NATIONAL SOURCE PROTECTION PILOT PROJECT
AT
CHURCHILL & ORAM

SECOND INTERIM REPORT – MAY 2008

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FOREWORD

This report presents the interim findings of the source protection project being conducted by the Centre for Fresh Water Studies in Dundalk Institute of Technology on behalf of the National Rural Water Monitoring Committee.

While the study is as yet in its early stages the report highlights many of the challenges which must be overcome in protecting water-catchment areas and in maintaining the quality of raw water at source.

This work is both seminal and pivotal. It uniquely brings together high level scientific and engineering expertise with local community and other statutory partners in a unique and combined endeavour to understand the nature of environmental degradation in rural areas and to identify and implement appropriate and cost-effective strategies in meeting the threats posed by such degradation. In this way the study will contribute to national policy formulation in a context of an increasing awareness that water quality is best addressed by preventative rather than end-of-pipe solutions.

I would like to thank all who have participated in and supported this work. In particular I would like to acknowledge the Department of Environment, Heritage & Local Government, Churchill-Oram GWS; Monaghan County Council, the National Federation of Group Water Schemes and especially Dr Suzanne Linnane and her team in Dundalk Institute of Technology.

PROFESSOR TOM COLLINS

TERMS OF REFERENCE

The Steering Group, under the supervision of the National Rural Water Monitoring Committee and in partnership with the local community, represented by the Churchill & Oram Group Water Scheme, will oversee the implementation of the National Source Protection Pilot Project within the catchment area of Milltown Lake, source for the group water scheme.

The methodologies, structures and systems to be employed in the conduct of this exercise to be such as to create a model of best practice, suitable for replication nationally as a key element of the national strategy on community-based drinking water source protection throughout Ireland.

As the catchment involved is cross-border in nature, strategies for community-based management of drinking water sources across international boundaries will be explored and models of best practice developed.

PERSONNEL

STEERING GROUP

Chairperson: Professor Tom Collins, National Rural Water Monitoring Committee

Secretary: Brian MacDonald, National Federation of Group Water Schemes

Members

Seán Clerkin, National Co-ordinator, National Federation of Group Water Schemes
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Oliver Fogarty, Department of the Environment, Heritage & Local Government
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1.0 OVERVIEW

Source water protection is recognised as the first of several barrier approaches for the protection of drinking water supplies. Typically, source protection involves identifying major contaminant pathways and implementing actions and strategies to address these issues on a catchment basis. Ireland's approach to source water protection is a recent phenomenon, owing to the implementation of the Water Framework Directive and the international need to provide low cost, safe drinking water.

This 2nd interim report is prepared on behalf of the National Rural Water Monitoring Committee (National Water Services Committee). It presents an overview of all aspects of the Source Protection Pilot Project at Milltown Lake catchment in Co. Monaghan (and partially in Armagh). The report includes findings in relation to diffuse and point source discharges to catchment nutrient loadings. More specifically, it addresses the potential contribution of farmyard management practices, on-site wastewater treatment systems and agricultural runoff to nutrient loadings in this eutrophic catchment.

The measures adopted through this study aim to co-ordinate efforts to monitor and assess water quality within the catchment, identifying reasons for its deterioration, and to implement community-led and low-cost remediation measures to restore and maintain the quality of raw water in the catchment. To achieve these goals, community interest and support is actively developed through inclusion at all stages of the process.

The model being applied throughout this project was designed to address core issues relating to water quality and catchment management. Two main components are integrated to produce a Source Protection Strategy (figure 1.1): (i) catchment characteristics; and (ii) protection responses for potential contamination sources.

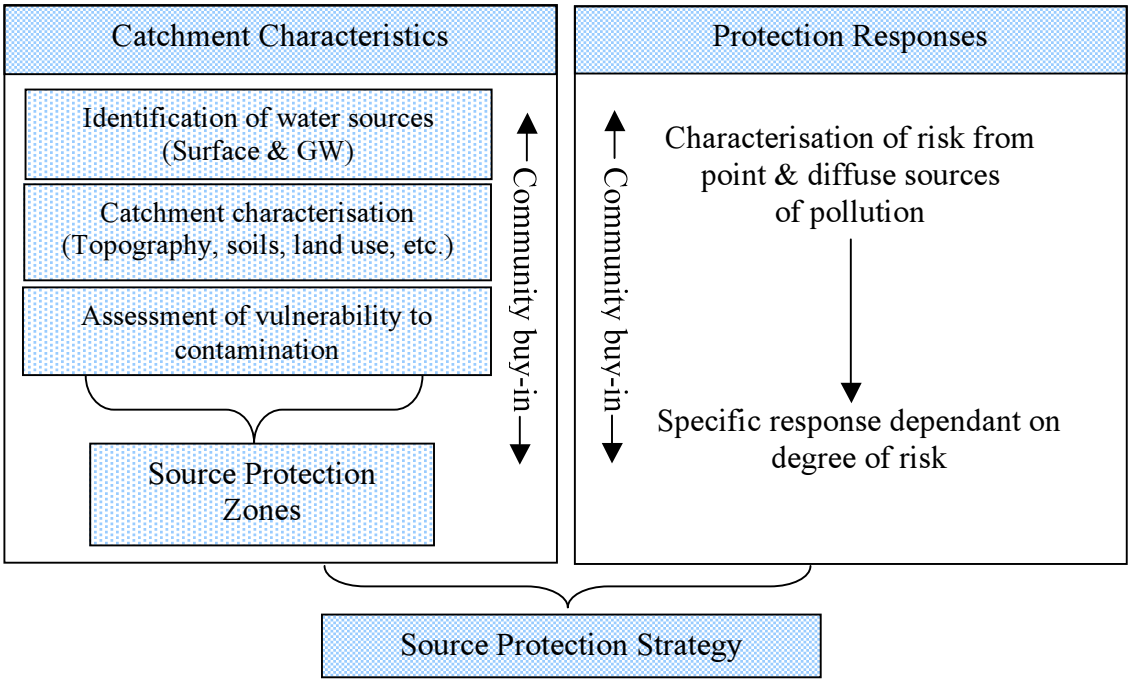


Figure 1.1 Summary of the components of the catchment protection scheme

2.0 MONITORING AND MANAGEMENT SYSTEMS UPDATE

2.1 INTRODUCTION

The project's co-ordinated monitoring approach has been in operation in the catchment since 1st September 2005 and data presented in the 1st interim report (Linnane *et al.*, 2006) is not repeated in this report. A full year's data collected between spring 2007 and spring 2008 forms the basis of this second interim report.

2.2 CATCHMENT WATER QUALITY MONITORING

2.2.1 Chemical monitoring:

The general catchment monitoring programme, which includes 28 individual river sites and two basins in Milltown Lake (Plate 2.1) is ongoing and is providing catchment-wide data for a range of chemical parameters (Figure 2.1 & Table 2.1). This extensive monitoring programme, in conjunction with the ecological monitoring programme, is designed to provide a baseline from which improvements in water quality arising from the implementation of remediation measures (pollution abatement strategies) may be assessed. Summaries of key chemical parameters are presented in Section 3.1.2.

