspection of records in 2008 showed no breaches of this regulation in 2007. Fertiliser sales trends (Section 3.3) would also indicate a general decline in the use of chemical N fertiliser.
Recommendation: No change to existing regulation.

NAP Regulations

Regulation 10.1: The total nitrogen fertiliser applied to crops other than grassland shall not exceed the crop requirements for nitrogen when calculated in accordance with paragraphs 4 to 8 (Schedule 1 Tables 1, 2, 3, and 6).

Comment: : Assessment of compliance against this regulation can only be made in the following calendar year as records are not available for inspection until 1 July of the following calendar year.

Inspection of records in 2008 showed 2 breaches of this regulation in 2007. Both breaches were high severity, with crop requirements exceeded by over 30%. These breaches appear to reflect lack of knowledge of the requirements of the maize fodder crops involved and failure to take account in the nutrient supplied by organic manures. Further training and advice in this area will be factored into ongoing advisory activity.

Fertiliser sales trends however (Section 3.3) would indicate a general decline in the use of chemical N fertiliser.

Recommendation: Proposed revision of pig excretion values in Schedule 1 Table 1 as described under section 6.7. No other change to existing regulation.

6.7 Livestock Manure Application Limits

Nitrates Directive
Annex III.2: "These measures will ensure that, for each farm or livestock unit, the amount of livestock manure applied to the land each year, including by the animals themselves, shall not exceed a specified amount per hectare.

The specified amount per hectare be the amount of manure containing 170 kg N."

Annex III.3: "Member States may calculate the amounts referred to in paragraph 2 on the basis of animal numbers."

NAP Regulations
Regulations 9.1 and 10.3: The amount of total nitrogen in livestock manure applied to the agricultural area of the holding, both by land application and by the animals themselves shall not exceed 170 kg N/ha/year when calculated in accordance with paragraphs 9.3 and 9.4 or 10.4 and 10.5 (Schedule 1 Tables 1, 2 and 3) NB 250 kg N/ha/year grazing livestock manure if operating under derogation
Comment: Assessment of compliance against these regulations can only be made in the following calendar year as records are not available for inspection until 1 July of the following calendar year. Inspection of records in 2008 showed four breaches of this regulation in 2007, by farms operating under derogation conditions. Two breaches were due to excess application of grazing livestock manure by up to 120% of total N loading (i.e. up to 300kg N/ha/year). Both of these farms failed to provide evidence of the control of sufficient land for their grazing livestock manure loading. The breaches on the other two farms were due to the excess application of non-grazing livestock manure i.e. pig and poultry manure by up to 130% of total N loading (i.e. up to 221kg N/ha/year). AFBI has recently conducted research which investigated the effect of protein levels in diets of finishing pigs and the subsequent effect on nitrogen excretion levels. The results have shown that finishing pigs excrete less nitrogen than the values quoted in the NAP Regulations. In reviewing the area, AFBI has also suggested that the values for sows and weaning pigs, quoted in the DEFRA 2008 Nitrates Action Programme be adopted. The NAP Regulations were based on a previous publication by DEFRA (2003) and the values quoted then for nitrogen excretion did not take full account of the nitrogen lost through volatilisation. However, the current DEFRA Nitrates Action Programme has now taken account of volatilisation. The scientific case to support these changes is given in **Annex 7.**

Recommendation: It is proposed that the values given in Schedule 1 Table 1 be changed according to the following table:

	NAP Regulations	DEFRA 2008 Nitrates Action Programme	Proposed values
Sows + litter	**19.5**	**15.9**	**As for DEFRA**
Boar	**16.0**	**17.5**	**As for DEFRA**
Gilt	**13.0**	**11.1**	**As for DEFRA**
Weaner 1	**0.26 (7-18 kg)**	**0.09 (7-12 kg)**	**As for DEFRA**
Weaner 2	**0.46 (18-35 kg)**	**0.29 (13-30 kg)**	**As for DEFRA**
Grower	**Not given**	**1.1(31-65 kg)**	**0.87 (31-65 kg)**
Finisher	**2.69 (35-105 kg)**	**1.45(66-100 kg)**	**1.14 (66-100 kg)**
Total (wean to 100 kg)	**3.41**	**2.93**	**2.39**

No other change to existing regulation.

