



Boyne

Liffey

Suir

# THREE RIVERS PROJECT

Water Quality Monitoring & Management



## Final Report Technical Summary

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European Union Cohesion Fund

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# Introduction



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## What is The Three Rivers Project ?

The Three Rivers Project is a Government initiative to develop catchment based water quality monitoring and management systems for the Boyne, Liffey and Suir rivers. This three year project is sponsored by the Department of the Environment and Local Government and by the constituent Local Authorities (L.A.), with support from the European Union Cohesion Fund (85%).

The Project has been carried out on behalf of the Government by a group of consultants led by M.C. O'Sullivan and Co. Ltd (MCOS), in collaboration with catchment co-ordinators, under the guidance of a single Steering Committee and three Operational Management Groups.

**This Report marks the completion of the Three Rivers Project and is a technical summary of the Final Report.**

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## Water Quality

### The need for improvement

Prior to the start of the Project in 1998, water quality in Irish rivers had been deteriorating since the 1970s.

This increase in pollution has been due mainly to over-enrichment of our streams and rivers by nutrients such as phosphorus and nitrogen. This national deterioration has been reflected in the water quality of the rivers Boyne, Liffey and Suir.

Nutrients enter our watercourses either as point source discharges from sewage treatment plants and industrial installations or as diffuse source discharges from activities such as agriculture and forestry or from urban drainage. Whilst point sources may be relatively easy to find and address, diffuse sources often can remain hidden and pollution may be difficult to trace and tackle.

Over-enrichment, referred to as eutrophication, can result in excessive growth of aquatic plants which choke waterways and deplete oxygen resources required for the survival of fish and other aquatic species. The presence of healthy salmonid (salmon and trout) populations in a waterway is a good indication of a healthy aquatic ecosystem suitable for beneficial uses such as water abstraction and amenity activities.

## Project Objectives and Achievements

It is the objective of the Three Rivers Project, and other similar catchment management projects, to reverse this trend of deteriorating water quality by developing management strategies for the river catchments as a whole which reflect a cross-sectoral approach to reducing organic and nutrient inputs to rivers and lakes.

Management strategies have been identified by the Project to tackle pressures on water quality emanating from all sectors of the community operating in the catchments. Available management measures include the implementation of regulations, licensing, application of codes of good practice, capital expenditure and cross compliance (**Part 5**). The Project adopted, and recommends, a targeted, stepwise approach to determining the appropriate management measures to be implemented in any particular area as the most efficient use of limited regulatory resources in tackling water quality problems (**Part 4**).

The Project approach is based on:

The collection of comprehensive datasets on pressures/risk characteristics of the catchments (**Part 1&2**).

A comprehensive water "quality" and "quantity" monitoring system to determine water status and nutrient loading and to identify the likely pressures influencing the water environment (**Parts 1&3**).

Prioritising the implementation of appropriate measures in areas of poor water quality to address these likely pollution sources (**Part 3**).

Additional focus on areas with "high risk" characteristics and areas which are sensitive to change due to their use or ecological importance.

"On the ground" investigation in priority areas where pollution sources are not immediately apparent.



*By 2015, watercourses should be returned to good ecological status suitable for all beneficial uses (WFD requirement).*

Appropriate management strategies, when combined with the available statutory instruments, give Local Authorities (L.A.) and statutory bodies the means to halt the trend of deteriorating water quality and produce improvements to meet quality targets set under the Phosphorus Regulations (1998) and other National and EU legislation.

The Project advocated the implementation of "Best Management Practice" across all sectors including Best Farm Management Plans (BFMP) in the agricultural sector, Sustainable Urban Drainage Systems (SUDS) in urban areas, the Code of Best Forest Practice for forestry activities, waste minimisation at source for industrial installations and better operation, monitoring and management of municipal wastewater treatment plants (MWWTPs). Best Farm Management Plans incorporate Best Farm Management Practices including nutrient management planning.

**(Key Recommendation 6G).**

In conjunction with Teagasc, the Project has refined the methodology for developing "BFMP" and "NMP" to minimise the impact of agricultural activities on water quality. The main features of this methodology are a focus on good farmyard management, assessment of the "hydrological risk" of the land in terms of potential loss of applied nutrients to water bodies, relating slurry storage requirements to "hydrological risk" and a field by field assessment of crop nutrient requirements. This methodology has been successfully implemented on 157 farms in the Rivers Yellow (Boyne), Clonmore, Dawn and Ara (Suir) sub-catchments.



*Urban drainage schemes like this settlement pond can reduce pollution from industrial and residential developments.*

The Project has established a river monitoring system, comprising of hydrometric, physico-chemical and biological elements.

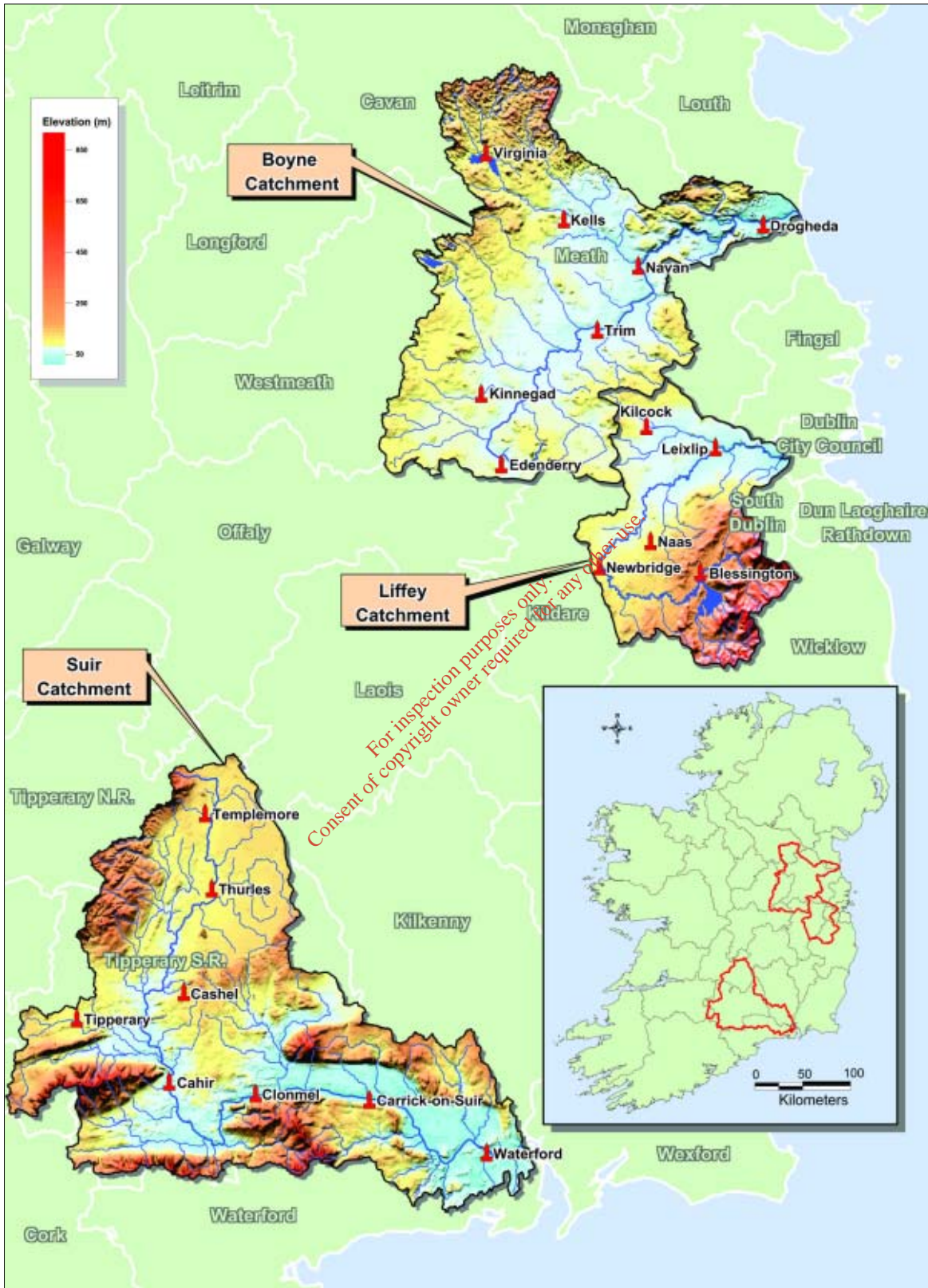
This system monitors water status in each catchment on an ongoing basis. Recommendations relating to future monitoring strategies within the 3 catchments are given.

Recommendations have also been made with respect to "facilities monitoring" (e.g. wastewater treatment plants and industrial discharges).

A Geographical Information System (GIS) "Catchment Envisage", has been developed to integrate, manage, analyse and present data on pressures/risk characteristics and results generated by Project, L.A. and EPA monitoring systems operating in the catchments. In addition, modules have been developed to manage data from both preliminary and detailed farm surveys and to assist in the development of BFMP. Catchment Envisage will facilitate the updating of management strategies on an ongoing basis to target specific catchment areas or sectors contributing significant pollution loads to the river systems.

The training of staff who will operate the monitoring and management systems in the future has been an important function of the Project. Approximately 70 personnel from Local Authorities and other statutory bodies have received training in the GIS system while approximately 50 Local Authority staff involved in water quality and waste management in the catchments have attended Project workshops and site visits on Best Farm Management Practices and Nutrient Management Planning.

A public awareness campaign aimed at engendering ownership and protection of our water resources across all sectors has been ongoing since the start of the Project. In addition to successful campaigns aimed at school children, advice leaflets on management of septic tanks, "BFMP" and a Project website, the campaign focused on involving various sectors at a local level.



Map 1 Boyne, Liffey and Suir Catchments Location

## What Happens Next?

To comply with the requirements of the Water Framework Directive, the Department of the Environment and Local Government is currently funding the establishment of river basin management projects to manage all inland and coastal waters around the country. River Basin Districts (RBD's) in Ireland have been delineated by the natural grouping of hydrometric areas (i.e. river catchments) into water resource regions already familiar to Local Authorities and public bodies.

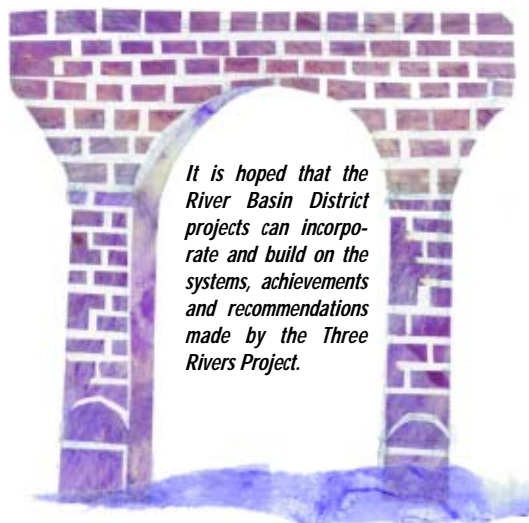
The Boyne and Liffey catchments will be incorporated into the Eastern River Basin District while the Suir catchment will be incorporated into the South Eastern River Basin District.

The aims and objectives of these projects are similar to but broader in scope than the Three Rivers Project and other catchment projects. They seek to establish management systems, including a programme of measures designed to maintain and/or achieve at least "good status" for all waters. The new projects will address inland surface waters, groundwaters and transitional and coastal waters and must address all pollutants.

## Acknowledgements

The Project personnel acknowledge the contribution of all those bodies and individuals who participated in the project particularly those who participated in the pilot/special studies in the Yellow (Blackwater), Ara, Clonmore, Dawn, Clonshanbo, Camac and Kings River catchments. A list of Project Partners is included in this document and particular thanks is offered to staff of Teagasc (research and advisory units), the EPA (water quality and hydrometric sections), Waterford Co.Co., local farming communities and organisations, and lead Local Authorities of Meath, Kildare and Tipperary South Riding County Councils.

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## Three Rivers Project

# Water Status



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# Water Status

## Pressures and Risk Characteristics

The first step in developing management strategies for protecting and improving water quality is identifying and quantifying the pressures that have the potential to impact on that quality.

Pressures on a river system are defined as "any activity that will alter its physical, hydrological (water flow), biological and chemical elements, including discharges to or abstractions from the system". Activities that result in discharges to river systems can generally be divided into those that result from point and diffuse discharges.

**Regulated Point Discharges** are typically those discharges that can be easily identified, monitored and quantified, e.g. discharges from municipal wastewater treatment plants or industries.

**Diffuse discharges** are primarily associated with runoff from landuse such as agriculture, forestry or urban development. However, because of the difficulty of establishing the locations of certain point discharges, for example those from farmyards, septic tanks and urban drains, these "unregulated/other point discharges" are also considered as contributing to diffuse pollution.



All these discharges, whether from regulated point or diffuse sources, present a potential risk to water quality in the catchment. Generally, it can be expected that the potential risk will increase as the density/intensity of these activities increase.