Plate 2.1 Milltown Lake

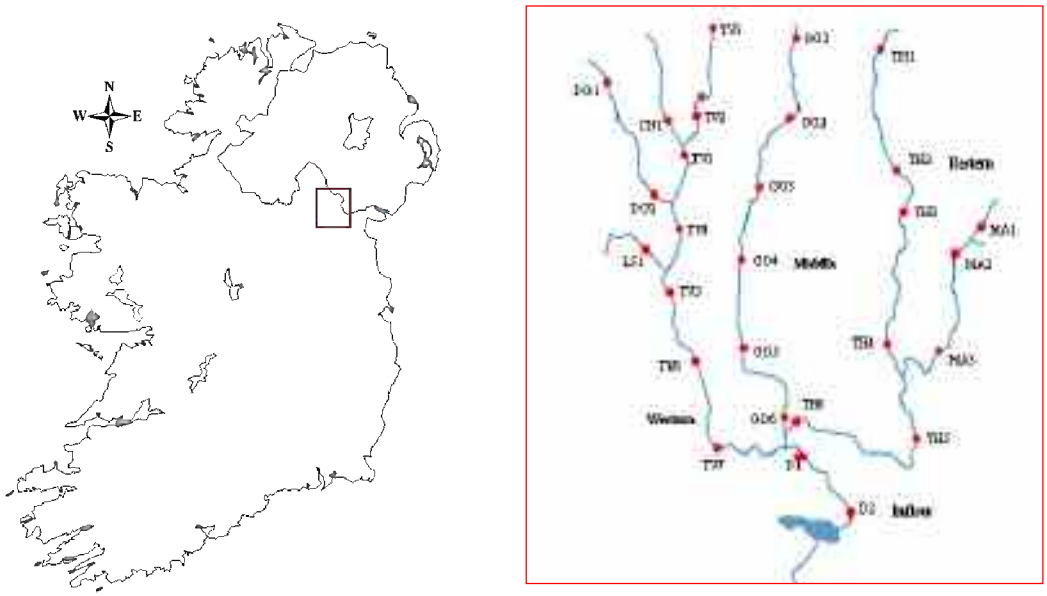


Figure 2.1 Milltown Lake Catchment sampling site locations

Table 2.1 Water quality monitoring

Description	Number of Sampling Locations	Frequency	Range of Parameters	Additional Sampling	
				Frequency	Parameters
Lake Input	**1**	**Weekly**	**T°C, DO, BOD, pH, Cond, TRP, TP, NH_3, NO_2, NO_3**	**Storm Events (24 hour sampling)**	**Weekly list**
General River Sites	**27**	**Monthly**	**T°C, DO, BOD, pH, Cond, TRP, NH_3, NO_2, NO_3**	**-**	**-**
Lake	**2**	**Monthly (Surface)**	**Transparency, Chlorophyll, T°C, pH, DO, TRP, TP**	**Monthly (1 meter depth intervals)**	**T°C, DO, TP**

2.2.2. Ecological monitoring:

Macroinvertebrate monitoring (RIVERS & LAKE):

The monitoring of macroinvertebrate populations and assemblages continues to be carried out on a seasonal basis at 28 individual stations across the catchment. This aims to determine the current condition of communities and to assess (in time) any recovery resulting from remediation measures in the catchment (Plates 2.2 & 2.3). The systems being followed are the EPA Q-value system (Clabby *et al.,* 2004) and the Small Streams Risk Score (SSRS) (WRBD, 2005). Profundal invertebrate sampling was also carried out on Milltown Lake during the summers of 2006 and 2007 and will be repeated in summer 2008.

Plates 2.2 & 2.3 Macroinvertebrate sampling in Milltown Lake catchment

Microbiological monitoring (RIVERS):

All 28 sites continue to be sampled for *Escherichia coli* and total coliforms. In addition, it is planned to begin sampling for *Cryptosporidium* from summer 2008 onwards.

Phytoplankton & macrophyte monitoring (RIVERS & LAKE):

The monitoring of benthic phytoplankton (diatoms) on a seasonal basis is ongoing and the system being followed is the Trophic Diatom Index (TDI) of Kelly *et al.* (2001). Phytoplankton samples are also being collected from the lake on a monthly basis to assist in assessing its productivity. Macrophyte surveys are being conducted on a seasonal basis at 26 individual stations and the system being followed is the Mean Trophic Rank (MTR) system (Holmes, 1999). Macrophyte surveys of the lake were also conducted in 2006 and 2007 on two occasions during the growing period.

Summaries of key ecological parameters are presented in Section 3.1.1.

2.2.3 Hydrometric monitoring

The hydrometric programme established in the first year of the project with the assistance of the Environmental Protection Agency (EPA) in County Monaghan is ongoing. This programme is ensuring the provision of accurate flow data through the collection and analysis of weekly samples and storm events over 24 hour periods.

2.3 Additional Study

2.3.1 Sediment study

An extensive palaeolimnological study is being carried out on the lake to establish its trophic status over time. This is being done in order to assist in managing the lake in the future. An additional study to ascertain the potential contribution of lake sediments in the lake through internal recycling is planned for summer 2008.

3.0 Catchment Water Quality

The biological and chemical river and lake monitoring programmes are summarised in the following sections. More detailed databases are available directly through the project.

3.1 River Water Quality

3.1.1 Biological water quality

Macroinvertebrates
Macroinvertebrate sampling has shown that the western tributary (TV) (Figure 2.1) is consistently of 'doubtful' quality with Q-values suggesting that the majority of sampling sites were 'moderately' polluted. The middle tributary (GO) is only 'slightly' polluted in comparison, with most sites achieving a Q-value of 3-4 and one achieving a Q-value of 4 (unpolluted) in Autumn 2005 and Spring 2006. The eastern tributary (TH) is also 'slightly' polluted with the majority of sites on that river achieving a Q-value of 3-4. The main inflow, the Drumleek River, is of 'moderate' quality downstream of the confluence of the three tributaries and the final sampling station above the lake had a Q-value of 4 in Spring 2006. This however, had deteriorated to a Q 3-4 in both May 2007 and October 2007. Summary Q-values for each tributary are presented in Table 3.1.

Table 3.1 Predominant Q-values for the Milltown Lake Catchment tributaries

	Q-value Autumn 2005	Q-value Spring 2006	Q-value Autumn 2006	Q-value Spring 2007	Q-value Autumn 2007
Western Tributary (TV)	**2-3, 3**	**3, 3-4**	**3, 3-4**	**3, 3-4**	**3**
Middle Tributary (GO)	**3-4, 4**	**3, 3-4, 4**	**3-4**	**3-4**	**3-4**
Eastern Tributary (TH)	**3, 3-4, 4**	**3-4, 4**	**2-3, 3, 3-4**	**3, 3-4**	**3, 3-4**

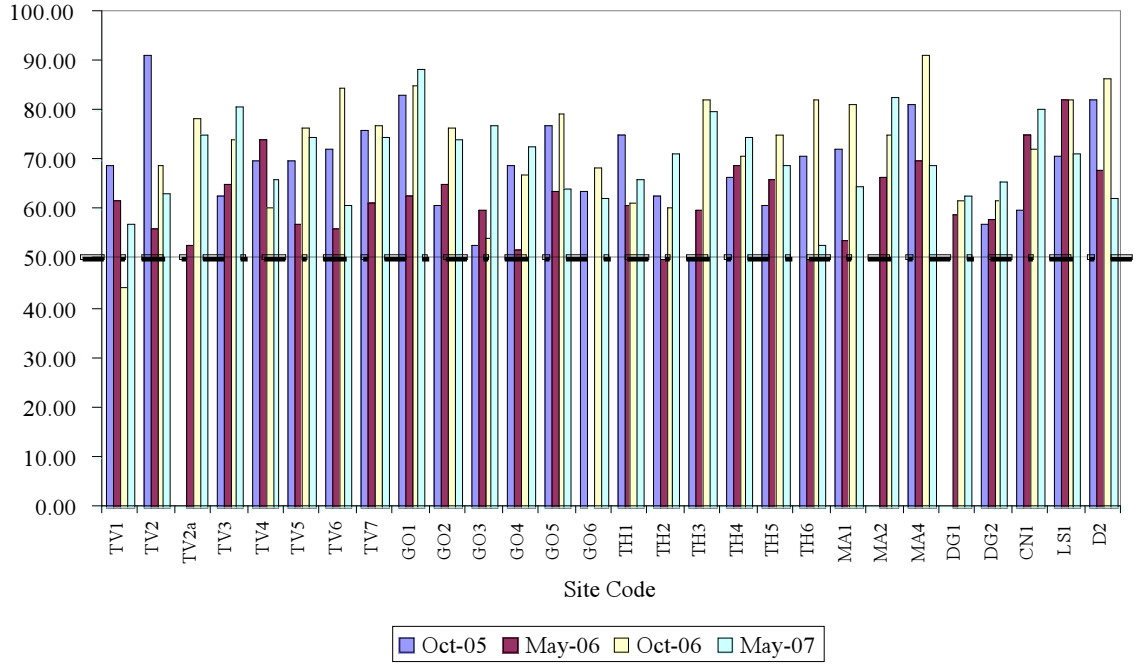


Figure 3.2 TDI values for Milltown Lake catchment
(TDI scale: 0-50 = good quality; >50 = nutrient enrichment)