6.8 Restrictions for Application near Watercourses

Nitrates Directive
Annex II A.4: "the conditions for land application of fertilizer near water courses;"

NAP Regulations *Regulation 7.4: The land application of chemical fertiliser shall not be permitted within 1.5 m of any waterway.*
Comment : There were no breaches of this requirement in 2007 or 2008.
Recommendation: No change to existing regulation**.**

NAP Regulations *Regulations 7.5 and 8.3: The land application of organic manures and dirty water shall not be permitted within:-* *a) 20m of lakes; or* *b) 50m of a borehole, well or spring; or* *c) 250m of a borehole, well or spring used for a public water supply; or* *d) 15m of exposed cavernous or karstified limestone features (such as swallow holes and collapse features); or* *e) 10m of any waterway, other than lakes, including open areas of water, open field drains, or any drain which has been backfilled to the surface with permeable material such as stone/aggregate; except that* *f) the distance for (e) may be reduced to 3m of any waterway where the land has an average incline less than 10% towards the waterway and where:* *i. organic manures are spread by bandspreader, trailing hose or trailing shoe or soil injection; or* **ii.** *the adjoining area is less than 1 ha or not more than 50m wide.*
Comment: In 2007 and 2008 there were 6 and 30 breaches of these regulations respectively. In 2007, breaches related to spreading within 10m of waterways. In 2008, all breaches involved spreading within 10m of waterways, with the exception of one instance of spreading within 50m of a well. This area of non-compliance needs to be addressed through increased awareness of requirements through the media and training.
Recommendation: No change to existing regulations**.**

6.9 Conditions for Uniformity and Rate of Land Application

Nitrates Directive
Annex II A.6: "procedures for the land application, including rate and uniformity of spreading, of both chemical fertilizer and livestock manure, that will maintain nutrient losses to water at an acceptable level;"

NAP Regulations *Regulation 7.1: The land application of nitrogen fertilisers shall be done in an accurate and uniform manner.*
Comment: In 2007 there were no breaches of this regulation, whilst in 2008, 8 breaches were recorded. The breaches in 2008 related to the release of slurry from a single point in the field with no effort made to spread. This is an area that would benefit from increased awareness.
Recommendation: No change to existing regulation**.**

NAP Regulations *Regulations 7.6, 7.7 and 8.2: The maximum land application of solid manures and slurry at any one time shall be 50 t/ha and 50m^3/ha respectively provided this does not exceed 107 kg N/ha and a period of at least 3 weeks shall be left between such applications. The maximum land application of dirty water at any one time shall be 50m^3/ha and a period of at least 2 weeks shall be left between such applications.*
Comment: In 2007 there was one breach of this regulation, whilst in 2008, no breaches were recorded. This is an uncommon problem.
Recommendation: No change to existing regulation.