### Regulated Point Discharges

An inventory of all known regulated point source discharges to rivers in the 3 catchments was completed during the first and second years of the Project. These discharges emanate from MWWTPs (37, 12, 60 in the Boyne, Liffey and Suir catchments respectively) associated with population centres, and licensed discharges from industrial installations (17, 11 and 40 in the Boyne, Liffey and Suir catchments respectively).

Monitoring results of effluent from these activities indicated that in the majority of cases there was insufficient data available to allow accurate quantification of pollution load from these sources, particularly in relation to nutrient loads. Discharges from MWWTPs are regulated under the Urban Wastewater Treatment Regulations. Discharges from industrial installations discharging to watercourses are licensed under IPC legislation or under Section 4 of the Water Pollution Act, or to foul sewer under Section 16 of the same Act.

Under the Urban Wastewater Treatment Regulations (UWTRs) the majority of MWWTPs in the 3 catchments are not required to provide the type of treatment prescribed under the Regulations until 2005. The Project team concluded that as they stood these Regulations did not provide adequate protection to river systems against eutrophication.

In light of the quality objectives set by the Phosphorus Regulations the Project recommended in its Preliminary Report, an urgent review of the UWTRs particularly with regard to the frequency and scope of monitoring required at treatment plants.

While the Regulations have been reviewed in the intervening period, the Project recommendations have not been incorporated into this legislation. The Project further recommended that Local Authorities and the EPA should re-assess the monitoring requirements and discharge limits on all IPC and Section 4 licences with the express goal of meeting quality objectives in receiving waters and providing accurate load data from each installation (**Key Recommendations 6D & 6E**). Two surveys of progress on the implementation of these recommendations indicate that implementation is slow due to a lack of manpower resources.

### Diffuse Discharges

Diffuse discharges are primarily associated with runoff from land as a result of landuse activities and its physical characteristics. The major landuse and physical characteristics that indicate potential risk from diffuse pollution are listed in **Table 1a**.

Particular areas of a catchment may have a higher potential to generate diffuse pollution than other areas due to their physical characteristics (slope, soil characteristics, rainfall etc.) and the type and intensity of landuse.

Therefore management measures should be focused on these higher risk areas to enable efficient use of resources. The development of a methodology for assessing the potential risk for diffuse pollution from landuse sources in the 3 catchments is described below.

## Risk Assessment for Agricultural Landuse

Considerable work was carried out in the initial phase of the Project in developing a risk assessment methodology/model, based on physical and landuse characteristics.

GIS techniques were used to interrogate various datasets to identify areas that had the potential to contribute significantly to diffuse nutrient pollution (Model 1).

Risk was principally related to physical and landuse characteristics, animal numbers and the application of nutrients to the land as mineral or organic fertilisers. Attempts to validate the resultant model using existing water quality data were unsuccessful, however, as areas identified as high risk did not necessarily exhibit poor water quality (as defined by MRP concentrations in the water).

Potential Risk Indicators	
<p><i>Inputs/ landuses</i></p> <p><b>Regulated Point Discharges</b> MWWTPs, IPC &amp; Section 4 licensed discharges</p> <p><b>Unregulated/Other Point Discharges (contributing to diffuse pollution)</b> MWWTP and pump station overflows Population centres/urban drainage outfalls Rural housing/septic tanks Animal housing units/farmyards/slurry storage tanks Non IPC piggeries Unlicensed industries</p> <p><b>Diffuse pollution sources</b> Intensively farmed areas (high stocking rate, arable farming) Slurry/sludge spreadlands Areas where fertiliser applications exceed crop requirements</p>	<p><i>Physical Characteristics</i></p> <p>Low gradient river stretches Steep gradient catchments Areas of high rainfall Poorly draining/water logged soils Areas of high runoff risk (after Teagasc: incorporating soil type, drainage density, slope and rainfall)</p> <p>Urbanised/paved areas</p> <p>Areas with Soil phosphorus level greater than Index 3</p>

**Table 1a.** Potential Indicators of Point and Diffuse Pollution Risk

Substantial water quality data was collected at a catchment scale over the course of the Project while higher resolution landuse data was collected in 4 sub-catchments. Further work has now been carried out in developing a risk model using this new data (Model 2). In addition, the model developed by the Derg/Ree Catchment Project was also applied. However, once again, neither of the models could be validated to a statistically significant level.

Statistical analysis of both catchment and sub-catchment scale data sets suggest a number of reasons why a good fit could not be found. The primary reason was attributed to the major influence that point sources (including unregulated discharges such as badly managed farmyards, septic tanks, storm overflows and urban drainage) have in the Three Rivers catchments. The lack of detailed information on their pollution load or location does not allow their effect to be removed from the equation and so they can mask the influence of diffuse pollution impacts from land runoff.

Data analysis at a sub-catchment scale found a correlation between the presence of farmyards and farm buildings, and the MRP loads in the watercourse, taking into account the condition of the yards (i.e. well or poorly managed) and their distance from the river. In addition a correlation was found between the presence of residential buildings and MRP load, although farmyards were found to have a much greater influence. For example, field investigations and monitoring data indicated that in one of the sub-catchments studied, a poorly managed farmyard at the u/s end was contributing approximately 20% of the MRP load to the watercourse.

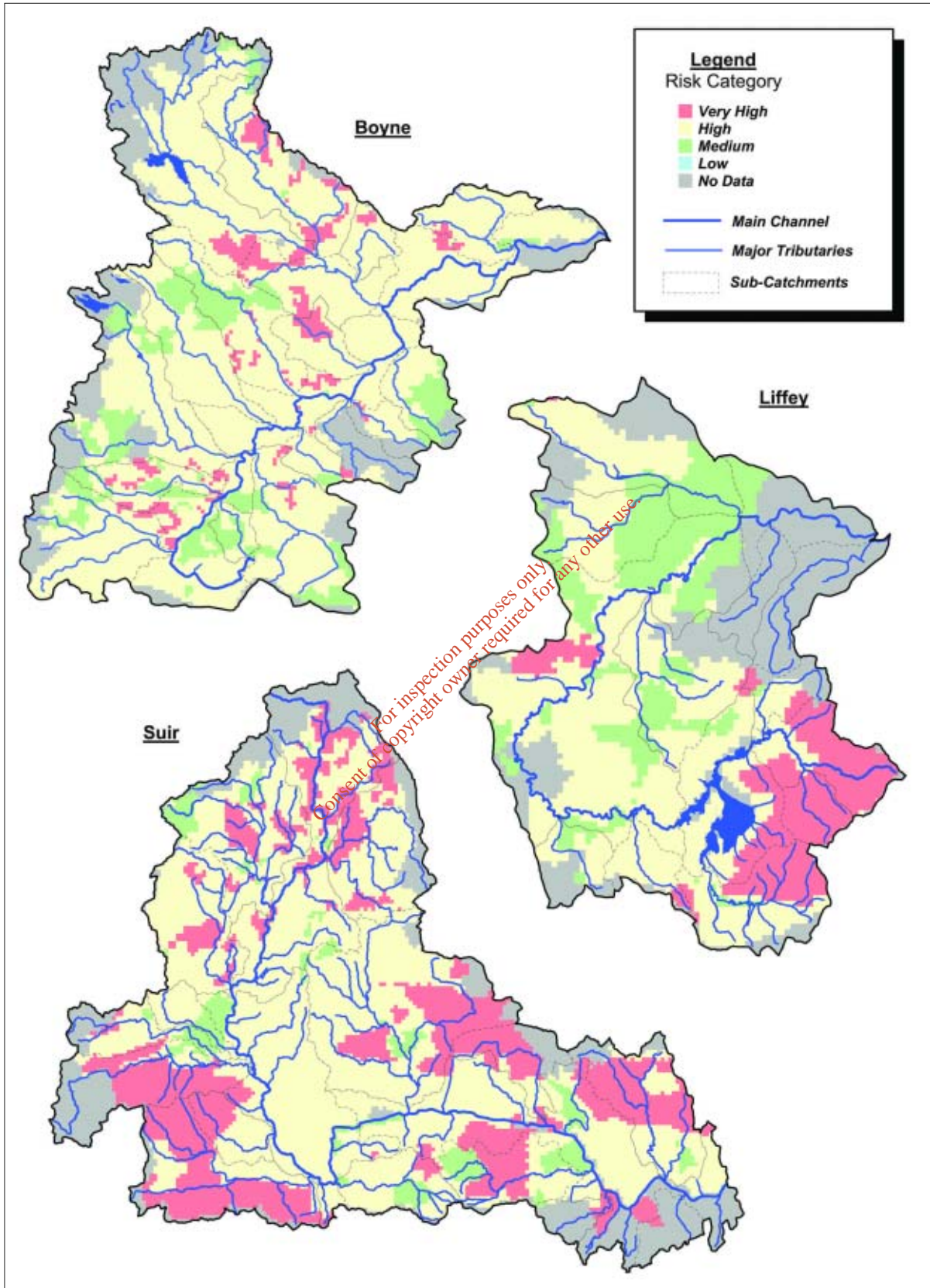
A significant correlation was found between MRP concentrations in watercourses and the over application of phosphorus (as defined by existing phosphorus levels in the soil, the amount of P applied and crop requirements) at a sub-catchment scale. Similarly, a correlation was found between MRP concentrations and the mean stocking rate of animals though over application of phosphorus had a greater influence. **Table 1b.** shows the most statistically significant factors identified.

The Lough Derg and Lough Ree Catchment Project (Derg/Ree Project) and other studies and research have established a correlation between agricultural landuse and nutrient concentrations/loads in watercourses based on national datasets. While the Three Rivers Project was not able to establish a statistical relationship at catchment scale, it is considered that when the influence of all point sources is resolved and data sets improve, these models can be validated in the Three Rivers catchments (**Key Recommendation 1A**). Thus the Project recommends that a risk model should be included as part of the strategy for determining and prioritising management measures to be implemented in the catchment.

**Map 2** indicates Potential Agricultural Risk Areas for phosphorus loss (after the Derg/Ree Project) for each catchment. Experience in the sub-catchment study areas suggests that local knowledge from organisations such as farming organisations, fisheries, and local anglers is a good and accurate method of assessing the pollution sources in an area. This method should be used along with water quality (WQ) data to validate model results.

Significant Risk Factor
<ul style="list-style-type: none"> <li>• Presence of farmyards and farm buildings in proximity to watercourses</li> <li>• Presence and density of residential buildings within a catchment</li> <li>• Application of phosphorus over and above crop requirements</li> <li>• Higher stocking rates</li> </ul>

**Table 1b.** Significant factors contributing to P loss to watercourses (Three Rivers - Statistical Analysis)

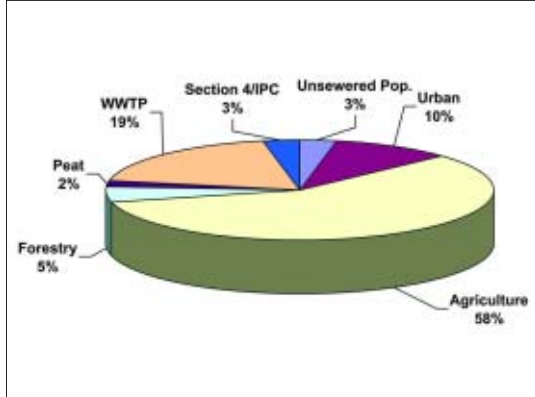


**Map 2 Risk Areas for Loss of Diffuse Phosphorus from Agricultural Systems (after Derg/Ree 99) for the Boyne, Liffey and Suir Catchments.**

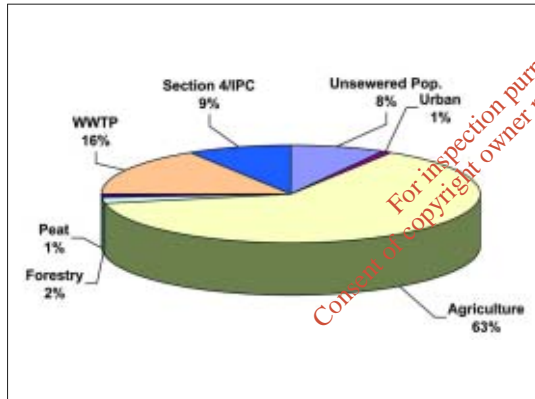
Note: Risk areas not validated by observed water quality.

## Sectoral Loads

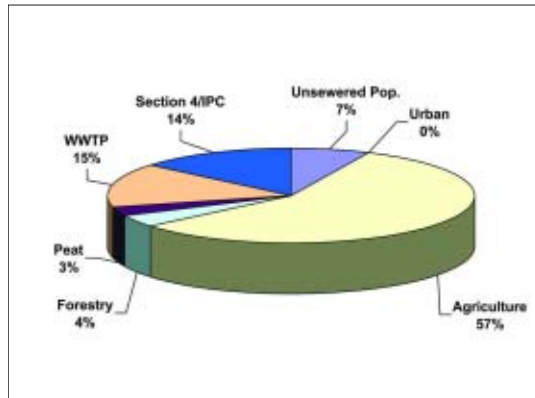
At the start of the Project the nutrient load discharged from each sector of the community was estimated based on available data.