Macrophytes
Macrophyte species present in the catchment also showed moderate levels of enrichment and MTR values computed to date are showing that the majority of sites within the catchment are either eutrophic or at risk of eutrophication. The surveys are, therefore, suggesting a decline in water quality in the catchment during the summer months. Only one site has been deemed 'unlikely to be eutrophic' while 79% of sites were classed 'eutrophic or at risk of eutrophication'. No sites were classed as 'badly damaged'. Sites that achieved the lowest quality rating using the MTR were also the sites with the lowest dissolved oxygen concentrations.

Diatoms
The diatom flora of a river reflects the trophic status and degree of enrichment. The TDI runs on a scale of 0-100 and sites of good status have a TDI value between 0 and 50, while sites experiencing nutrient enrichment have a TDI value greater than 50.

The majority of sites in the catchment have been assigned a TDI value equal to or greater than 50 since sampling started in October 2005 (Figure 3.2). Two sites, TV1 and TH2, had TDI values less than 50 for a single sampling period. However, in subsequent sampling periods their TDI values increased to values greater then 50. These high TDI values would suggest that the catchment is impacted and suffering from eutrophication.

Microbiology

Escherichia coli numbers, while still relatively high in the lower reaches of the catchment, are considerably lower than those presented in the 1st interim report and are highly variable. Highest levels of *E. coli* recorded during this report's sampling period were during spring 2007 and were all on the TV tributary. In general, the TV tributary records high levels of *E. coli* in the catchment during each sampling period (Figure 3.3).

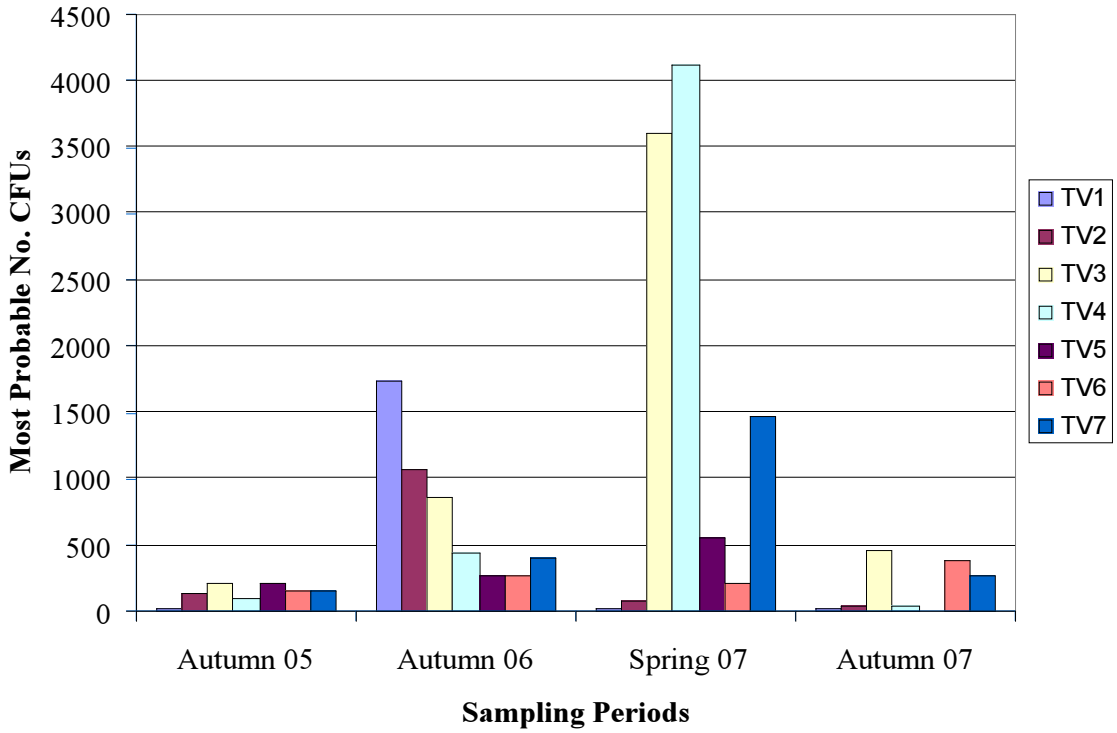


Figure 3.3 TV *E. coli* values (autumn 2005-autumn 2007)

3.1.2 Chemical water quality

Chemical water quality remains variable throughout the catchment and is subject to fluctuations as a result of rainfall and land-use practises. Preliminary analysis suggests a strong link between wet weather and highest chemical concentrations in all tributaries. Summaries of key parameters (yearly means and ranges) are presented in table 3.3.

Table 3.3 Summary of Milltown catchment water quality 2007

	TRP _g/l	Dissolved Oxygen mg/l	Conductivity _S/cm	pH
Mean	**96.1 ± 8.9 SE**	**7.6 ± 0.04 SE**	**222 ± 7.7 SE**	**7.5 ± 0.24 SE**
Ranges	**21.4-219.4**	**3.9-9.3**	**151.4-219.2**	**7-7.9**

3.2 Lake Water Quality

Chlorophyll a and total phosphorus (TP)

Milltown Lake was classified as 'eutrophic' for the period of the 1st interim report with an annual maximum TP value of 95 g/L and an annual maximum of 43mg/m^3 chlorophyll *a*.

For the period covering this report (spring 2007-spring 2008) the annual maximum chlorophyll *a* value recorded was 14.6mg/m^3 (April 2007) with a mean of 6.95mg/m^3. According to the O.E.C.D. Lake Classification Scheme, these values should place Milltown Lake in the mesotrophic category (table 3.3).

In contrast, TP values remain high (figure 3.2) with a maximum of 197 g/L recorded (September 2007) and a yearly average of 99.05 g/L. Therefore, according to the O.E.C.D. Lake Classification Scheme, TP places the in the 'eutrophic' category (Table 3.4).