NAP Regulations
Regulations 7.8 and 8.4: The land application of slurry and dirty water shall only take place by spreading close to the ground using inverted splash plate spreading, bandspreading, trailing hose, trailing shoe, soil injection or soil incorporation methods and in the case of dirty water only by irrigation.
Comment: During the development of the NAP Regulations the authorities in Northern Ireland agreed to undertake research into minimising phosphorus losses. Relevant research projects are described in **Annex 3.** In 2007 and 2008 there were 6 and 7 breaches of these regulations respectively. Upward-facing splash-plates remain the commonest cause of breach. From discussions in mid-2008 with the main agents and manufacturers of advanced slurry spreading equipment, it was estimated that there were approximately 45 trailing shoe/shallow injection slurry tankers in Northern Ireland. Of these, 27 were owned by farmers and 18 by contractors. Over 90% of the machines were thought to be trailing shoe. Based on this information along with assumptions on the types of farm and slurry production rates involved, it was estimated that the trailing shoe/shallow injection spreading capacity in Northern Ireland was about 4% of the cattle slurry produced in mid-2008. Approximately 170 offers of grant aid towards advanced slurry spreading equipment were issued in 2009 through the METS of Northern Ireland's Farm Modernisation Programme. Uptake of this grant aid and purchase of this specialised machinery will improve nutrient efficiency on farms and help to achieve farm nutrient balance targets. If all of the 170 offers of grant aid towards advanced slurry spreading equipment under the METS capital grant scheme are fulfilled it is estimated that trailing shoe/shallow injection spreading capacity in Northern Ireland would rise to 21% of the cattle slurry produced. At the lowest, if all the METS applicants were assumed to be farmers, spreading 4000m^3 of slurry per year, the spreading capacity would still be more than doubled to over 10%.
Recommendation: No change to existing regulations.

6.10 Vegetation Cover in Winter and During Rainy Periods

Nitrates Directive
Annex II B.8: "the maintenance of a minimum quantity of vegetation cover during (rainy) periods that will take up the nitrogen from the soil that could otherwise cause nitrate pollution of water;"

NAP Regulations
Regulation 17: After harvesting a crop of cereals (other than maize), oil seeds or grain legumes (ego pea or beans) the controller shall ensure that from harvest until 1 March the following year one of the following conditions is met on the land at any one time: *a) the stubble of the harvested crop remains in the land; or* *b) the land is sown with a crop which will take up nitrogen from the soil; or* **c)** *the land is left with a rough surface, ploughed or disced, to encourage infiltration of rain.*
Comment: There were no breaches of these requirements in 2007 or 2008.
Recommendation: No change to existing regulation.

6.11 Record Keeping

Nitrates Directive
Annex II B.9: "the establishment of fertilizer plans on a farm-by-farm basis and the keeping of records on fertilizer use;"

NAP Regulations

Regulation 19: The control shall keep sufficient records for inspection so as to allow the following information to be ascertained on an annual basis:-

a) the controller of the land for the calendar year;
b) the total agricultural area of the holding, including size and location of each field;
c) cropping regimes and their individual areas;
d) soil nitrogen supply index for crops other than grass estimated in accordance with fertiliser technical standards;
e) the number of livestock kept on the holding, including species, type and length of time kept on the holding;
f) the capacity of livestock manure storage and where applicable details of rented storage, farmyard manure production, out wintered livestock, manure separation and manure processing facilities utilised;
g) details of any rental or contractual agreement to demonstrate compliance with regulations 16.1c or 16.1d;
h) the quantity of each type of nitrogen fertiliser moved on or off the holding, the amount of each type of nitrogen fertiliser applied, the certified nitrogen content of chemical fertiliser, the total nitrogen content per tonne of organic manures as declared under regulations 9.5 and 10.6, the date of that movement, and in the case of organic manures the name and address of the consignee, the consignor and any third party transporter of manure; and
i) evidence of right to graze common land.

Records shall be prepared for each calendar year by 30 June of the following year and retained for a period of 5 years from that date.

Comment: Assessment of compliance could only be made for the first time in 2008 as records for the calendar year do not have to be available for inspection until 1 July of the following calendar year.

There were 29 breaches of record keeping requirements in 2008. Eight breaches were of high severity, with a total lack of records preventing any assessment. There were 9 medium severity breaches, allowing only partial assessment. Most breaches were due to a lack of understanding of record-keeping requirements.

Further ongoing training and engagement with the agricultural media and interest groups is required to ensure that this problem is addressed.

Recommendation: No change to existing regulation

6.12 Prevention of Water Pollution

Nitrates Directive
Annex II B.10: "the prevention of water pollution from run-off and the downward movement beyond the reach of roots in irrigation systems."