1A. Sectoral TP Loads - Liffey



1B. Sectoral TP Loads - Boyne



1C. Sectoral TP Loads - Suir

Figures 1A. to 1C. Sectoral TP Loads, Boyne, Liffey and Suir Catchments

This included existing water quality monitoring data, discharge limits set for licensed discharges, design loads and populations served by MWWTP, estimates of rural populations and estimates for nutrients exported for different landuse categories.

Following extensive monitoring and investigation over the 3 years of the Project more accurate figures on the loads exported from different sectors can now be estimated. These estimates are summarised in **Table 2** and **Figures 1A-C**.

The derived co-efficients of Total Phosphorus loss from differing landuses, based on investigations carried out in the Project Pilot Catchments (Part 2) are 2.4 kg/ha/yr for arable areas, 0.32 kg/ha/yr for grassland and 1.29 kg/ha/yr for urban areas.

It is estimated that agricultural landuse exports approximately two-thirds of the TP load to each of the catchments while regulated point discharges (MWWTPs and licensed discharges) contribute approximately one quarter of the total load. The remaining load is generated by unsewered populations (3 to 8%), urbanised areas (1 to 10%) and forestry/peat land (3 to 7%).

However, loads calculated from water quality and flow data collected at the freshwater limit (FWL) of the catchments indicate the methods used may either over-estimate the discharges or that all of the nutrients discharged do not reach the FWL but are utilised by aquatic flora or are adsorbed to sediment en route.

Increased monitoring of regulated point discharges as recommended by the Project (**Key Recommendation 6E**) will resolve much of the difference between estimated and measured loads.

# Monitoring Systems

## Introduction

A comprehensive monitoring system has been established in each of the 3 catchments. This system is comprised of hydrometric, biological and physico-chemical elements and focuses on determining the biological and physico-chemical status of the river systems and on quantifying the nutrient loads emanating from different tributaries in each catchment and from different type of landuse and activities. These networks are shown in **Maps 3, 4, and 5**. Monitoring commenced in January 2000 and is ongoing. Some data gaps exist, however, due to access problems during the Foot and Mouth restrictions, particularly on the Suir catchment.

## Hydrometric Monitoring

A hydrometric network was established in conjunction with Local Authorities, EPA Hydrometric Section, ESB and the Office of Public Works. Where possible, existing stations were incorporated into the Project network. However, many new stations were required, as was additional work at existing sites to adapt these stations to measure low flows more accurately.

The EPA rated (calibrated) these stations on behalf of the Project and levels measured up to spring 2001 were used to establish rating curves for all newly installed or improved stations.

### Boyne/Liffey Catchments

Forty-one new or upgraded sites were installed in the Boyne and Liffey catchments representing a 140% increase in the number of hydrometric stations in the two catchments, at a cost of approximately €164,500. The increase in the number of sites was most pronounced in the Liffey where only 8 of 29 previously existing sites were available at the start of the Project. The current functional system represents 78% of the Projects proposed hydrometric network.

**Some further work is needed at 18 sites and 25 new logger systems are recommended over the 2 river catchments. The budgetary requirement to complete the upgrade is estimated at €276,500.**

### Suir

Twenty-nine new or upgraded sites were installed in the Suir river catchment representing a 120% increase in the number of hydrometric stations, at a cost of approximately €164,500. The current functional system represents 84% of the proposed upgrade.

**Some further work is needed at 29 sites and 32 new logger systems are recommended. The budgetary requirement to complete the upgrade is estimated at €336,500.**

In the main, the various authorities installed a significant portion of the required network and the overall upgrade was a success.

	Revised Estimates Final Report – TP Loads		
	Boyne	Liffey	Suir
<b>Point (regulated)</b>	55	34	56
<b>Diffuse</b>	155	77	139
<b>Total Estimated Load</b>	210	111	195
<b>*Load measured at the freshwater limit.</b>	161	79	189

\*calculated from continuous water quality and flow monitoring data collected at the freshwater limit  
 Units = Tonnes of TP/ year (Total Phosphorus)  
 Note: Estimated loads do not include discharges made directly to the estuary

**Table 2 Phosphorus Loads**

Unfortunately, there were generally significant delays in implementing the required upgrades in most of the L.A. areas due to the absence of funding. The Project budget did not include provision for hydrometric works and L.A. had to provide funding from their own resources.



*Hydrometric surveying on the Kings River.*

## Recommendations

The Project recommends the transfer of the primary responsibility for all hydrometric stations from the L.A. to the EPA, except for OPW and ESB stations (**Key Recommendation 2B**). The EPA would then be responsible for all aspects of the hydrometric systems. This would only be possible if the EPA was awarded complete control of budgetary requirements and is resourced accordingly. The advantage of this management system lies in the centralisation of responsibility to the organisations with the most expertise (i.e. the EPA, OPW, and ESB). It negates the management difficulties of co-ordinating each L.A. within a catchment or RBD, each with its own budgets, priorities, resource problems, and possible involvement in several catchments or RBD's.

## Physico-Chemical Monitoring

Comprehensive networks of water quality monitoring sites were established in each catchment (76 in the Boyne, 75 in the Liffey and 85 in the Suir) and have been monitored regularly by the Project catchment teams since January 2000.

During the first 2 years of monitoring, more than 25,000 samples were generated and analysed in the 3 catchments. A schedule of sampling and parameters analysed is given in **Table 3**. The monitoring systems relied to a large extent on grab sampling; (a single sample of water) carried out at weekly intervals with samples returned to the Project laboratory for analysis within 24 hours. In addition, automatic water samplers were deployed at key locations in the catchments, i.e. at the bottom of pilot study areas, at the confluence of the major tributary with the main channel and at the freshwater limit of the main channel. These samplers were permanently housed on the bank of the river, and either sampled water at half-hourly intervals (Time Related), or took samples with reference to a set flow passing the sample point (Flow Related). The flow related samples taken at the bottom of the pilot catchments were used to make more precise estimates of nutrient loads discharged from these catchments.

The 48 samples taken over the course of a day were stored in one bottle and the 7 bottles collected weekly and returned to the Project laboratory for analysis.

Due to the interval between sampling and analysis (up to one week), auto-sampler samples were only analysed for the more stable parameters (Total Oxidised Nitrogen [TON], Total Phosphorus [TP] and Suspended Solids [SS]). Grab samples were also taken at each of these sites when the auto-sampler bottles were collected to establish the relationship between MRP (Molybdate Reactive Phosphate) and TP at these sites.

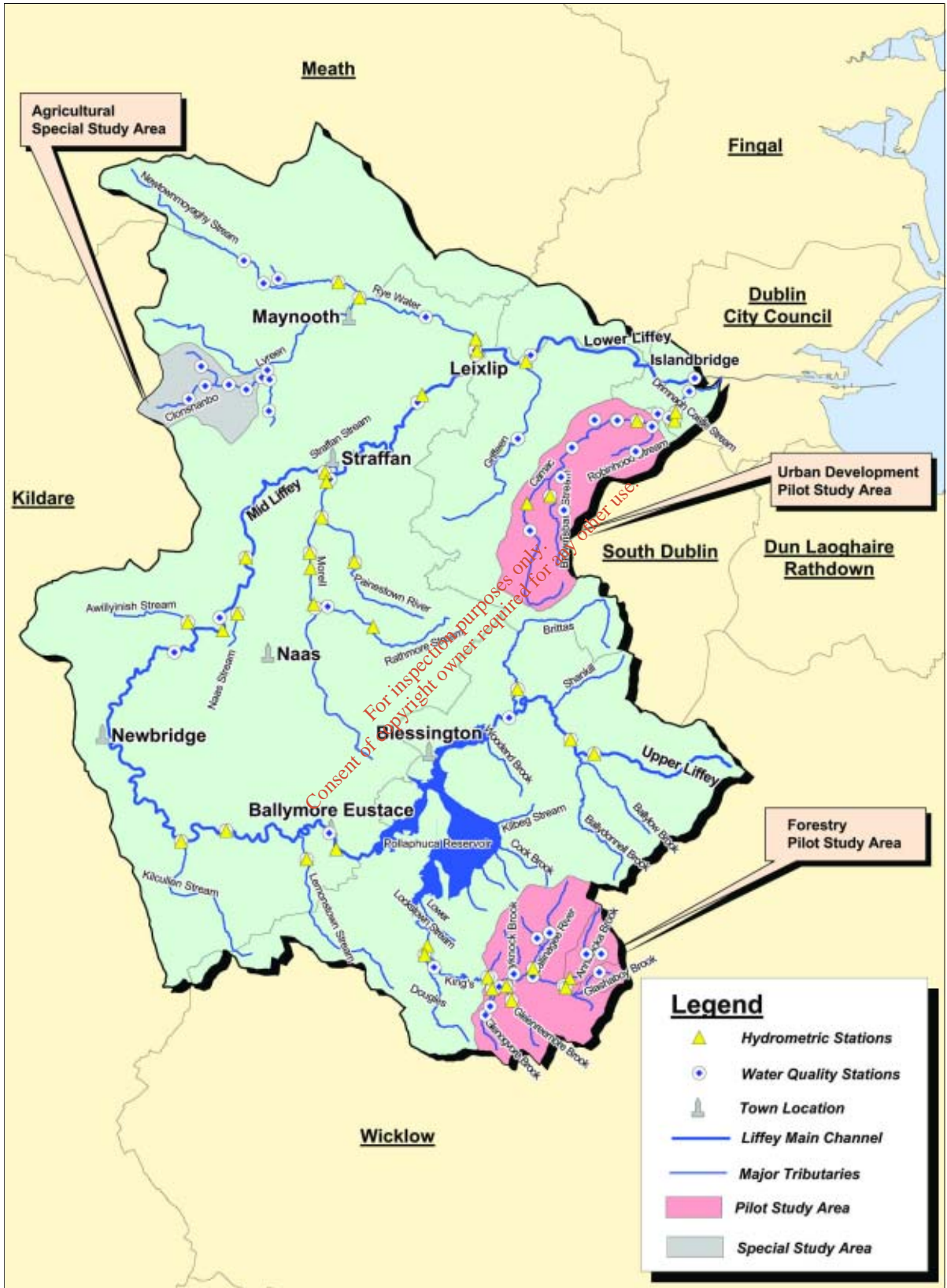
## Biological Monitoring

Annual monitoring of water quality using the EPA's macro-invertebrate index (Q index) was carried out at the majority of the Project water quality monitoring sites, 60 in the Boyne, 52 in the Liffey, and 70 in the Suir.

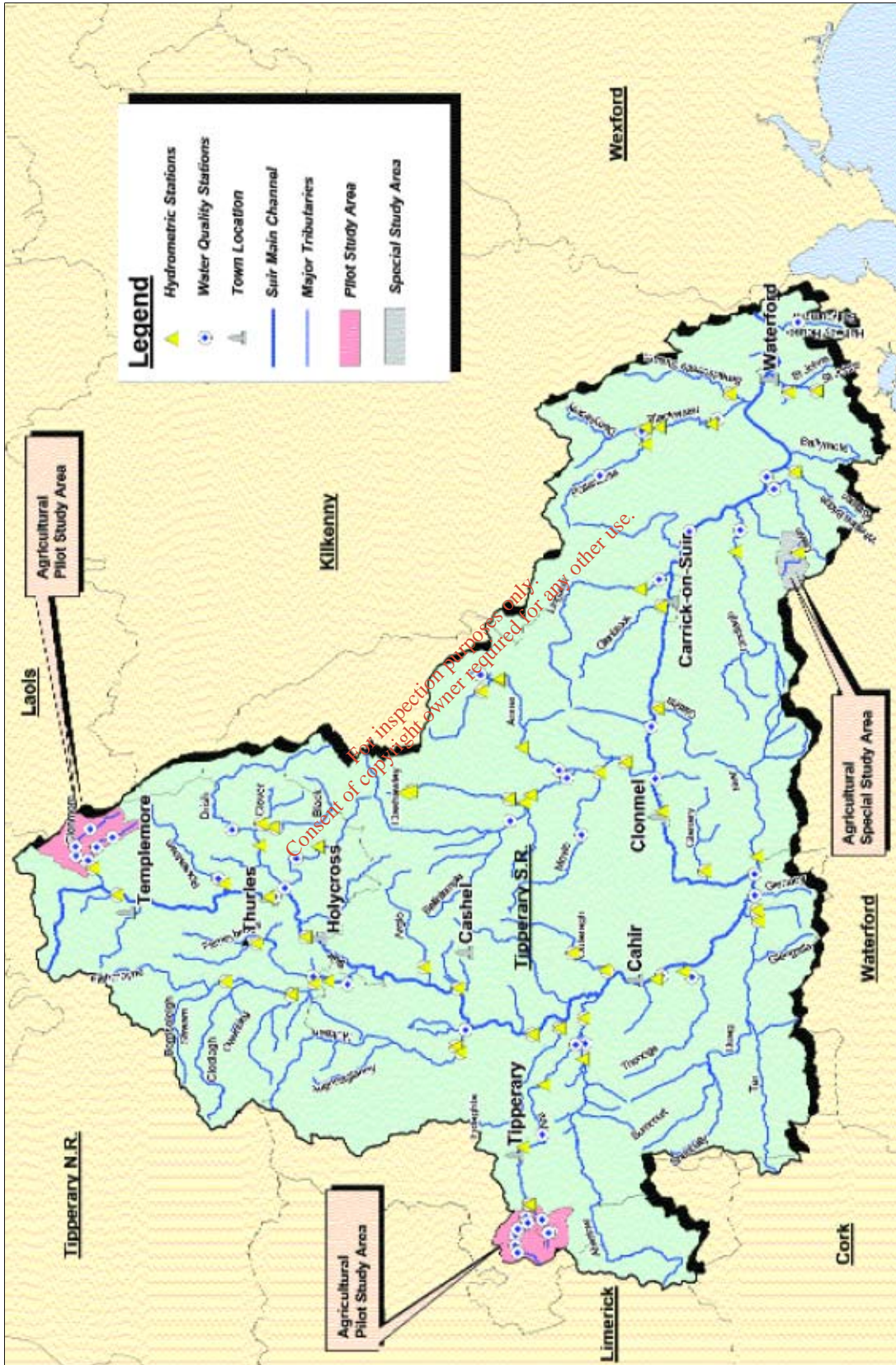
In addition to monitoring invertebrate communities, both fish habitat and aquatic flora in the vicinity of the sites were surveyed on each sampling occasion.