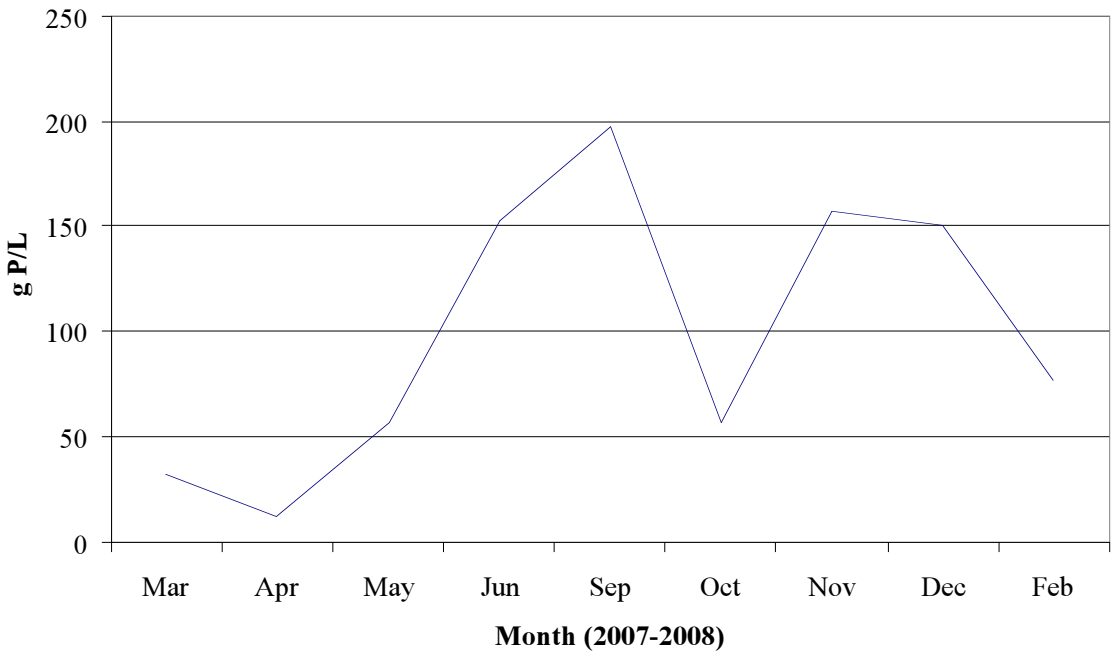


Figure 3.2 Monthly TP values for Milltown Lake (Spring 2007 - Spring 2008)

Table 3.4 Classification of Milltown Lake using O.E.C.D. Lake Classification Scheme

Lake Category	Total Phosphorus g/L Mean	Chlorophyll mg/m^3 Mean	Chlorophyll mg/m^3 Max	Milltown Lake		
				Total Phosphorus g/L Mean	Chlorophyll mg/m^3 Mean	Chlorophyll mg/m^3 Max
Ultra-Oligotrophic	<4	<1.0	<2.5			
Oligotrophic	<10	<2.5	<8.0			
Mesotrophic	**10-35**	**2.5-8**	**8-25**		**6.95**	**14.6**
Eutrophic	**35-100**	**8-25**	**25-75**	**99.05**		
Hypertrophic	>100	>25	>75			

Total Phosphorus (TP) loadings

The TP loadings to Milltown Lake from the Drumleek River for 2007 are shown in figure 3.3. The discharge for 2007 followed a typical pattern of increase over the winter and early spring (November 2006-March 2007). It was also noted that some of the highest periods of discharge occurred during July and August 2007 reflecting an unusually wet summer with the highest daily discharge for that year occurring on 8th August 2007. While some of the highest TP concentrations were recorded during periods of low flow, the overall storm runoff volumes seem to be having the biggest impact on TP loads. This is indicated by the fact that the months with the highest discharge are also the months with the highest phosphorus loading. The phosphorus loadings computed to date are based on an average monthly concentration multiplied by the monthly discharge as per Preston *et al.* (1989).

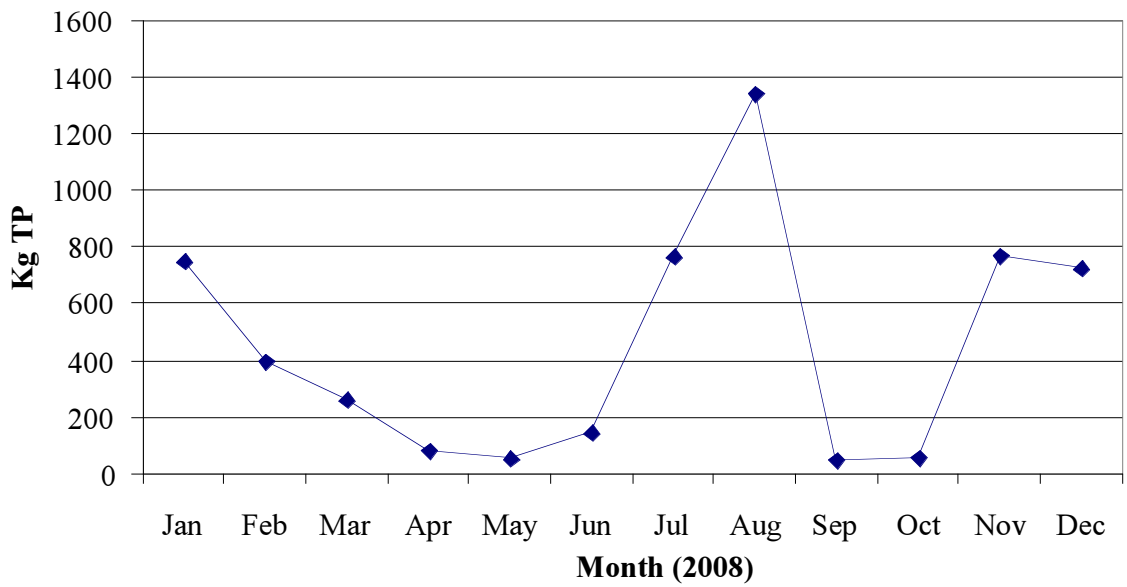


Figure 3.3 TP loadings for Milltown Lake (January 2008-December 2008)

Sediment study

A series of sediment cores have been taken from Milltown Lake over the past two years. Details of the potential for phosphorus release through migration from the sediments of to the overlying water column during periods of anoxia was documented in the 1st interim report.

A long core (86cm) was taken from the lake (summer 2006). When dated, it was established that this core contained sediments laid down since the 1930's to present. Marked changes in mineral content can be seen over the entire length of the core. Mineral content is greatest from the bottom of the core to the 1970's. The mineral content then decreases from the 1970's onwards. This change in mineral content may be explained by changes in farming practices within the catchment. Flax production and localised tillage activities in the early part of the twentieth century would have left the soil exposed and susceptible to erosional losses. The change from these agricultural practices to beef production on grassland, and associated reductions in erosional losses can be seen within the sediment record of Milltown Lake.

In addition, when the preserved algal pigments from the cores were examined using High Performance Liquid Chromatography (HPLC), changes in the productivity of the lake over time were also highlighted. Prior to the 1970's the lake seemed to produce less algae every year than is currently the case. From the 1970's to present there is a marked increase in the quantity of algal pigments preserved in the core. This increase coincides with the intensification of agriculture after Ireland's entry into the European Economic Community. In addition, recent increases in rural housing may also be contributing to the increase in algal productivity within Milltown Lake.

4.0 AGRICULTURE & WATER POLLUTION

4.1 IMPACT OF AGRICULTURAL PRACTICES ON WATER QUALITY

4.1.1 Farmyard surveys

RPS Consulting Engineers were commissioned in conjunction with members of the project team to undertake farm surveys in the Milltown Lake Catchment in winter/spring of 2006/2007 to ascertain the pollution risk, if any, from farms situated in this catchment. A simple methodology was employed to undertake these surveys;

Letter drop and catchment familiarisation; and,
Farm survey/survey sheets.

A letter drop was completed within the catchment and, where possible the farmer was met. The farmer was then informed that the farm would be surveyed within fourteen days or on a day of his choosing. In many cases the farmer suggested that the survey could be conducted there and then.

Farms were visited and a survey sheet was completed in the presence of the farmer. The survey sheet was set up to establish a number of key indicators using factors from S.I. 378 of 2006 (EC, 2006). The survey sheets contained information on a number of different topics including;

(a) Adjusted area farmed;
(b) Stocking rate;
(c) Organic nitrogen produced;
(d) Storage; and,
(e) Fertiliser usage.