NAP Regulations *Regulation 4: The controller of a holding shall not knowingly or otherwise cause directly of indirectly the entry of nitrogen fertiliser into any waterway or groundwater.*
Comment: In 2007 and 2008 there were 11 and 46 breaches of this regulation respectively. These breaches were usually recorded in association with other breaches. In 2008, 12 breaches were of medium severity. The increase in 2008 appears to be related to increasing awareness particularly among fieldstaff.
Recommendation: No change to existing regulation

NAP Regulations *Regulation 7.3: The land application of nitrogen fertiliser shall not be permitted on any land in a location and manner which would make it likely that the nitrogen fertiliser will directly enter a waterway or groundwater.*
Comment: There was a single breach of this regulation in both 2007 and 2008. There would appear to be few circumstances which are not already covered by other regulations.
Recommendation: No change to existing regulation

7.0 FEEDBACK FROM STAKEHOLDER MEETING AND WORKSHOP

The Departments held a meeting and workshop with stakeholders at AFBI Hillsborough on 24 November 2009, presenting the findings of the review to date and seeking input from stakeholders of their experiences of the action programme **(Annex 8)**. During the workshop sessions participants were asked to give their views on four questions. Feedback is summarised below and will be considered in the ongoing review process.

QUESTION 1 - What has worked well during the implementation of the Action Programme to date?

Stakeholders felt that good communication prior to the commencement of the NAP avoided problems in the "lead-in" period. Also, that engagement between government departments, industry and environmental non-government organisations (NGO's) has worked well. It is important that stakeholder engagement continues and representation is kept as wide as possible.

Training and education for farmers provided by DARD had been valuable. It has resulted in increased awareness, improvements in working practice and efficiency. There has also been a change in the mindset of farmers. For example, slurry is now recognised as a valuable resource and there has been a reduction in the use of phosphorus fertiliser.

Stakeholders acknowledged the significant investment of £200 million through the FNMS with farmers investing over £80 million of this. They recognised this as a real demonstration of farmers' commitment to the environment and sustainable good farming practice. Stakeholders also recognised the benefits of METS.

QUESTION 2 - What hasn't worked well during the implementation of the Action Programme to date and what could be done to improve it?

Stakeholders felt it is important to emphasise that RB209 should not be used for a regulatory purpose. Also, that is very complex. Farmers need clarification on soil maps and there is a lack of soil science data available to farmers.

Whilst it was recognised that training and education to date has been valuable, it was the general consensus that it needed to continue to build wider knowledge and in particular awareness of compliance on spreading slurry outside the closed period and the effect of slurry spreading on climate change.

It was suggested that a Helpline service should be provided by NIEA and DARD as farmers need a clear message on how to deal with exceptional and unforeseen circumstances.

It was also suggested that to encourage uptake in training by farmers, attendance could be a condition of receipt of Single Farm Payment.

There were a few concerns about record keeping. It was felt that guidance is complicated in parts and therefore farmers need more help and encouragement with records.

Also, derogation fertiliser accounts procedures need to be simplified and made more "farmer-friendly". The amount of records required for crops is not relative to impact on environment.

The following general points were discussed:

- more emphasis needed on enforcement;

- resolution of the poultry litter storage issue and the wider sustainable use of poultry litter;
- research results should be disseminated to industry when available;
- the need for more advice on the requirements of the derogation; and
- breaches need to be linked to advice and training by NIEA and CAFRE.

QUESTION 3 - Is there any evidence that has not been considered in relation to any of the NAP measures?
Stakeholders felt that evidence of the following has not been considered in relation to the NAP measures:

- there is no correlation of soil analysis data and that national dataset of soil analysis is missing;
- the calculation of atmospheric NH_4 losses and monitoring of ammonia levels needs to be considered;
- it is considered there are knowledge gaps in the nitrogen cycle under crops (maize);
- consideration needs to be given to the breakdown of pollution incidents caused by other industries outside farming;
- an attitude survey of farmers may be worthwhile;
- effect on greenhouse gases;
- denitrification in the soil; and
- the application of nitrification inhibitors to improve efficiency.