Map 3 Boyne Catchment - Project Monitoring Network



Map 4 Liffey Catchment - Project Monitoring Network



Map 5 Suir Catchment - Project Monitoring Network

The Project monitoring programme was carried out in conjunction with the EPA's tri-annual national monitoring programme. The EPA monitored the Suir catchment in 1999 and the Boyne catchment in 2000 and these results have been made available to the Project. Unfortunately, the planned EPA 2001 survey for the Liffey catchment was not carried out due to Foot and Mouth Disease restrictions, and other time constraints.

## Additional Monitoring

### Groundwater

A limited programme of groundwater monitoring was undertaken in the Clonshanbo Special Study area to investigate nutrient concentrations in groundwater and subsequent impact on nutrient concentrations in watercourses due to recharge of surface water from groundwaters.

Nutrient concentrations were measured in a random sample of 14 existing wells/bore holes in the catchment that were in everyday use. Faecal coliforms were used as a "marker" to indicate the possible source of contamination by septic tanks or animal slurries. The findings are discussed in **Part 2**, Clonshanbo study area.

### Dangerous Substances

A limited programme of "Dangerous Substance" (DS) monitoring, i.e. certain metals, solvents and pesticides, was undertaken twice in 2000 (July and October) and again in autumn 2001.

The aim of the monitoring was to give a broad indication as to what substances were present d/s of significant discharges in order to focus future monitoring programmes. It aimed also to aid compliance with the 76/464/EEC Dangerous Substances Directive, and provide input to other international obligations, e.g. OSPAR (Oslo Paris Conventions for the prevention of Marine Pollution).

Both sediment and water column samples were collected in 2000 from sites d/s of MWWTPs, a landfill site and an arable agricultural area. Following evaluation of results, only sediment samples were included in the 2001 round of sampling. This was due to the difficulties encountered in detecting the required determinands by the laboratory techniques used.

The preliminary evaluation indicates that results of this monitoring were inconclusive, mainly due to sampling and analytical constraints. However, the monitoring did identify the need for the establishment of a more comprehensive national Dangerous Substances monitoring programme, assisted by specialised, accredited, laboratory facilities capable of achieving the limits of detection required (**Key Recommendation 2C**). This monitoring programme should be incorporated into the new River Basin District (RBD) projects, and be supplemented by a National protocol dealing with the taking, treatment, analysis and reporting of Dangerous Substances samples.

### Fisheries

Electro-fishing surveys of fish populations were carried out at 25 selected sites within the three catchments in the autumn of 2000. The survey was repeated at 11 sites in the Suir catchment in autumn 2001. Unfortunately, legal difficulties with the licensing of these surveys precluded monitoring in the Liffey and Boyne catchments in 2001.



Station	Location	Frequency	Sample Type	Parameters
<b>Estuary</b>	St Mary's Bridge (Boyne) Suir Lodge & Fiddown (Suir)	Weekly	Grab	DO, T, pH, MRP, NH <sub>3</sub> , TON, SS, Cond., NO <sub>2</sub>
<b>Freshwater Limit</b>	Obelisk Bridge (Boyne) U/s Island Bridge (Liffey) St. Thomas's Bridge (Suir)	Daily	Auto Sampler (Time Related)	DO, T, TP, TON, SS
		Weekly		DO, T, pH, TP, DRP, MRP, NH <sub>3</sub> , TON, TN, SS, Cond.
<b>Confluence of major tributaries</b>	Kells Blackwater, at Liscarton (Boyne) Ryewater at Leixlip (Liffey) Anner at Silver Br (Suir)	Daily	Auto Sampler (Time related)	DO, T, TP, TON, SS
		Weekly	Grab	DO, T, pH, Cond, TP, DRP, MRP, NH <sub>3</sub> , TON, SS, NO <sub>2</sub>
<b>Pilot Study Areas (d/s Stations)</b>	Yellow Blackwater (Boyne) Camac (Liffey) Kings (Liffey) Clonmore (Suir) Ara X 2 (Suir)	Daily	Auto Sampler (Flow related)	DO, T, TP, TON, SS
		Weekly	Grab	DO, T, pH, Cond, SS, TP, DRP, MRP, NH <sub>3</sub> , TON, TN, NO <sub>2</sub>
<b>Pilot Study Area</b>	Other stations	Weekly	Grab	DO, T, pH, Cond, SS, TP, MRP, NH <sub>3</sub> , TON, NO <sub>2</sub>
<b>All other sampling locations</b>	Main channels and tributaries	Weekly	Grab	DO, T, pH, Cond, MRP, NH <sub>3</sub> , TON, NO <sub>2</sub>

**Table 3** Current schedule of physico-chemical Monitoring

Type of Monitoring	Purpose	Frequency
<b>Surveillance</b>	Generation of data for compliance and surveillance monitoring e.g. Phosphorus Regulations	Monthly
<b>Investigative</b>	Targeting specific water quality problems identified by routine physico-chemical or biological sampling (operational monitoring)	Weekly for a 1 to 6 month period (in conjunction with an auto-sampler)
<b>Load</b>	d/s end of catchments for calculation of the nutrient load	Weekly
<b>Point Source/Hotspot</b>	u/s & d/s of major point sources, to measure impact on the watercourse	Weekly
<b>Auto-sampler</b>	Permanent at Key sites; portable and deployed to target areas for investigative monitoring	Daily

**Table 4** Recommended Schedule of Future Monitoring

The purpose of these surveys was to establish a baseline against which to monitor changes in fish populations in order to provide an insight into how fish populations respond to changing water quality brought about by improved management practices.

More long term monitoring of fish populations will be required before such a response can be quantified.

## Recommended Revision to Sampling Programmes

Statistical analysis of physico-chemical sampling results was undertaken to establish the most appropriate frequency at which sampling should be undertaken in order to :

- Obtain a representative annual median or mean concentration value.
- Determine a best estimation of nutrient load emanating from a catchment/sub-Catchment.

This analysis indicated that :

With respect to  $\text{NH}_3$  (ammonia), MRP (phosphorus) and TON (Total Oxidised Nitrogen), monthly sampling tends to over estimate median concentrations, relative to weekly sampling.

Thus monthly sampling (12 samples per year) will give a conservative annual median and thus is acceptable in terms of compliance and surveillance monitoring.

It was also found that an annual median is more representative than an annual mean when considering monthly samples.



*Fishery survey work being carried out on the Boyne catchment*

With respect to estimating nutrient loading, weekly sampling is more representative than monthly sampling. While infrequent measurement of elevated concentration events during monthly sampling will not significantly influence annual medians; such measurements can influence load estimates as elevated concentrations frequently occur during high flows. Daily "flow related" sampling will give the best available estimate of nutrient loads.

Based on the results of this analysis, it is proposed that the 3 Rivers monitoring programme be tailored to the specific data requirements of each sample point as outlined in **Table 4**. The recommended locations of the different types of sample points are shown in **Map 6**.

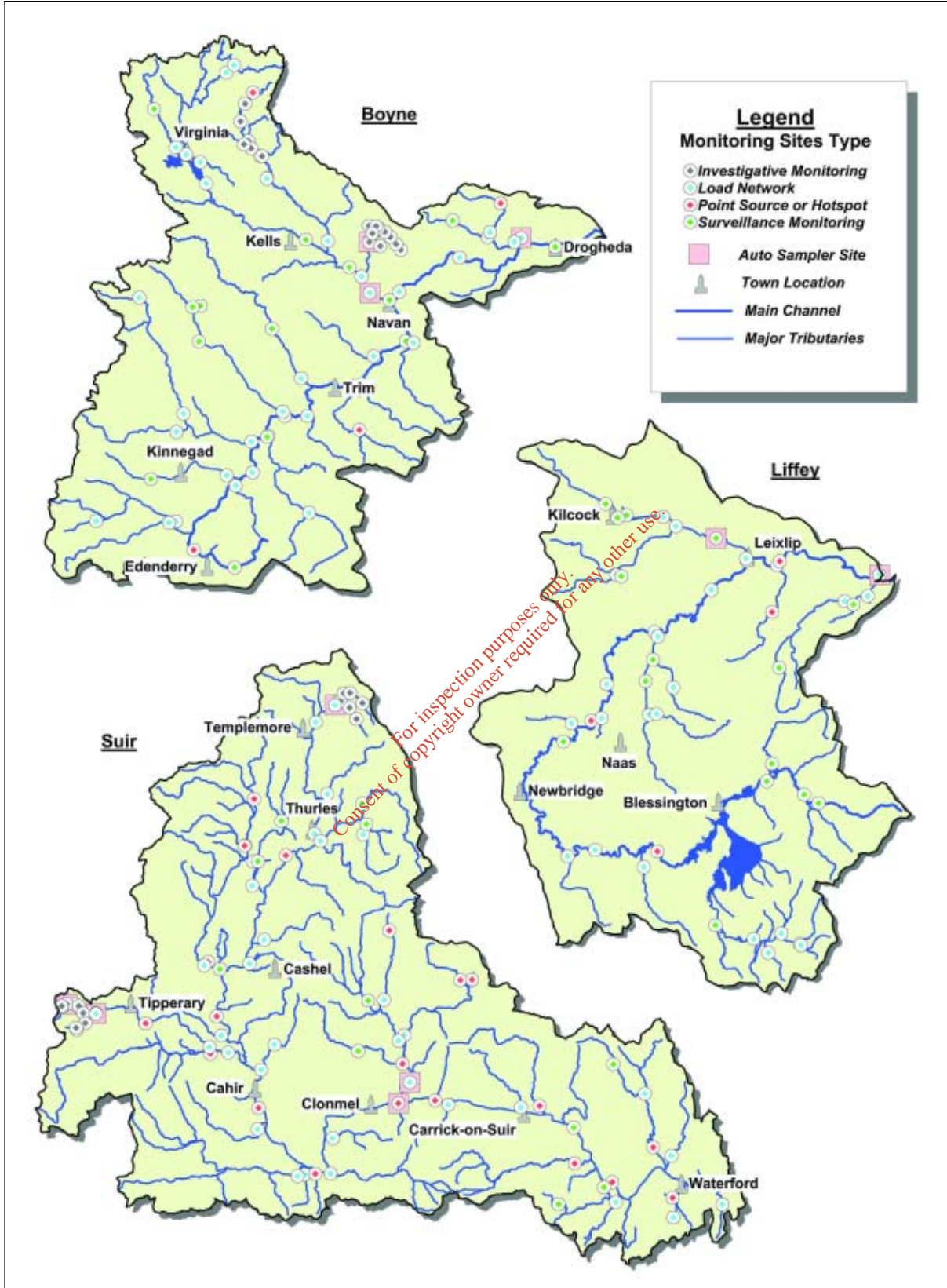
## Water Status Monitoring Results

### Water Quality Criteria

The criteria used to assess water quality in the three catchments are shown in **Table 5**. These criteria are mainly based on threshold limits that the EPA have identified as being indicative of potential poor water quality.

For example, median annual concentrations of greater than 5.65 mg/l TON or 0.03 mg/l MRP may indicate that the natural ecosystem of that waterbody is impaired. The DIN (Dissolved Inorganic Nitrogen) criterion of 2.6 mg/l N is relevant to stations at the freshwater limit of a catchment, and estuarine sites, only. Concentrations of greater than this may lead to eutrophication problems in the receiving estuary.