(a) Adjusted area farmed

The area farmed was obtained from discussions with the farmer and included both the area owned by the farmer and the area rented. An assessment was also made of the quality of the land and the farmer was asked to evaluate his land allowing a factor of 1.0 for his best land, 0.5 for land that was poorer and 0.25 for his worst land. This gave an adjusted area farmed that allowed for a more accurate calculation of the ability of the farm to carry stock. Commonage is also listed under area farmed but was not an issue in this catchment.

(b) Stocking rate

Stocking rate is estimated from the adjusted area farmed and the livestock units (LUs). LUs were calculated from the factors used in *S.I. 378 of 2006*, by the length of time an animal is on the farm over a twelve-month period.

(c) Organic nitrogen

A threshold of 170kg ON/Ha has been set for the volume of organic nitrogen that is allowed per hectare under *S.I. 378 of 2006*. This is estimated from the volume of organic nitrogen that is produced from different animal types over a twelve-month period and/or the volume of livestock manure applied. The expected volumes of organic nitrogen produced for different animal types are given in *S.I. 378*. These volumes where used to estimate the volume of organic nitrogen produced on each of the farms surveyed. This, together with the stocking rate per hectare gives a good indication of how intensely the farm is farmed. It should be noted that the average yearly stock numbers where given by the farmer during the interview and are not based on Cattle Movement Monitoring System (CMMS) data.

(d) Storage

County Monaghan lies in Zone C under the newly implemented *S.I. 378* and under this legislation there is a requirement of 22 weeks storage for animal manures in Zone C. Storage was one of the categories that was assessed during the surveys. The storage assessment was based only on the farm's ability to store animal wastes either in a slurry tank or in a purpose built dungstead. If the farm used sheds to store dung then it was assumed that there was sufficient storage.

However, an assessment was made of the storage to ensure that there was no runoff that was not collected. Dung storage or the lack of it was found to the biggest issue in this

catchment. Slurry storage was calculated by multiplying the numbers of stock by the volume of slurry that a particular stock type produced in one week during housing (obtained from *S.I. 378*). If there are different stock types then the different volumes of weekly slurry produced are combined giving a total volume of slurry produced per week. Added to this is any extraneous water that is entering the storage facilities and the amount of "freeboard" required whether the tank is under cover (200mm) or not (300mm).

Extraneous water is calculated from the expected weekly rainfall (obtained from *S.I. 378*) multiplied by the area that is exposed to that rainfall. The total weekly volume of liquid entering storage (animal slurry and extraneous water) is divided into the total volume of storage giving the number of weeks' storage available.

(e) Fertiliser usage

Fertiliser usage was also calculated in the survey. The data for chemical fertiliser usage was obtained during the interview with the farmer. Organic fertiliser usage was calculated from the slurry/dung produced during the winter period and any additional organic fertiliser that was imported to the farm.

4.1.2 Risk classification

Farms were divided into 5 risk classifications varying from farms that were causing pollution on the day the survey was undertaken to farms that posed little or no threat of pollution. Table 4.1 shows the colour coding that was used and the classification.

Table 4.1 Colour coding for risk assignment

Colour Coding	Classification
	Red (high risk) - Currently causing pollution
	Yellow 3 (medium/high risk) - Has probably caused pollution in the past and is likely to cause pollution again in the future
	Yellow 2 (medium risk) - May not be currently polluting but has a number of problems that require sorting
	Yellow 1 (low/medium risk) - Some issues relating to farm management or storage that prevent this farm obtaining low risk status
	Green (low risk) - Unlikely to cause pollution

4.1.3 Results

A total of 126 farms were surveyed in the catchment. A summary of the survey results are given table 4.2. The percentage of farms categorised according to risk shown in table 4.3.

Table 4.2 Summary of survey results

Parameter Measured	Number
Number of farms surveyed	126
Average farm size (Ha)	23.31
Number of farms in dairying	22
Average stock numbers (LUs)	39.08
Average stocking rate (LU/Ha)	1.61
Median storage capacity (weeks) Note 1	40.95
Number of farms high risk - Red	4
Number of farms medium risk – Yellow 3	9
Number of farms medium risk – Yellow 2	19
Number of farms medium risk – Yellow 1	42
Number of farms low risk - Green	52
Percentage farms in REPS/QMS/CMS Note 2	38
Average organic nitrogen/ha/yr	120.05

Note 1 - Used median instead of average due to a small number of farms with large storage capacities that are skewing data.
Note 2 - Some owners where not contactable, we have therefore assumed that these farms are not in REPS or similar schemes.

Table 4.3 Percentage of farms classified according to risk

Risk Classification	Percentage of Total Farms Surveyed
Green	41
Yellow 1	33
Yellow 2	15
Yellow 3	7
Red	3

74% of the farms surveyed present little or no risk of pollution. This percentage is similar to other catchments surveyed in the region. However, the percentage of farms in REPS or similar schemes in this catchment is quite high and is possibly not reflected in the numbers of "green" and "yellow 1" farms. The percentage of "green" and/or "yellow 1" farms would normally be expected to be in the mid eighties.
The number of farms in REPS or similar schemes was 48 or 38% of the total. Four of these farms were classified as "Yellow 2" and one was classified as "Red".
The CSO statistics for 2000 show the average farm size in County Monaghan at 21.8 hectares. The average farm size in the Milltown Lake Catchment was slightly greater at 23.31 hectares.
The largest area farmed by a single farmer within the Milltown Lake Catchment was 100 hectares. This farm also had the greatest number of livestock units at 260. This farm was classified "Yellow 1", low/medium risk.
There are a total of 4,689 livestock units in the Milltown Lake Catchment and 18% of farms had stocking rates greater than 2 LUs/Ha.

16% of the farms surveyed were less than 10 hectares in size.
The median for numbers of week's slurry storage for the catchment was 37.62 weeks.

4.1.3 Recommendations

Recommendations were made to each farmer on management practices that would improve the functioning of their individual farmyards. It is anticipated that this advice would have been taken on board, the effects of which should be evident during selected farmyard revisits in Spring 2008.

4.2 Soil Nutrient Status

Soil samples collected during the winter period in 2006 as outlined by Linnane *et al.* (2006). All 161 samples were analysed for soil pH, plant available potassium and phosphorus using Morgan's extracting solution, which is commonly used for agricultural and horticultural purposes in Ireland.

4.2.1 Results

Agriculture has been traditionally represented as a diffuse source of N and P to water systems, especially where an adequate soil nutrient status for the desired agricultural production has been achieved. The extent of this phenomenon is quite small in this catchment (table 4.1), as only 9.4% of soils are within the P index of 4 (>8 mg l^{-1} P), which is surplus to crop requirements, while an average available P concentration of 4.19 mg L^{-1} was recorded throughout the area.

However, lime is required throughout most of the catchment, as noted in the low pH values obtained (5.68 ± 0.577), and if this pH adjustment was carried out, the resultant available P concentrations will elevate as P becomes available in soils at a neutral pH. The relationship between the soil P indices and soil pH are presented in table 4.1.

Table 4.1 Distribution of soil P indices and relationship with soil pH

Soil P (mg l^{-1})	Index 1 0 - 3 %	Index 2 3.1 – 6 %	Index 3 6.1 – 8 %	Index 4 > 8 %
Percentage	49.38	35	6.25	9.4
pH	5.56	5.74	5.89	6.07

As the soils in the catchment are predominately gleys, their associated poor drainage and absorption capacity and the spreading of agricultural manures and fertilisers during unsuitable weather conditions and/or without adhering to recommended buffer strips (EC, 2006) are thought to impact greatly on the nearby water systems.

The average organic nitrogen applied to the area is 120 kg per hectare, as estimated from the various animal types over a 12-month period and the volume of livestock manure

applied to land (EC, 2006), which is below the threshold level of 170 kg/Ha as stipulated by the Nitrates Directive. However, instances of cattle access and direct slurry input to watercourses are high throughout the area, with obvious impacts on the water quality, river habitats and associated bank side erosion.