QUESTION 4 - What are your views on future stakeholder engagement?
All Stakeholders shared the opinion that the engagement process is very worthwhile and it is vital that it continues into the future.

In relation to future meetings, they should be round table format with less formal presentations. AFBI Hillsborough was considered to be a suitable venue.

Stakeholders proposed the next meeting should be after the EU meetings in January 2010 and again after the consultation period to assess feedback and deal with the detail.

The consultation period could be used as an opportunity to reinforce the message of the NAP.

Northern Ireland has established a good scientific evidence-based approach and stakeholders would like to see a copy of the NAP Review report that is being presented to the European Commission.

8. CONCLUSIONS AND RECOMMENDATIONS

The NAP Regulations came into operation on 1 January 2007. The Regulations contained some transitional arrangements on closed spreading periods and manure storage requirements and therefore all measures have only been operational from 1 January 2009.

Surface freshwaters and groundwaters in Northern Ireland continue to have nitrate levels well below the 50 mg NO_3/l limit. Comparing data between the periods 2001-2004 and 2005-2008 indicates that the majority of sites are showing stabilisation in nitrate concentrations. There are still a very small number of groundwater sites with average concentrations greater than 50 mg NO_3/l situated in areas which were previously designated in 1999 and 2003 as NVZs.

Long-term seasonal trend analysis showed that the monthly trends in average nitrate concentrations in rivers in Northern Ireland were predominantly decreasing or stable over the 15-year period, 1994-2009. The most significant decreasing trends occurred in the winter months December to March. Seasonal trend analysis also showed that the direction of monthly trends of average phosphorus concentrations in rivers in Northern Ireland was predominantly decreasing or stable over the nine year period, 1999-2009. The most significant decreasing trends occurred between April and September.

Since the adoption of the WFD in 2000, new methodologies and criteria for assessment of trophic status in rivers, lakes and marine waters have been developed.

Overall WFD assessment for all three trophic indicators together indicates that eutrophication continues to be a problem in rivers in Northern Ireland. This is in agreement with previous assessments under the Nitrates and UWWT Directives and is borne out when considering each trophic indicator separately. Despite the majority of water bodies being classed as High/Good for phosphorus, both macrophyte and diatom classifications suggest that the plant and algal communities in the majority of river water bodies continue to show signs of response to nutrient pressures with a large proportion being Moderate or Poor status suggesting enrichment to some degree. It is possible that biological components within rivers may not yet have responded to reductions in nutrient loading to river water bodies, and changes in trophic status will need to be monitored over a longer time period.

The assessment of 27 surveillance lakes under the WFD in 2006-2008 confirms that the majority (70%) of lakes in Northern Ireland continue to display trophic conditions indicative of nutrient enrichment, including the three largest lakes, Lough Neagh and Lower and Upper Lough Erne. This is in agreement with previous assessments carried out in 2000-2005 using the OECD classification. The lack of change in lake systems may not be unexpected for a variety of reasons including differences highly related to individual lake typologies e.g. flushing times of these systems and the release of phosphorus reserves already built up in sediments.

The assessment of coastal and transitional waters under the WFD in 2007-2009 broadly aligns with previous assessments under both the Nitrates and UWWT Directives. The sites that are definitely at Moderate or worse for trophic status are Belfast Harbour, Quoile Pondage and the Tidal Lagan. Sites which have failed the DIN criteria but passed the biological criteria will invoke the ‘checking procedure’ to refine classification before further measures are required. As the marine receiving waters are at the very end of the catchment, it is anticipated that improvements will be slowest to manifest in these areas.

The results of water quality assessments are not unexpected, given that nearly all assessments are based on water quality up to 2008 i.e. prior to operation of all measures within the NAP Regulations on 1 January 2009.

Northern Ireland farming continues to be a predominantly grass-based system. In general the numbers of sheep and pigs on farms in Northern Ireland are declining, whilst cattle numbers remain stable and poultry numbers are increasing.