The following assessment of physico-chemical water quality is based on the Project sampling program carried out in the years 2000 and 2001. Results are compared to baseline data collected during L.A. sampling programmes for the period 1995-1997 to establish an increasing or decreasing water quality trend.



Map 6 Recommended Monitoring Network

It should be noted that monitoring sites that were established in the study areas to investigate specific pressures were **not included** in this assessment as their focus in areas of poor water quality may tend to skew the results. However, for information, the quality results for these sites are shown on the relevant maps.

The assessment of biological quality is based on the most recent EPA/Project monitoring results, 2001 for the Boyne and Suir catchments and 2000 for the Liffey catchment. Baseline data for the Boyne and Suir was generated from sampling in 1995-97, with the Liffey baseline data being from the 1998 EPA survey on this catchment.



## Boyne Catchment

### Biological Status

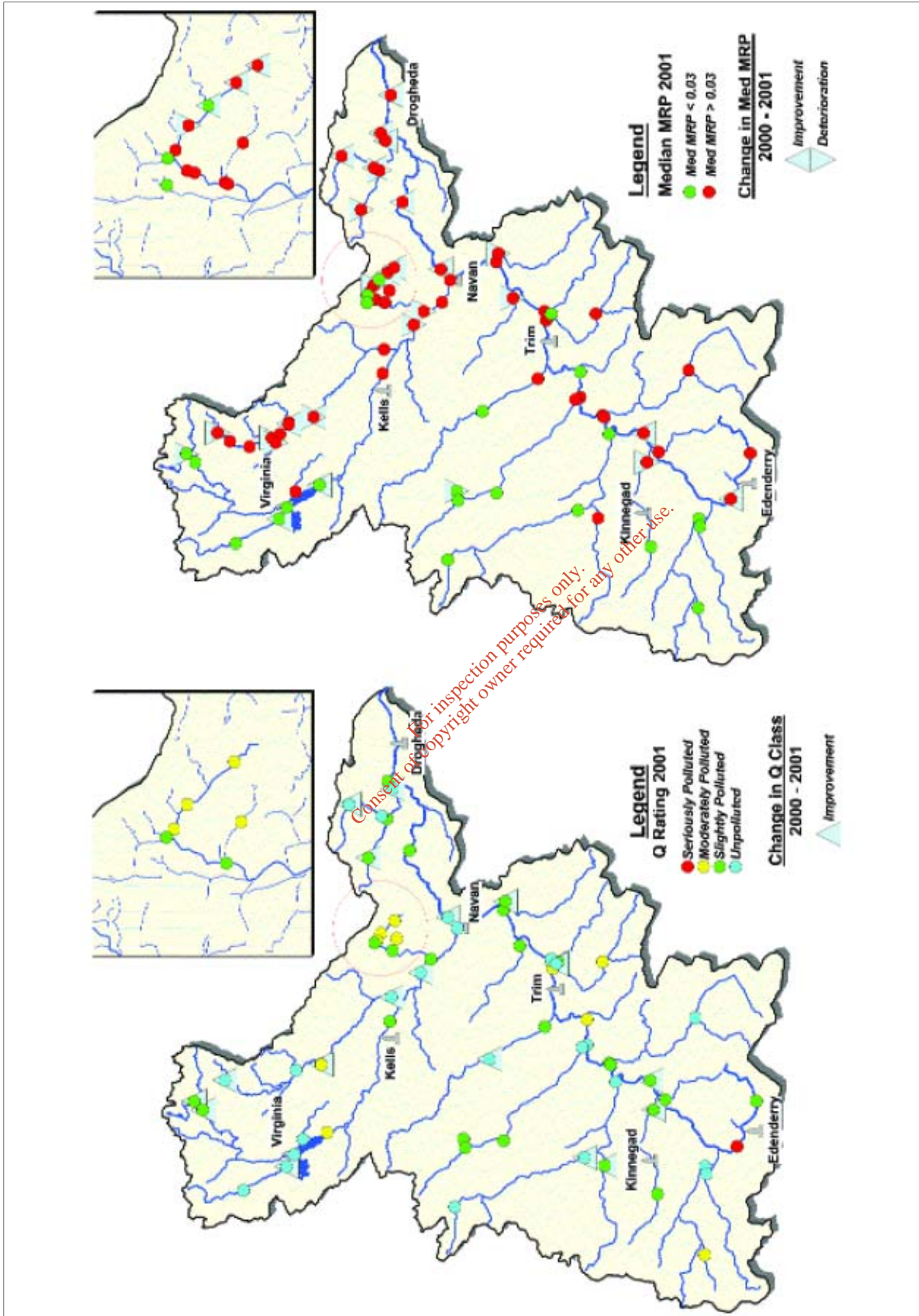
The quality class, calculated from Q-Ratings, is shown for each monitoring site in the Boyne catchment in **Map 7** for 2001. Any change in class since the year 2000 is also indicated. Excluding sites in the Pilot catchments, 22 sites were rated "unpolluted", 25 "slightly polluted", 6 "moderately polluted" and 1 "seriously polluted" in 2001.

There has been a significant overall improvement in biological quality between 2000 and 2001. In this period, 45% of sites improved their quality classification and 55% of sites remained the same. No sites deteriorated in classification. The main improvements were on the **Boyne main channel, the Mattock, Knightsbrook, Deel** and the **Moynalty**. However, poor quality sites remained on the **Rivers, Blackwater (Kells), Moynalty, Mattock, Devlins and Knightsbrook**.

**Figure 2** shows the percentage of Project sites falling into each quality class over the last 3 years, and compares 2001 results with the Baseline data for comparable sites. Of the 54 Project sites monitored both in 1997 and in 2001, 28 (52%) improved in quality and 25 (46%) remained stable.

Determinand	Min	Med	Max
Dissolved Oxygen (%)*	≥80	≥80 or ≤120	≤120
Total Ammonia (mg N l <sup>-1</sup> )	≤ 0.1	≤ 0.1	≤ 0.3
Total Oxidised Nitrogen (mg N l <sup>-1</sup> )**		≤ 5.65	
MRP (mg P l <sup>-1</sup> )	≤ 0.02	≤ 0.03	≤ 0.15
DIN (mg N l <sup>-1</sup> )***		≤ 2.6	
	Biological Quality Index		
Q-value	Q≥4		
Based on the most onerous of the EPA's criteria limits indicating potentially poor water quality (1999) and legislative requirements. (*) EPA "Characteristics of various biological quality classes" (1999) (**) This criterion relates to a drinking water Standard in lieu of suitable limit values for eutrophication in fresh water (***) DIN Freshwater Limit and estuarine sites <u>ONLY</u>			

**Table 5** Three Rivers Project Water Quality Criteria



Map 7 Boyne Catchment

The watercourses that had shown the greatest improvement included the **Blackwater (Kells), Moynalty, Mattock, Castlejordan, Devlins, Deel, Nadreegeel and Kinnegad**. The most improved site was on the **Boyne main channel** d/s of the old Navan MWWTP, where the rating improved from Q 2-3 (moderately polluted) in 1997 to Q4 (unpolluted) in 2001. This was due to the decommissioning of this MWWTP.

Only one site had deteriorated since 1997, the **Boyne** at Kinnafad Bridge. This site is located d/s of Edenderry MWWTP, and was rated as "seriously" polluted.

### Physico-Chemical Status

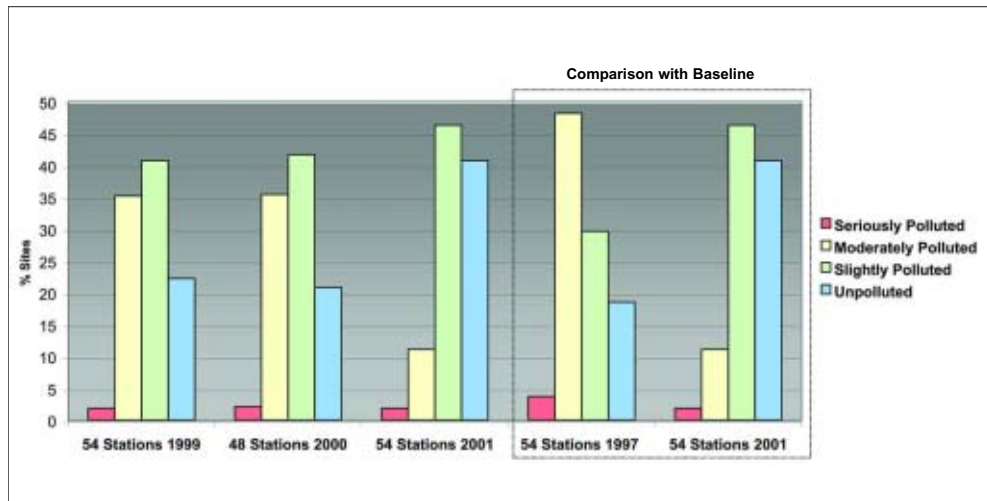
Annual median MRP concentrations exceeded the Project criterion limit of >0.03mg/l at 65% of sites in 2000. More than half the sites surveyed in 2001 showed lower MRP concentrations than in 2000.

Compared to the baseline data of 1995-97 there was an improvement (ie. a decrease in concentration) at 24 of 29 comparable sites. The recent MRP results are illustrated in **Map 7**. There has been a general improvement in MRP concentration on the **Boyne main channel**, particularly between Navan and St. Mary's Br, Drogheda. This continued improving trend is indicated in **Figure 3**.

The criterion for median TON of 5.65 mgN/l was met at all sites in 2000 and 2001, with 23% of sites improving in 2001 and 10% of sites deteriorating. There was also a substantial improvement in comparison to 1995-1997 data, with 86% of sites having lower TON concentrations. The most improved sites included the **Mattock, the Yellow (Blackwater) and u/s of Lough Ramor**.

Annual median concentrations of DIN at the freshwater limit and the estuarine site at St Mary's Bridge achieved the Project criterion of 2.6 mg/l in 2000 and 2001. This criterion applies specifically to waters discharging into estuarine waters.

Median ammonia concentrations decreased at 28% of sites in 2001 compared to 2000, with concentrations at the other sites remaining largely constant. However, 39% of sites still failed the criterion for maximum ammonia levels in both years. Comparing with baseline data, median ammonia concentration decreased at 17% of sites, whilst the maximum recorded concentrations fell at 55% of sites. This shows an improvement in the overall ammonia status of the Boyne, although some individual sites did deteriorate.



**Figure 2** Boyne Catchment Biological Status, Baseline-2001

### Overall Trend

Both biological and physico-chemical monitoring indicate a general improvement in water quality in the Boyne catchment since 1997 with the most dramatic improvement in biological quality occurring between 2000 and 2001. The general trend for lower MRP concentrations in 2001 than 2000 is also reflected in those of other determinands, with both TON and ammonia concentrations having decreased.

In summary, water quality has improved in the Boyne catchment during the life time of the Project. While the trend is encouraging there is a significant amount of work needed to achieve the target of "good ecological status " by 2015. The majority of sites (67%) still exceed the Project target MRP criterion of 0.03 mgP/l.

### Liffey Catchment

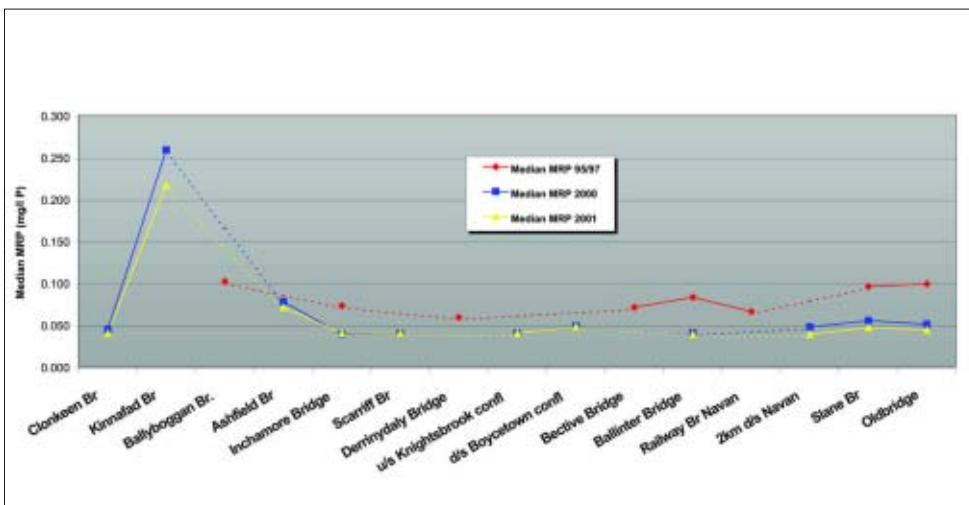
#### Biological Status

The quality class, calculated from the Q-Ratings, is shown for each monitoring site in the Liffey catchment for 2000, in **Map 8**. Any change in classification since 1999 is also indicated.