4.3 Nutrient Management Planning

Soil samples have also been taken on individual farms and from these analyses, nutrient management plans have been devised and implemented (figure 4.1). This will continue during 2008, until nutrient management plans have been implemented on all farms. It is anticipated that by taking this advice on board, that farmers will save money on fertiliser and become more aware of the impact of fertiliser application rates and the impacts of nutrient run-off on adjacent water courses.

Figure 4.1 Soil phosphorus levels on sampled fields.

Phosphorus range (mg L^{-1})	
0-3	
3.1-6	
6.1-10 (recommended)	
>10	

5.0. ON-SITE WASTEWATER TREATMENT SYSTEMS

5.1. WORK & DEVELOPMENTS TO DATE

5.1.1 Questionnaires

To date about 80% of the households in the catchment have completed a questionnaire regarding their on-site wastewater treatment system (OSWTS). This represents a small increase on the number of completed questionnaires reported in the 1st Interim Report.

5.1.2 Planning permissions

A review of planning permissions granted for developments in the catchment incorporating an OSWTS, as described in Linnane *et al.* (2006), has begun. The planning application files were inspected for the location of the development, the type of OSWTS applied for, the permission granted, any conditions imposed relating to the OSWTS and documents relating to compliance with conditions requiring post-permission submissions. Documentation relating as far back as 1989 have been reviewed with approximately 80 planning permissions examined to date.

5.1.3 Non-intrusive inspections

Forty-two OSWTSs (nearly 25% of all systems in the catchment) have been inspected non-intrusively. These inspections recorded the type of OSWTS (septic tank or proprietary system), the material from which the tank was constructed (concrete, fibre-glass or PVC), the number of chambers in the tank (from one to four) and the method of disposal of the effluent (percolation area, soakaway or direct discharge to drain or stream).

5.1.4 Intrusive examinations

Five OSWTSs were chosen for intrusive examination, four conventional septic tanks system and one with a proprietary system. At each of these sites, a minimum of three monitoring wells was installed. This allowed the level of the water table to be measured, the soil profile to be recorded and the soil and sub-surface water to be analysed. The monitoring wells consisted of boreholes of varying diameters (5cm, 6.3cm and 7.5cm) formed by window sampler gouges driven by a percussion hammer to a depth approximately 1m below the water table (Plate 5.1).

Plate 5.1 Borehole installation

Into these, rigid high-density polyethylene tubing of 3.2cm diameter was inserted. The lowest 1m section was perforated; a closed point was fitted at the bottom and a removable cap at the top which was finished off slightly above ground level. The gap between the walls of the borehole and the perforated lower part of the tubing was filled with clean filter sand. The void around the upper portion of the tubing was sealed with bentonite to prevent the direct ingress of surface water through the borehole. The method of forming the boreholes afforded the opportunity of recording the soil profile at each site and soil samples were retained for later laboratory analysis.

The relative locations and levels of the top of the tubing in each monitoring well was surveyed using traditional land surveying equipment (measuring tape, dumpy level and leveling staff). The depth of the water table below the top of the tubing was measured using an electronic dipper which gives both a sound and light indication of contact with water. Based on these measurements, it was possible to determine the relative levels of the water table in each borehole on any particular site. Samples of the sub-surface water in each of the boreholes were extracted using new flexible polyethylene tubing of 0.8cm diameter for each sample and a peristaltic pump. This ensured that there was no contamination of the samples by the sampling equipment or cross-contamination of the samples.

5.1.5 Extension of work as part of Water Framework Directive response

Recently, the National Centre for Freshwater Studies agreed a project plan and funding arrangements with Galway County Council, on behalf of the Western River Basin District (WRBD), for a National OSWTS Study as an extension of the National Source Protection Pilot Project. A full description of the scope of this study, which is part of the WRBD response to the Water framework Directive, is given in section 5.4.4.

Mr. Donal Daly, of the Hydrometric and Groundwater Section of the Environmental Protection Agency, has agreed to join the Steering Committee of the Project to provide general advice to the project and specific guidance in relation to hydrogeology.

5.2 RESULTS

5.2.1 Questionnaires

The results of the questionnaire survey were presented in the 1st Interim Report. The small number of additional surveys completed since then (12 in number) have not altered the conclusions reached previously.

5.2.2 Planning permissions

The review of planning permissions, as described at 5.1.2 above, reveals three distinct chronological phases.

(a) Permissions granted prior to 1991: All of these applications were for septic tanks; many did not specifically state a method of effluent disposal. The conditions imposed by Monaghan County Council reflected the standards of SR6:1975 (*Recommendations for Domestic Effluent Treatment and Disposal from a Single Dwelling House*), the earlier Standard Recommendation on OSWTSs.

(b) Permissions granted between 1992 and 2001: Most of these applications were for septic tanks with percolation areas; a minority were for proprietary systems. The conditions imposed by Monaghan County Council referred directly to SR6:1991 (*Recommendations for Domestic Effluent Treatment and Disposal from a Single Dwelling House*), the revised version of the 1975 Standard Recommendation on OSWTSs.

(c) Permissions Granted since 2002: The vast majority of these were for proprietary systems, rather than septic tanks. The conditions imposed required compliance with *Wastewater Treatment Manual: Treatment Systems for Single Houses*, published by the Environmental Protection Agency in 2000, and required the post-permission submissions to the County Council, typically certification by a competent person that the OSWTS was correctly installed and evidence that a maintenance contract was in place.

None of these files contained evidence of the required submissions or of enforcement action due to breach of these conditions.

5.2.3 Non-intrusive inspections

As part of the non-intrusive inspections, as described at 5.1.3 above, forty-two OSWTSs were inspected to establish the type of system installed, the material used to contrast the tank, the number of chambers and the type of effluent dispersal used.

(a) Type of system: Of the 42 systems inspected, 35 (83%) were conventional septic tanks and 7 (17%) were proprietary systems. All of the proprietary systems had been

installed within the past 10 years. Of these, three were bio-filter systems and four were air-flow systems. Three of the proprietary systems were broken or were not operating correctly (e.g. turned off) and six were still under maintenance contracts, including annual desludging.

(b) Material used to construct tank: Twenty-four (57%) of the systems inspected had tanks constructed of concrete; all of these were conventional septic tanks. Fourteen (33%) had PVC tanks (5 of which were proprietary systems) and two (5%) had fibreglass tanks (both proprietary systems). The remaining two (5%) systems had no settlement tank and discharged untreated wastewater directly to a drain.

(c) Number of chambers in tank: The number of chambers in the tanks inspected varied from one to four. Twenty-seven (64%) systems were single-chambered, seven (17%) double-chambered, four (10%) triple-chambered and two (5%) quadruple chambered. The remaining two (5%) systems had no tank, as detailed above.

(d) Method of effluent dispersal: Sixteen (38%) systems relied on soakaways; all of these were conventional septic tanks and nineteen (45%) had percolation areas, including seven proprietary systems. The remaining seven (17%) had direct discharge, two of these without a settlement tank.

Based on these visual inspections, 37 (88%) of the OSWTSs were assessed as not complying with current standards. These included:

systems with a single-chambered tank;
systems relying on a soakaway (i.e. pits filled with stone) for dispersal of effluent;
systems with no settlement tank;
systems discharging directly to a drain; and,
proprietary systems which were broken or turned off.

However, it should be noted that some of these, in particular those in the first two categories, may have complied with the standards current at their time of installation. Present standards require a double-chambered tank discharging to a percolation area (i.e. perforated pipes laid in trenches filled with stone).

The last three categories listed above, comprising ten systems (24%), are considered to have the potential to present a serious risk of contaminating surface water which contributes to the source water.