Fertiliser purchases in Northern Ireland have significantly declined in recent years. The level of sales of nitrogen and phosphate-based fertilisers in 2008 were at their lowest since 1975 and 1938 respectively. Nitrogen inputs to farms in Northern Ireland have decreased while outputs increased, therefore increasing the gross efficiency of nitrogen use. Whilst the increase is modest historically it is large compared to the levels throughout the period 1975 -2000.

Compliance with many measures has been very good. There are some key areas of non-compliance including record keeping, farm yard manure storage and P balances for derogated farms. Other measures such as applications near waterways or using inappropriate techniques show lower levels of non-compliance. It is recommended that awareness of these issues continues to be raised through the media and training.

A comprehensive programme of research has been put in place in recent years to address some outstanding issues in relation to a number of the measures and to provide additional information as to how soils and water quality are responding to the measures.

Stakeholder engagement has played a key role in the development and implementation of the NAP to date in Northern Ireland. A stakeholder event was held on 24 November 2009 presenting the findings of the review to date and seeking input from stakeholders of their experiences of the action programme. Overall the event was considered to have been a success and all present agreed that continued stakeholder engagement is vital. Stakeholders were content that the majority of issues raised are being addressed by the current NAP. The Departments will consider the suggestions made by stakeholders on how to improve the implementation of the NAP during the ongoing review and consultation process.

The SWG has considered all of the information in this Report and the following are the key conclusions and recommendations of the Group:

- the NAP Regulations have been in place from 1 January 2007, and all measures have been operational from 1 January 2009;
- nitrate levels in surface freshwaters and groundwater appear to be generally stable;
- long-term trend analysis shows that the monthly trends in average nitrate and phosphorus concentrations in rivers in Northern Ireland are predominantly decreasing or stable;
- there is still evidence of eutrophication in rivers, lakes and marine waters;
- it will take longer for a response to be detected in biological indicators of trophic status and in lakes and marine waters;
- trends in fertiliser use and improved use of manures are very encouraging;

- compliance with measures is generally good;
- some keys areas require further awareness and training to improve compliance;
- the research programme should continue to be funded over the next NAP period to inform the next review;
- the NAP measures for 2007-2010 should be carried forward into the NAP for 2011-2014 with minimal change to allow time for the existing measures to “bed-in” and for sufficient data to be collected to determine environmental response;
- the values for pig excretion rates should be updated in the NAP Regulations for 2011-2014;
- the authorities in Northern Ireland should review proposals for the sustainable use of poultry litter;
- stakeholder engagement should continue to play a key role in the development and implementation of the NAP 2011-2014; and
- the development and implementation of the NAP 2011-2014 should continue to incorporate Better Regulation principles.

REFERENCES

Bailey, J.S. (2005). The Effect of Action Programme Measures on Manure Nitrogen Efficiency and Fertiliser N-usage. *Discussion Paper 17th November 2005.* DARD, Agricultural, Food and Environmental Science Division.

Betts, N.L. (1997). Climate. In: Cruickshank, J.G. (Ed.) *Soil and Environment: Northern Ireland* pp 63-84. Agricultural and Environmental Science Division, Department of Agriculture for Northern Ireland.

British Standard EN 13946: 2003. Water Quality – Guidance standard for the routine sampling and pretreatment of benthic diatom samples from rivers.

British Standard EN 14184: 2003. Water Quality – Guidance standard for the surveying of macrophytes in running waters.

British Standard EN 14407: 2004. Water Quality – Guidance standard for the identification, enumeration and interpretation of benthic diatom samples from running waters.

Butler, C.J., Coughlin, A.D.S & Fee, D.T. (1998). Precipitation at Armagh Observatory 1838-1997. *Biology and Environment 98B*: 123-140.