Excluding the Pilot catchments 12 (29%) sites were classified "unpolluted", 10 (24%) "slightly polluted", 16 (39%) "moderately polluted" and 3 (7%) "seriously polluted" in 2000. Most of the unpolluted sites were situated in the upper reaches of the Liffey including 4 sites on the **main channel**. The seriously polluted sites were situated in the **Camac** and the **Lyreen** Rivers.

**Figure 4** shows the percentage of Project sites falling into each pollution category over the monitoring period, and compares with the Baseline data. A considerable reduction in the percentage of "slightly polluted" sites can be seen from 1999 to 2000 (13%) and from 1998 and 2000 (7%). However, this reduction has been at the expense of an increase of "moderately" and "seriously polluted" sites, whilst the number of "unpolluted" sites remained constant. These results indicate a deterioration in biological quality from 1998 to 2000.

Deterioration was seen in biological quality at 32% of sites in the Liffey catchment that were monitored in 1998 and 2000, an improvement was seen at 23% of the sites and 45% remained the same from 1998 to 2000. The majority of the sites that deteriorated were situated on tributaries. However, on the main channel itself, an improvement in biological status was seen at sites monitored during this period.



**Figure 3** Median MRP on main Boyne channel

This improvement was primarily due to the upgrading of the Leixlip and Osberstown MWWTPs. No sites on the main channel had Q-ratings indicative of serious pollution in 1999 or in 2000.

In most cases the changes in Q ratings are small (e.g. Q3-4 to Q3) but at a number of sites these changes have been significant. The most significant positive change in biological status from 1998 to 2000 occurred on the **Liffey main channel** d/s of the Osberstown MWWTP. This site improved from Q2 in 1998 to Q3-4 in 2000.

The site with the most significant deterioration occurred on the **Camac River** u/s of Saggart Village situated in a predominantly rural setting, this site deteriorated from Q4-5 in 1998 to Q3 in 2000.

### Physico-Chemical Status

Annual median MRP concentrations exceeded the Project water quality criterion of 0.03 mg/l at 58% of the sites monitored on the Liffey in 2000 and 56% of sites in 2001 (**Map 8**). Sites satisfying this criterion for both 2000 and 2001 were situated on the **Liffey** u/s of Newbridge and in the upper sections of the **Morrell** and **Camac** Rivers. Compared with Baseline (1995-1997), 10 of the 11 comparable sites on the **Liffey main channel** had improved in quality (**Figure 5**).

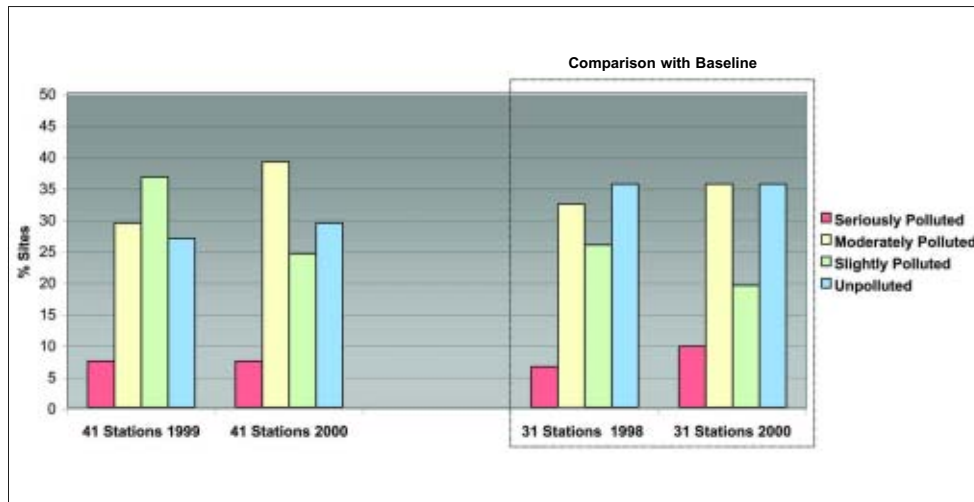
The main channel d/s of Oberstown and Leixlip MWWTPs showed the most significant improvement, along with some sites on sub-catchments, particularly below decommissioned MWWTPs at Saggart and Newcastle.

None of the Liffey stations exceeded the Project annual median TON criterion of 5.65 mgN/l and 51% of stations showed significantly decreased (improved) median TON concentrations from 2000 to 2001. All comparable sites on the Liffey also showed a decrease in TON concentrations from 1997 to 2001 except for the site at Ballymore Eustace where concentrations showed a slight increase.

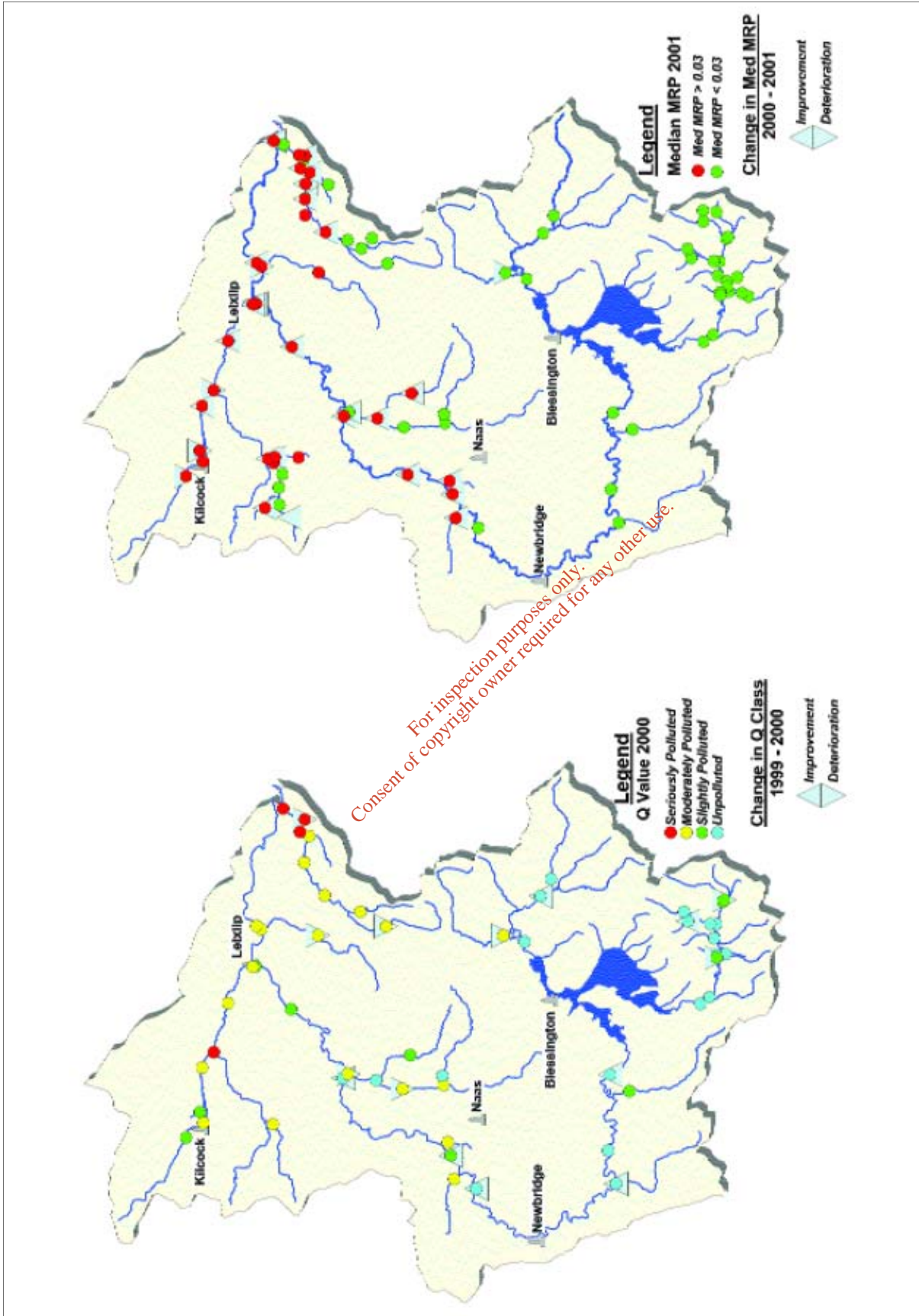
Most of the sites exhibited only small changes in TON concentrations from 1997 to 2001 (less than 0.5 mgN/l) but two sites showed considerable improvement, the **Rye-water** at Leixlip and the **Griffeen** at Lucan village. At these sites, concentrations of TON have reduced by almost 2 mgN/l in the intervening years.

Median annual concentrations of DIN at the Freshwater Limit site at Islandbridge did not exceed the Project criterion in 2000 or 2001.

Although ammonia concentrations increased at 8 sites in 2001, and decreased at 5 sites compared with 2000, there was an improvement in quality at 55% of sites over the project lifetime.



**Figure 4** Liffey Catchment Biological Status, Baseline-2000



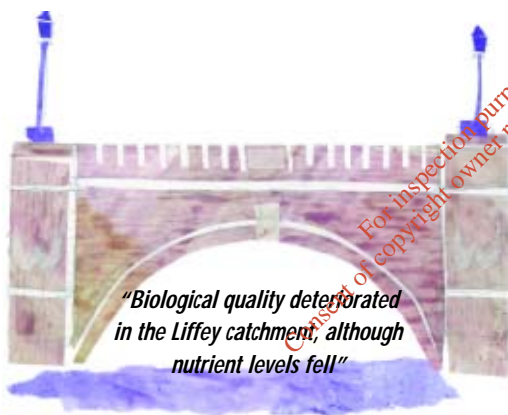
Map 8 Liffey Catchment

Much of this improvement is on the main channel d/s of Osberstown MWWTP.

### Overall Trend

Trends in biological quality show that the number of "seriously" and "moderately" polluted sites have increased during the life of the Project, at the expense of "slightly" polluted sites which decreased in number. The number of "unpolluted" sites remained the same. Nutrient concentrations have generally reduced during the Project indicating improving water quality.

In summary, nutrient monitoring shows an apparent improvement in water quality, whilst biological monitoring shows the reverse. On balance, water quality in the Liffey catchment has remained constant over the lifetime of the Project.



## Suir Catchment

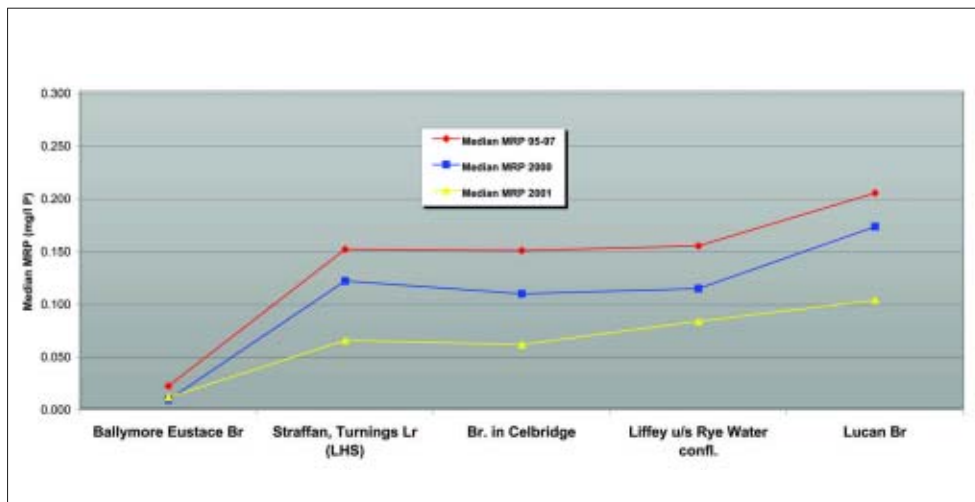
### Biological Status

The quality class at all sites in the Suir catchment in 2001 is shown in **Map 9**. Any change in classification since the year 2000 is also indicated.

Excluding sites in the Pilot catchments, 29 sites (49%) were classed "unpolluted", 18 (31%) "slightly polluted", 11 (19%) "moderately polluted" and 1 "seriously polluted" in 2001.

The site with the worst water quality in the Suir catchment is on the **St. Johns River**, which is the only site in the Suir catchment that is classified as "seriously" polluted. The catchments with "moderately" polluted sites are the Rivers **Anner, Drish, Black (Cashel), Clodiagh** and the **Outeragh**. There are also 2 sites on the **Suir main channel** that are "moderately" polluted.

**Figure 6** shows the percentage of Project sites falling into each quality class over the last 3 years, and compares these with the Baseline.



**Figure 5** Median MRP on main Liffey channel

There was no change in classification at 45 sites (76%), an improvement at 5 sites (8%) and there was deterioration at 9 sites (15%). The Rivers **Dawn, Glenbrook, Anner and Templetothy Stream** all showed improvements.

The largest decrease in quality was on the **St Johns River**, whilst the largest increase was on the **Suir main channel** at New Bridge.