5.2.4 Intrusive examinations

Only preliminary sampling has been undertaken at the five sites, and wells for control sampling (i.e. clear of the influence of the percolation area to show the level of background contamination) have not been installed. Therefore the results to date must be treated with caution. Nevertheless, these initial analyses have indicated a high level of contamination associated with faecal matter, and further investigation, as planned and described in 5.4.4(b) below, is warranted.

Three of the four conventional septic tank systems examined had mean water table level within 0.8m of ground level. On this basis alone, these three sites would be deemed unsuitable for conventional septic tanks.

5.3 CONCLUSIONS

The results to date do not provide any definitive evidence of actual contamination of source water by OSWTS but do provide indications of risk of contamination. The questionnaire survey reveals a significant proportion of systems installed prior to current standards and a lack of regular desludging. The inspection of planning files indicates that their conditions have been ignored. The non-intrusive inspections point to a majority of systems which are considered sub-standard when compared to current standards, and a significant minority which may be at serious risk of contaminating surface water bodies, but this is dependant on location and proximity to nearby water courses. The intrusive examinations revealed that the majority of the chosen sites are unsuitable for the conventional septic tanks installed due to the high water table. In addition, soil profiles indicate that the soil type on each of the sites probably renders them unsuitable for septic tanks.

5.4 PLANNED WORK

5.4.1 Questionnaires

The questionnaire survey will be completed by end of 2008.

5.4.2 Planning permissions

The review of planning permissions granted, as described in section 5.1.2 above, will be extended to include years prior to 1989 and the location of these permissions will be related to the data from the questionnaire survey and the non-intrusive inspections. This geographical relationship must be based on site location maps submitted with the applications as the application addresses are not sufficiently precise.

5.4.3 Intrusive examinations

The intrusive examinations will be continued and extended as described at 5.4.4(b) below.

5.4.4 Extension of work as part of Water Framework Directive response

The National OSWTS Study, which is part of the WRBD response to the Water framework Directive will comprise of four phases as follows:

(a) Desk Study: This will include an extensive literature review, an evaluation of current practices by planning authorities in Ireland and internationally relating to both new and existing systems and study visits to existing models of best practice (e.g. Limerick, Carlow and Cavan County Councils, STEDS, Brittany Pure Water, etc.).

(b) Field Study: This will entail the extension of the existing range of monitoring wells to include defined controls (clear of the influence of the percolation area) and zones between the percolation areas and the nearest surface water bodies. Bi-weekly

sampling and analysis of sub-surface water from each of the monitoring wells for a wide range of parameters will be undertaken (level of water table, BOD_5, electrical conductivity, pH, MRP, NO_3, NO_2, NH_3, TN, *E. coli* and Total coliforms). In addition, full site characterisations, in accordance with the Environmental Protection Agency's *Wastewater Treatment Manual: Treatment Systems for Single Houses*, will be undertaken on each of the chosen sites, subject to owners' permissions.

(c) Hydrology Modeling: This will involve the application of software models (SIMCAT and MIKE-NAM) already being utilised by the River Basin Districts in selected sub-catchments and an extension of its application to the Churchill and Oram Catchment.

(d) Dissemination: A final report will be produced within one calendar year from the start date and interim reports will be delivered on a quarterly basis. In addition, all opportunities for dissemination through additional publication, conferences etc. will be availed of in association with the WRBD and their consultants, ESB International.

6.0 REMEDIAL MEASURES

The integrated approach taken by the project to catchment management at the stakeholder and community level, based on effective consultation, is proving to be a key component to successful implantation of source protection measures. It should achieve sustainable improvements in source water protection and catchment management. All activities, including monitoring and implementation of remedial measures are being carried out in association with the requirements of relevant EU and National legislation, in particular the WFD and the newly implemented Nitrates Directive. Defined objectives, targets, procedures for monitoring progress, public consultation, support from the relevant authorities, review and reporting are all proving crucial to success.

Farmyard remediation measures have been undertaken and nutrient management plans implemented across the catchment (Section 4). Community education meetings are also providing farmers with additional advice on fertiliser application, farmyard management practices and overall environmental awareness, while educational workshops and a water awareness curriculum have been devised for primary schools (http://www.dkit.ie).

On a larger scale, fencing is currently being installed along a tributary that converges to form the Drumleek River on the western side of the catchment (figure 6.1, plate 6.1). It is anticipated that by excluding cattle access from waterways, a gradual improvement in water quality will be evident owing to a reduction in bank-side erosion and restoration of riverbed habitats. The effect of this may be seen during the summer sampling period of 2008. Cattle drinkers are also being installed, particularly where direct access to the river was available. In some areas, bridges were constructed to exclude cattle access.

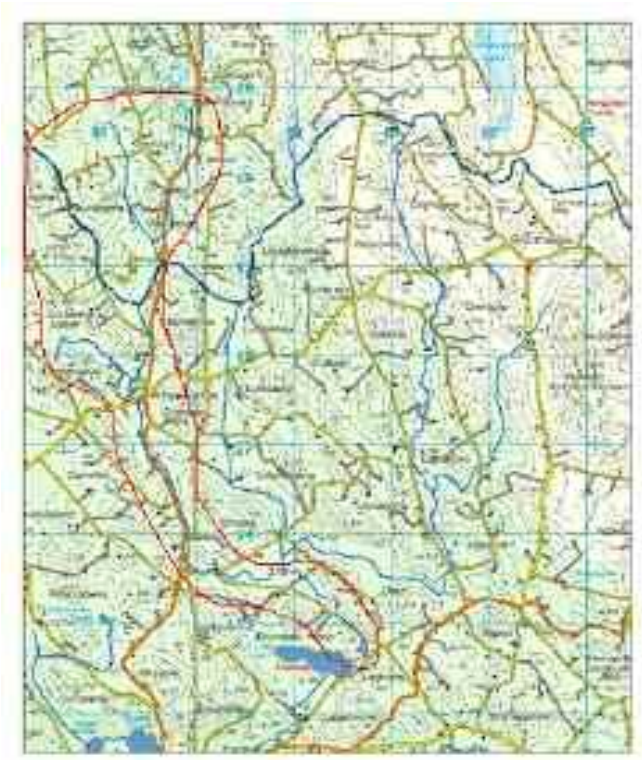
Where possible grass buffer strips were established between the fencing and the river bank in an attempt to filter out and trap excessive nutrient concentrations entering the nearby watercourse, particularly from steeply sloping drumlins. Following an extensive literature review, it was decided to establish buffer strips of 3m in size. However, owing to practical considerations including size of fields and agreement of landowners, buffer strips now vary in size and are ultimately dependent on the permission of the landowner, with the minimum requirement being 1.5m, as stipulated by Rural Environmental Protection Scheme (REPS).

All farmers with land adjacent to the rivers concerned have shown a positive response to the implementation of this simple remedial measure and have signed agreements with the project team, allowing farm relief services to carry out the associated work. Work on fencing in the catchment began in January 2008. At the time of writing, fencing had been installed on approximately sixteen farms. The work is ongoing and there is an expectation that it will be completed by the end of May 2008.

In addition to the fencing and subject to further investigations, it may be recommended that many on-site wastewater systems may need to be replaced and percolation areas installed as appropriate. A complementary study funded through the Environmental Protection Agency's (EPA) STRIVE initiative[1] will address best management practices

[1] Proposal Ref 2007-WRM-FS-f -Spent Mushroom Compost (SMC) Management and Options for Use

for dealing with problematic organic waste within the catchment and aims to find alternative solutions for the management and use of this by-product.