Cardoso, A. C., Solimini, A., Premazzi, G., Carvalho, Lyche, L. & Rekolainen, S. (2007). Phosphorus reference concentrations in European Lakes. *Hydrobiologica 584: 3-12*

CEN (2003a). Water Quality – Guidance Standard for the Routine Sampling and Pretreatment of Benthic Diatoms from Rivers. *EN 13946: 2003*. Geneva: Comité European de Normalisation.

CEN (2003b). Water Quality – Guidance Standard for the Surveying of Aquatic Macrophytes in Running Waters. *EN 14184:2003*. Geneva: Comité European de Normalisation.

CEN (2004). Water Quality – Guidance Standard for the Identification, Enumeration and Interpretation of Benthic Diatom Samples from Running Waters. *EN 14407:2004.* Geneva: Comité European de Normalisation.

Charlesworth, M., Taylor, J. and Service, M. (2001). Nutrient Inputs and Trophic Status of Lough Foyle. *Contract Report to EHS.*

DARD-DOE (2002). Report on the Environmental Aspects of the Nitrates Directive in Northern Ireland. Department of Agriculture for Northern Ireland and Department of Environment for Northern Ireland, Belfast.

DEFRA (2002). UK supplement to agreed criteria for identifying sensitive areas (Eutrophic) and polluted waters (eutrophic). Department of Environment and Rural Affairs, UK.

DOENI (1993). Methodology for identifying sensitive areas (Urban Waste Water Treatment Directive) and designating vulnerable zones (Nitrates Directive) in Northern Ireland. *Consultative Document of the Department of the Environment for Northern Ireland,* Environment Service, Belfast.

DOENI, (1999). The Urban Waste Water Treatment Regulations (Northern Ireland) 1995. Working Document for Dischargers and Regulator. *A guidance note issued by the Department of the Environment (Northern Ireland).*

Foy, R.H., Bailey, J.S. & Lennox, S.D. (2002). Mineral Balances for the Use of Phosphorus and Other Nutrients by Agriculture in Northern Ireland from 1925 to 2000 – methodology, trends and impacts of losses to water. *Irish Journal of Agricultural and Food Science 41*: 247-264.

Free, G., Little, R., Tierney, D., Donnelly, K. & Caroni, R. (2007). A Reference based typology and ecological assessment system for Irish Lakes – preliminary investigations. *ERTDI Report 57. 2007* University College Dublin.

Gibson C.E. & Jordan, C. (2004). A Synoptic Survey of Lakes in Northern Ireland. Report to Environment and Heritage Service, Department of Environment for Northern Ireland, Queens University Belfast and Science Service, Department of Agriculture for Northern Ireland.

Hirsch, R.M., J.R. Slack, & R.A. Smith. (1982). Techniques of trend analysis for monthly water quality data. *Water Resources Research 18*:107-121.

Holmes, N. T. H. (1995). Macrophytes for Water and Other River Quality Assessments. A *Report to the National River Authority. March 1995.* National Rivers Authority, Peterborough.

Holmes, N. T. H., Newman J. R., Chadd, S., Rouen, K. J., Saint, L. & Dawson F. W. (1999). Mean Trophic Rank: A user's manual. *R & D Technical Report E38*. Environment Agency, Bristol.

Kelly, M.G. & Whitton, B.A. (1995). The Trophic Diatom Index: a new index for monitoring eutrophication in rivers. *Journal of Applied Phycology 7*, 433 – 444.

Kelly, M.G, Adams, C, Graves, A.C, Jamieson, J, Krokowski, J, Lycett, E. B, Murray-Bligh, J, Pritchard, S, & Wilkins, C. (2001). The Trophic Diatom Index: A user's manual. Revised Edition, Environment Agency, UK.

Kelly, M. G., S. Juggins, H. Bennion, A. Burgess, M. Yallop, H. Hirst, L. King, J. Jamieson, R. Guthrie & B. Rippey, (2006). Use of diatoms for evaluating ecological status in UK freshwaters. Environment Agency, Bristol.