Comparing the 41 Project sites monitored both in 1996 and in 2001, 6 sites (15%) improved, 29 sites stayed the same (71%) and 6 sites (15%) declined in terms of quality class. The sites that have seen deterioration in water quality over this period include those on the **Black Stream, Farneybridge, Drish, Nier and Clashawley**. The site on the **Black Stream** deteriorated in quality from "unpolluted" to "moderately" polluted.

Watercourses that showed an improvement in classification over the Project lifetime were the **Suir main channel**, the Rivers **Fidaghta, Ara, Clodiagh** and the **Halfway House Stream**. The largest improvement was on the River **Fidaghta** which improved from "moderately" polluted to "unpolluted" status.

### Physico-Chemical Status

Annual median MRP concentrations for 2001 exceeded the Project criterion at 46% of the monitoring sites in the catchment including all but one site on the main channel. The majority of these sites had concentrations indicative of slight or moderate pollution while 17% had concentrations indicative of serious pollution. The sites having the highest MRP concentrations were the Rivers **Ara, Clover, Outeragh, Clashawley** and **Moyle**.

Compared with 2000, 39% of sites showed significant decrease in MRP concentrations in 2001, whilst 18% of sites showed significant increases (**Map 9**).

All of the sites on the main channel improved in quality over this period.

Comparison with Baseline (95-96) data indicates that MRP concentrations have increased at 49% of sites over the Project period, whilst at 40% of sites, concentrations decreased.

Sites on the Rivers **Anner, Outeragh** and **Clashawley** showed significant deteriorations in water quality, whilst sites on the **Black Stream (Cashel), Glenbrook** and **Fishmoyne** all showed significant improvements.

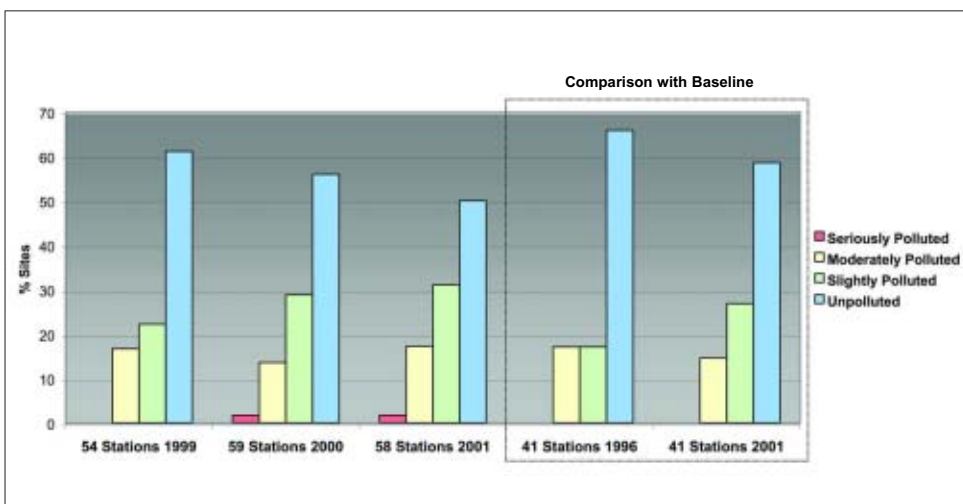


Figure 6 *Suir Catchment Biological Status, Baseline-2001*

Median TON concentrations satisfied the 5.65 mg/l quality criterion at all but 1 site (**Moyle River**) in 2001 though the maximum criterion was exceeded at 6 sites. There was however, very little significant change in TON concentration between 2000 and 2001.

Comparison of 2001 data with that from 1995 shows a decrease in concentration at 76% of sites where data is available. Almost 15% of sites saw a decrease in concentration of more than 1 mg/l in TON during this period, two of these sites being in the upper reaches of the Suir. The largest improvement was at the **Rossestown River** sample site where the median concentration fell from 3.5 mg/l to 2 mg/l.

At 24% of sites, TON concentrations increased on average by 0.1 mg/l. Three of the sites were located on the lower reaches of the **Suir main channel**.

The DIN criterion of <2.6 mgN/l was achieved at the Freshwater Limit site (Sir Thomas' Bridge) in 2000 and 2001. Over 87% of sites achieved the median ammonia criterion in 2001. Compared with 2000 data, 16% of sites showed a significant improvement and 17% of sites deteriorated.

Compared with the Baseline data, 53% of sites showed a significant increase in ammonia concentration, whilst only 26% of sites showed significant decreases during the Project period.

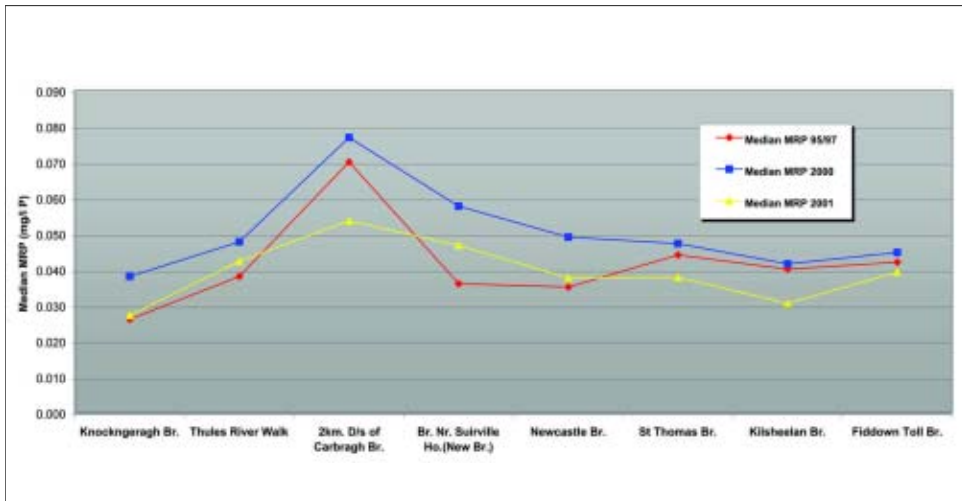
### Overall Trends

The overall trend in biological quality appears to be a declining one with a decrease in the number of sites classed as unpolluted and an increase in those classed as "slightly" and "moderately" polluted.

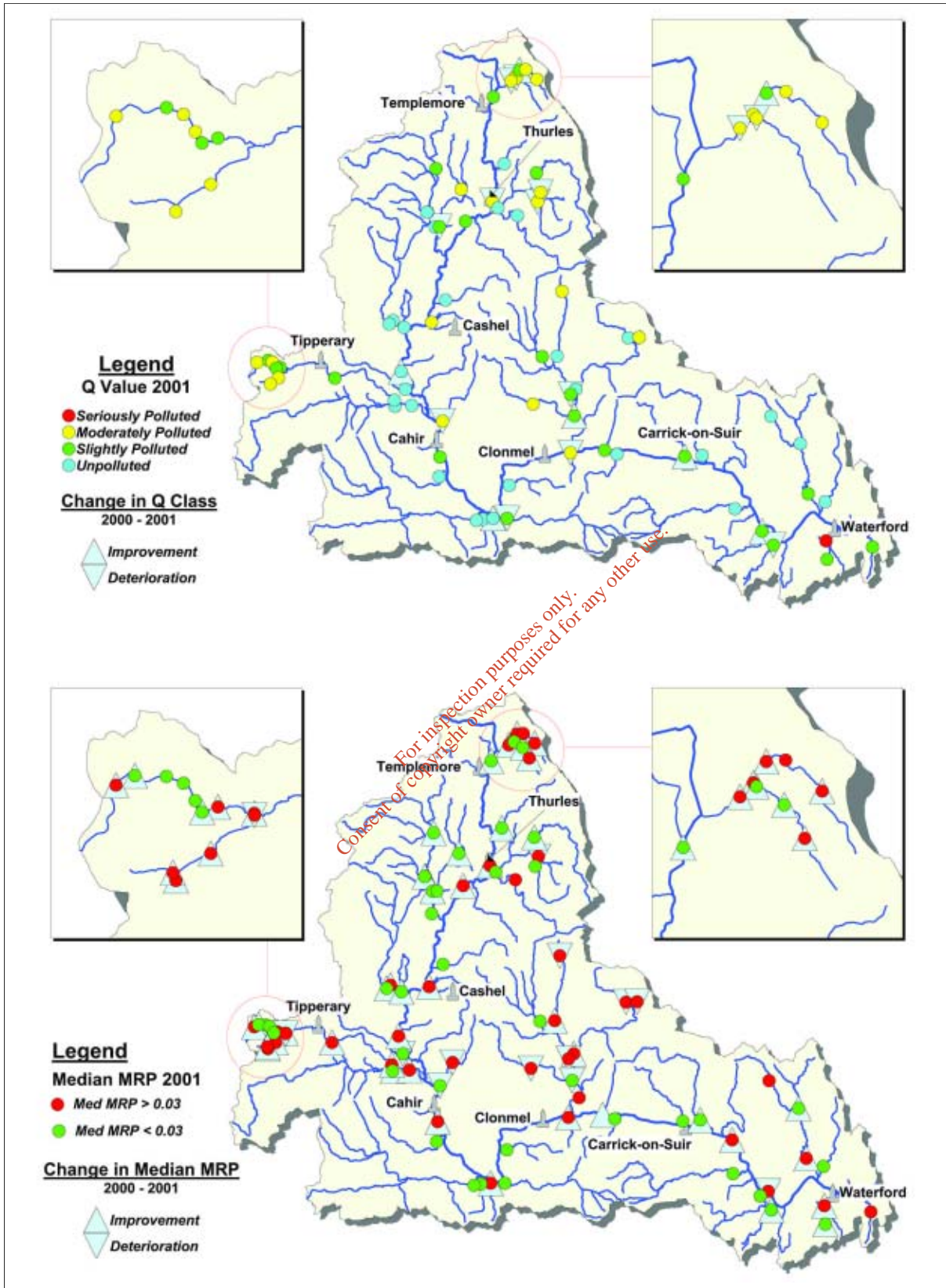
Over the lifetime of the Project, there was a net increase of 9% in sites showing an increase in MRP concentrations (i.e. a deterioration in quality) within the catchment, although there has been a short term improvement between 2000 and 2001. **Figure 7** summarises the trend in MRP concentrations on the main channel.

Ammonia concentrations also increased during the Project lifetime. TON remained relatively stable during the last two years, however there were significant improvements compared with the Baseline data. DIN concentrations at the freshwater limit were satisfactory.

In summary, water quality appears to have declined in the Suir catchment during the Project lifetime.



**Figure 7** Median MRP on Suir Main Channel



Map 9 Suir Catchment

## Phosphorus Regulations Compliance

The Phosphorus Regulations (1998) require that certain interim target phosphorus levels must be achieved at monitoring sites by 2007. Sites will be deemed to have achieved their Target if they pass either median MRP or Q value criteria set in the Regulations for individual sites. These criteria are aimed at improving or in some cases maintaining water quality based on the existing quality recorded in the EPA surveys carried out between 1995 and 1997. Where a site was not surveyed in that period, the targets must be achieved within 10 years of the Agency first assigning a Q rating. In the case of the Project network, it has been assumed for this report that sites surveyed by the Project in 1999, not previously included the EPA networks, must comply with the Regulations by 2009.

**Table 6** shows the percentage of Project monitoring sites passing one or both of the criteria set in the Phosphorus Regulations in the years 2000 and 2001. As it is likely to be a requirement of the WFD that sites should achieve both criteria, the percentage of sites passing both criteria is also noted.

The Boyne catchment had 73% of sites complying with the Regulations in 2000 increasing to 79% in 2001.

It had the lowest percentage of sites that passed both of the criteria in 2000, but the highest in 2001, with the number of WFD compliant sites doubling.

The Liffey catchment had the lowest percentage of sites (60%) complying with the Regulations, but had a higher percentage of WFD compliant sites than the Boyne. These sites were largely located in the upper Liffey catchment u/s of Osberstown MWWTP. There was no Q-rating data for 2001 so the compliance for this year could not be calculated.

The Suir catchment had the best compliance with the Regulations' targets in 2001, having 80% compliance increasing 15% over the previous years result. The percentage of WFD compliant sites fell slightly, which was the opposite of the situation on the Boyne catchment.

The increase in sites on the Boyne passing both criteria reflects the increase in the number of sites passing the Q criterion.

The increase in sites on the Suir passing P Regulations reflects the increase in sites passing the MRP criteria.

Criteria	% Comparable Water Quality Sites					
	Boyne (48 sites)		Liffey (50 sites)		Suir (69 sites)	
	2000	2001	2000	2001	2000	2001
Pass Q criteria ONLY/Fail MRP	23	27	12	-	16	17
Pass MRP criteria ONLY/Fail Q	25	6	20	-	14	29
Pass Both (WFD Compliant)	25	46	28	-	35	34
Pass P Regulation Objective (Either/or)	73	79	60	-	65	80
Fail P Regulation Objective (both)	27	21	40	-	35	20

**Table 6** Project Sites complying with the Phosphorus Regulations



BOYNE

LIFFEY

SUIR

## Three Rivers Project

# Special Investigations



P

A

R

T

2

# Special Investigations

## Introduction

"Pilot" and "Special" Study Areas were established to investigate the impact of different landuses and activities on water quality, to increase the understanding of the critical factors influencing nutrient loss from these sources and to recommend and implement management strategies. Detailed investigations were carried out into the effects of agriculture, forestry and urban developments in a number of sub-catchments of the Boyne, Liffey and Suir.