Fencing

Figure 6.1 Area where fencing is being installed

Plates 6.1 & 6.2 Fencing in the lower reaches of the catchment

7.0 DISSEMINATION

Since the launch of the 1st interim report in December 2006, the project has continued to ensure the effective dissemination of its findings through a number of mechanisms including:

Public and stakeholder consultation
The 1st interim report was made available to the following groups and all feedback was welcomed and has been carefully considered in the development of the project to date:

- Department of Environment, Heritage and Local Government
- Teagasc
- Environmental Protection Agency
- Irish Farmer's Association
- Monaghan County Council
- River Basin District Authorities
- Local Authorities
- All Group Water Schemes
- Media
- Other Academic Institutions
- All Catchment Stakeholders
- Any Interested Individuals

Direct consultation has continued with all interested parties and with bodies and groups that are immediately concerned with the catchment and have interests relevant to the quality of the water. This is ensuring that their viewpoints are represented throughout the development of the project.

Media coverage
Following the launch of the 1st interim report, the project has been highlighted on a regular basis by the various media coverage including:

- The Irish Times
- The Argus
- The Democrat
- The Northern Standard
- Rural Water News
- Northern Sound Radio
- Radio 1, RTE - Mooney Goes Wild

In order to ensure public participation, the project has continued to promote itself through the media and also through various awareness campaigns, education initiatives and workshops.

Conference participation

All members of the project team have been active in presenting project material at both National and International conferences since the launch of the 1st interim report (Table 7.1).

Table 7.1 Conferences and symposia presented at by the project team (spring 2007-spring 2008)

Conference / Symposia
National Rural Water Conference – September 2007 (Cavan)
Agricultural Research Forum - March 2007, March 2008 (Tullamore, Co. Offaly)
Environ - January 2007 (IT Carlow), February 2008 (DkIT)
30th Congress of the International Association of Theoretical & Applied Limnology - August 2007 (Montreal, Canada)
National Water Summit - September 2007 (Croke Park, Dublin)
Irish Water, Waste and Environment - March 2008 (RDS, Dublin)
Upcoming: EPA National Water Conference - June 2008 (Galway)

Relevant publications

1. Corrigan, D. 2008. *Onsite wastewater treatment systems and source water protection.* Unpublished M.Sc. thesis. DIT, Bolton St. & DkIT.
2. Jordan, S.N., Mullen, G.J. and M.C. Murphy. 2008. Composition variability of spent mushroom compost in Ireland. *Bioresource Technology*, **99(2),** 411-418.
3. Jordan, S.N., McCarthy, V., Corrigan, D., O'Donohoe, J., Carson, A., Wynne, C.A., Sweeney, N.F., Ba_ík, H.C. and S.M. Linnane. 2008. Evaluation of diffuse agricultural and point source contributions to catchment nutrient loadings. *Proceedings of the Annual Agricultural Research Forum,* March 2008.
4. Carson, A., Ba_ík, H.C. and S.M. Linnane. 2007. Detailed pigment analysis on a series of sediment cores taken from Milltown Lake, County Monaghan, Ireland. *30th Congress of the International Association of Theoretical and Applied Limnology (SIL)*, Palais des Congrès, Montreal, August 12-18, 2007. Accepted manuscript, In press at *Verhandlungen Internationale Vereingung für theoretische und angewandte Limnologie.*
5. Carson, A., Ba_ík, H.C. and S.M. Linnane. 2007. A Paleolimnological Investigation of Milltown Lake in County Monaghan, Ireland. *Proceedings of ENVIRON 2007*, In press.
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10. Linnane, S.M., Jordan, S.N., Cruikshanks, R.P., Carson, A., Sweeney, N.F., Wynne, C.A., McGoldrick, T., McGoldrick, J. and Ba_ík, H. 2006. National Source Protection Pilot Project at Churchill and Oram group water scheme, Co. Monaghan. 1st interim report.
11. Sweeney, N.F. and S.M. Linnane. 2007. Epilithic diatom communities as water quality indicators in the National Source Protection Pilot project, Co. Monaghan, Ireland. 30th Congress of the International Association of Theoretical and Applied Limnology (SIL), Palais des Congrès, Montreal, August 12-18, 2007. Submitted to *Verhandlungen Internationale Vereingung für theoretische und angewandte Limnologie.*
12. Sweeney, N. F. and S.M. Linnane. 2007. Epilithic diatoms as nutrient enrichment indicators in the National Source Protection Pilot Project, Co. Monaghan. *Proceedings of ENVIRON 2007*, In press.
13. Wynne, C.A. and S.M. Linnane. 2007. An investigation of the comparability of macrophyte and macroinvertebrate indices in lowland sites on the rivers of the Milltown (Muckno Mill) lake catchment, Co. Monaghan, Ireland. 3*0th Congress of the International Association of Theoretical and Applied Limnology (SIL)*, Palais des Congrès, Montreal, August 12-18, 2007. Accepted manuscript, In press at *Verhandlungen Internationale Vereingung für theoretische und angewandte Limnologie.*
14. Wynne, C. and S.M. Linnane. 2007. An assessment of the water quality in the Milltown Lake Catchment using a combination of macrophyte and macroinvertebrate Indices. *Proceedings of ENVIRON 2007*, In press.

8.0 MOVING FORWARD

Although source protection measures are only being implemented at this stage to combat both diffuse and point source pollution, their outcomes along with those of other remedial measures and incentives implemented in other countries like Canada and the United States, are pivotal to the devise of a source protection strategy for Ireland.

A multi-barrier approach towards source protection must be adopted in Ireland, from which potential benefits will not only protect public health but will also ensure lower treatment costs and maintain community education and character. As source protection refers to the implementation of policies to prevent and/or minimise contamination of water system, this project will eventually lead to the development of such policies and strategies pending the successful evaluation of the implemented remediation measures in terms of effectiveness and sustainability. This initiative will rely heavily on the effective participation of governmental authorities, local authorities, county councils, private stakeholders and local communities.

8.1 Project Recommendations to Date

This project strongly recommends that the starting point for source protection in Ireland must be **the enforcement of effective regulation** for both point and diffuse sources of pollution and furthermore, the enforcement of the Nitrates Directive in particular in this catchment[2].

In addition:

Effective monitoring must take place and is key to enforcement, particularly in targeting "one-off pollution incidences" which currently rely on community vigilance to track and therefore are not often reported.

Diffuse sources of pollution although difficult to combat, must be addressed and all targets will be achieved through initiatives such as:

- educating the community; or,
- providing grants to implement remedial measures and perhaps by adding extra incentives like tax rebates.

The enforcement of all existing relevant legislation must take place in order to be an integral tool in source protection and to this end:

- the introduction and enforcement of bye-laws such as those recently introduced by Cavan County Council to mitigate against malfunctioning of on-site wastewater treatment systems are essential[3].

Conditions of planning permissions in relation to on-site wastewater treatment systems must improve immediately as they are at present poorly enforced in the catchment, mainly due to a lack of essential personnel and this is a situation which needs to improve immediately. **Through project communication with local authorities and county councils, it appears that this situation is repeated throughout the country.**

Ongoing community involvement must underlie all of these initiatives and is a crucial element in the success to date of the National Source Protection Pilot Project. **Central to this community involvement is the continuing education of all local stakeholders.**

This project continues to succeed as a result of the enormous body of work undertaken initially in fostering community goodwill. It is therefore strongly recommended that, based on this success, the project continue to run for a suitable time period, allowing it to determine the effectiveness of ecosystem recovery following the implementation of source protection measures. For completion, it would be useful to test the recommended measures in two or three small catchments of differing topography and geology.

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[2] It should be noted that due to the confidentiality agreement between the project and landowners / stakeholders in the catchment, information gathered on individual premises is not passed on to Monaghan County Council for enforcement purposes. Monaghan County Council do however respond to environmental complaints received from the public both in this catchment and throughout the county.

[3] Cavan County Council Water Pollution (Wastewater Treatment Systems for Single Houses) Bye- Laws, 2004)

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