Kelly, M. G., S. Juggins, R. Guthrie, S. Pritchard, B. J. Jamieson, B. Rippey, H. Hirst & M. L. Yallop, (2008). Assessment of ecological status in U.K. rivers using diatoms. *Freshwater Biology 53:* 403–422.

MPMMG, (1997). Comprehensive Studies for the Purposes of Article 6 & 8.5 of DIR 91/271 EEC, The Urban Waste Water Treatment Directive. Comprehensive Studies Task Team.

Official Journal of the European Community. (1991a). Council Directive of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources. (91/676/EEC, Brussels).

Official Journal of the European Community. (1991b). Council Directive of 21 May 1991 concerning urban waste water treatment (91/271/EEC, Brussels).

Official Journal of the European Union, (2000). Directive 2000/60/EC of the European Parliament and the Council of 23 October 2000 establishing a framework for Community action in the field of water policy. Official Journal issue L 327, 1-72. Water Framework Directive 2000.

OECD, (1982). Eutrophication of waters, monitoring, assessment and control. Organisation for Economic Co-operation and Development, Paris, France.

RB209 DEFRA, (2000). Fertiliser Recommendations for Agricultural and Horticultural Crops, 7th Edition.

Service, M., Durrant, A.D., Mills, J. & Taylor, J. (1996). The Trophic Status of Two Northern Ireland Sea Loughs. *Journal of Coastal Conservation, 2(1)*: 159-165.

Service, M. (2000). Remote Monitoring of Belfast Lough. The *In-situ* Monitoring of Water Quality in Belfast Lough. *Contract Report to EHS.*

Taylor, J., Charlesworth, M. & Service, M. (2001). Nutrient Inputs and Trophic Status of Carlingford Lough. Nutrient Inputs and Trophic Status of Carlingford Lough. *Report to EHS.*

UKTAG, (2008). UK Environmental Standards and Conditions (Phase 1), Final Report., *Internal Document prepared by UK Technical Advisory Group on the Water Framework Directive.*

Vighi, M. & G. Chiauani, 1985. A simple method to estimate lake phosphorus concentrations resulting from natural, background, loadings. Water Research 19: 987–991.

Willby, N.J., Pitt, J & Phillips G. L. (2009). Development of a system for the classification of rivers and lakes in the UK using aquatic macrophytes. Part 2 Rivers. *Environment Agency Science Report.*

GLOSSARY OF ACRONYMS

AFBI	Agri-Food and Biosciences Institute
APHIS	Animal and Public Health Information System
CAFRE	College of Agriculture, Food and Rural Enterprise
DARD	Department of Agriculture and Rural Development for Northern Ireland
DARLEQ	Diatoms Assessment for Rivers and Lakes Ecological Quality
DEFRA	Department for Environment, Food and Rural Affairs
DIN	dissolved inorganic nitrogen
DO	dissolved oxygen
DOE	Department of the Environment for Northern Ireland
EQR	ecological quality ratio
ESG	Ecological Status Group
FNMS	Farm Nutrient Management Scheme
GVA	gross value added
LEAFPACS	Macrophyte Prediction and Classification System
LFA	Less Favoured Area
LTDI	Lake Trophic Diatom Index
MEI	Morpho Edaphic Index
METS	Manure Efficiency Technology Scheme
MTR	Mean Trophic Rank
NAP	Nitrates Action Programme
NGOs	non-government organisations
NI	Northern Ireland
NICMS	Northern Ireland Countryside Management Scheme
NIEA	Northern Ireland Environment Agency
NIRDP	Northern Ireland Rural Development Programme
NVZs	Nitrate Vulnerable Zones
RSL	Reduced Species List
SKT	Seasonal Kendall Tau
SMR	Statutory Management Requirement
SNIFFER	Scottish and Northern Ireland Forum for Environmental Research

SRP	soluble reactive phosphorus
TDI	Trophic Diatom Index
TP	total phosphorus
UKTAG	UK Technical Advisory Group
UWWT	Urban Waste Water Treatment
WFD	Water Framework Directive
WWTWs	waste water treatment works