Three Agricultural Pilot Areas (APA) were selected, where the primary aim was to reduce nutrient losses from agriculture by implementing Best Farm Management Plans (BFMP) including Nutrient Management Plans (NMP) on a voluntary basis. BFMP were developed for each participating farm excluding those already in REPS.

The key focus of NMP was management of farm effluents, such as slurry and soiled water, and their sustainable use, taking into account soil nutrient conditions, crop requirements, physical and climactic conditions.

The catchments were also assessed in terms of "Hydrological Risk." This is a method of

assessing the likelihood of rapid movement of water (hence chemicals and soluble nutrients) from fields to lakes and rivers, based on soil types and connectivity to nearby water-courses (see **Appendix 1**). Adequate storage is central to good effluent management. Storage deficit is defined as the difference between the storage capacity required for a standard 16 weeks storage period for all slurries and dirty water produced on a farm, and the actual storage available. A 16 week storage period was chosen as it represents the most common minimum storage period required by L.A.

Some farms used Farm Yard Manure (FYM) as a means of managing animal wastes. The addition of straw, or a similar material, soaks up much of the liquid element of the waste allowing easier storage and handling. The FYM can either be stored "in-house" (i.e. within the animal buildings), on yards and/or in field heaps. FYM can, with good management, allow farmer a means of dealing with animal wastes without the need for specialist storage facilities. Management, condition and location of FYM storage was assessed and recorded as adequate or inadequate. Storage deficit was not considered for FYM systems, though it was identified that the practice of FYM storage should be reviewed.

Study Area Name	Catchment	County	Description	Features of Investigation
Ara	Suir	South Tipperary	Agricultural Pilot Area	Cattle-Medium intensity
Clonmore	Suir	North Tipperary	Agricultural Pilot Area	Cattle-Medium intensity
Dawn (Ballyshonnock)	Suir	Waterford	Special Study Area	Nutrient pressure on water supply lake
Yellow	Boyne	Meath	Agricultural Pilot Area	Med. Intensity & arable
Moynalty (Annesbrook)	Boyne	Meath/Cavan	Special Study Area	Cattle-Medium intensity
Clonshanbo	Liffey	Kildare	Special Study Area	Low Intensity & Septic Tanks
Kings	Liffey	Wicklow	Pilot Study Area	Forestry
Camac	Liffey	South Dublin	Pilot Study Area	Urban

**Table 7** Pilot and special study areas in the Three Rivers Project

Within these catchments, a proportion of the farms were participating in the Rural Environment Protection Scheme (REPS), and whilst these farms were surveyed, storage capacities and NMP's were not calculated in detail due to limited resources. It was assumed that management practices on REPS farms were consistent with the requirements of the scheme.

In addition, Pilot Study Areas were established on the Kings River (Liffey catchment) to study the possible impacts of commercial forestry on surface water in an upland catchment, and the Camac River (Liffey catchment) where the nutrient exports from four different landuses associated with urbanisation were analysed.

A further 3 sub-catchments were selected as Special Study Areas (SSA) where investigations were carried out to assess the level of nutrient loss from agriculture, and other sectors, to surface water (and groundwater in the Clonshanbo). The surface waters in both the APA's and the SSAs were monitored continuously throughout the lifetime of the project.

## Clonmore Introduction

The Clonmore catchment is located on the north eastern edge of the Suir catchment and occupies an area of 2,807 hectares. The catchment is rural with the main landuse agricultural pasture (74%). The remaining area is mainly "semi-natural" (22%), consisting of peatland with scrub. Small areas of woodland are also present. The catchment landscape can be described as gently undulating.

## Agriculture in the catchment

A total of 71 farmers in the catchment participated in the Project (82% of farmers), and all Non-REPS farmers received NMPs prepared by the Project.

Of the participating farmers, 28 are in REPS (39%). Agriculture in the area is "medium intensity" drystock and dairying enterprises. The average farm size in the catchment is 30.3ha (**Table 8**) with an average stocking rate of 1.8 LU/ha (Livestock Units/ hectare).

## Water quality monitoring

A total of 8 "grab sample" sites were monitored weekly with an auto-sampler at the d/s site that sampled daily on a "flow proportional" basis.

Annual median MRP concentrations exceeded the 0.03 mgP/l criterion at 7 of the 8 sites indicating unsatisfactory water quality throughout the Clonmore catchment. Whilst median MRP concentrations remained fairly constant throughout the year, nutrient loads were highest in the winter. This is consistent with increasing levels of nutrient runoff in response to increased rainfall experienced at this time of year, typical of diffuse pollution sources.

Biological monitoring was carried out at 6 of the grab sampling sites in the Clonmore and results also indicated "slight" to "moderate" pollution throughout the catchment.

Agricultural Enterprises	Av. Stocking Rate (LU/ha)	Av. Area (ha)
All	1.8	30.3
Mixed	-	45.6
Drystock	1.8	20.7
Dairy	2.0	49.7

**Table 8** Clonmore, stocking rates and areas

Category	Non-REPS	REPS
Participating Farms	43	28
Yards in Catchment	21	27
No. Slurry Systems-Adequate	1	Not Surveyed
No. Slurry Systems-Inadequate	10	Not Surveyed
No. FYM Systems-Adequate	9	Not Surveyed
No. FYM Systems-Inadequate	12	Not Surveyed

**Table 9** Farm effluent management systems  
Clonmore Catchment

## Results of farm surveys

Results of the detailed farm surveys indicate that the water quality problems in the Clonmore originated from "unregulated point" and "diffuse" sources. The point sources in question are primarily farmyards. Diffuse sources refer to nutrient loss arising from diffuse agricultural sources, such as nutrient loss generated from grassland areas with high soil phosphorus.

Approximately three-quarters of the Non-REPS farms participating did not have dedicated slurry storage facilities. One quarter of these farms had yards outside the catchment, another quarter had no yards at all and the final quarter used FYM management systems only (**Table 9**).

It was found that all but 1 of the farms using slurry storage facilities (Non REPS), within the catchment had inadequate storage capacity (**Table 10**).



*Storage and disposal of cattle slurry and silage is an important issue in all of the Agricultural Pilot Areas.*

Slurry Storage Deficit (M <sup>3</sup> )	No. of farms
0	1
0-50	1
50-150	3
150-300	4
300-450	1
>450	1

**Table 10** Clonmore, storage deficits (non-REPS)

The overall condition and management of yards in the catchment was classified by the Project to ascertain the potential risk of nutrient loss from yards regardless of their storage capacity. It was found that 21% of the farmyards in the catchment were classified as "poor" in terms of management and this figure rose dramatically to 48% when non-REPS farms only were considered. The condition of "FYM storage" facilities were also assessed, and assuming that all REPS farmers had adequate "FYM storage" facilities it was found that 75% of yards in the catchment had adequate FYM storage facilities. However when non-REPS farms only were considered, 42% of farms had adequate FYM storage facilities.

There is a considerable risk of nutrient loss from the farmyards in this catchment, particularly due to the inadequate storage of FYM and poor yard management throughout the catchment. Storage deficits also exist on more than 20% of all farms.

Soil P concentrations (based on Morgans extractable P) in the catchment were relatively high with 65% of soil samples collected having soil P values in either index 3 or index 4. High levels of soil P are indicative of excessive applications of P related fertilisers over long periods of time (**Table 11**).

The risk potential from high soil P levels is intensified as a significant proportion (33%) of the catchment is categorised as "High Hydrological Risk" and a further 21% of the catchment is categorised as "Moderate Hydrological Risk" (**Table 12**). There is an increased risk of nutrient loss from diffuse agricultural sources in this catchment due to the above factors. Spreading of nutrients at inopportune times is a likely cause of diffuse pollution in this catchment.

## Summary

Poor water quality was found throughout the catchment.

The primary cause of poor water quality was due to runoff from fields.

The secondary cause of poor water quality was due to nutrient losses from yards owing to poor quality or management of the yard facilities and from yards with storage deficits.

## Ara Introduction

The Ara catchments (Upper and Lower) are located u/s of Tipperary Town with mainly flat to undulating topography. The combined catchment size is 2,806 hectares of which 99% of the landuse is grassland. There are small pockets of peatland and forestry in the catchment also. The soils in the catchment are dominated by grey brown podzolics and are regarded as agriculturally productive under suitable management. There are also areas of gleys, primarily along the flood plain of the river channel.

## Agriculture in the catchment

There were 67 farmers participating in the project accounting for 71% of the catchment area. Of these farmers, 23 (37%) were in REPS. Mixed dairy/drystock was the most prevalent form of agriculture accounting for 53% of the farms in the catchment. Dairy farms accounted for less than 1% of the farms in the catchment and Drystock only herds accounted for 40% of the farms. However on the mixed farms dairying was normally the most dominant practice. The average size of non-REPS farms in the catchment was 30.6 hectares. Mixed farms and dairy farms were on average considerably larger in terms of area than farms with drystock only (Table 13). Mixed and dairy farms were also more intensive than drystock only enterprises.

## Water quality monitoring

There were 13 "grab sample" sites in the Ara monitored weekly with two auto-samplers set to sample daily on a "flow proportional" basis at the d/s end of the catchments. Six sites had annual median MRP values of <0.03 mg/l whilst the remaining sites all exceeded this figure, the highest recording median being 0.17mg/l.

There was significant variation in nutrient concentrations across the Ara catchment suggestive of possible localised problems. Biological sampling was only carried out on the northern branch of the Ara River and resulting Q values were indicative of "slight pollution" at all sites monitored.

## Results of farm surveys

A number of yards in the catchment either had no slurry storage facilities or had farmyards outside of the catchment.

Of the farms with farmyards in the catchment, yard facilities were generally inadequate and present an increased risk of nutrient loss from the farmyard (Table 14).

Soil P Index	% of Samples
1	9
2	26
3	23
4	42

Table 11 Clonmore, Soil P

Hydrological risk category	% Catchment
High	33
Medium	21
Low	46

Table 12 Clonmore, Hydrological risk

Agriculture Enterprises	Av. Stocking Rate (LU/ha)	Av. Area (ha)
All	2.0	30.6
Mixed	2.2	39.0
Drystock	1.4	21.1
Dairy	1.6	36.3

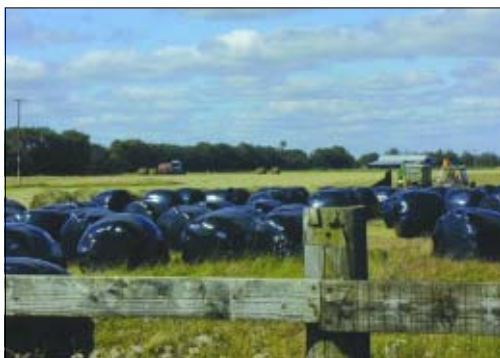
Table 13 Ara, stocking rates and areas

Category	Non- REPS	REPS
Participating Farms	44	23
Yards in Catchment	24	Not Surveyed
No. Slurry Systems-Adequate	8	Not Surveyed
No. Slurry Systems-Inadequate	15	Not Surveyed
No. FYM Systems-Adequate	5	Not Surveyed
No. FYM Systems-Inadequate	10	Not Surveyed

Table 14 Ara, farm effluent management systems

Of the non-REPS farms with FYM systems in the catchment, 66% were classified as having inadequate FYM systems.

The farm surveys also indicated that >60% of farms with yards in the catchment had a storage deficit (**Table 15**).



*Appropriate storage of slurry and silage on the farm was assessed during farm visits.*

Slurry Storage Deficit (M <sup>3</sup> )	No. of farms
0	8
0-50	1
50-150	1
150-300	3
300-450	4
>450	6

**Table 15** *Ara, storage deficits (Non-REPS farms)*

Soil P Index	% of Samples
1	21
2	45
3	21
4	13

**Table 16** *Ara, Soil P*

Hydrological risk category	% Catchment
High	10
Medium	8
Low	82

**Table 17** *Ara, Hydrological risk*

Some of these had very large storage deficits with 25% of those farms having deficits greater than 450m<sup>3</sup>. These yards were primarily in the southern part of the catchment. There were a number of yards in the catchment using clay lined lagoons for storage of slurry and FYM, and these structures were deemed unacceptable. These added greatly to the storage deficit problem in the catchment.

The soil P levels in the catchment are relatively low with 66% of soil samples analysed having a P index of 1 or 2 and 13% of the soils had a P index of 4 (**Table 16**).

The vast majority of the surveyed fields in the catchment were classified as having a low hydrological risk (82%), with only 10% of fields in the catchment categorised as having a high hydrological risk (**Table 17**).

Thus, low soil P combined with a low hydrological risk across the catchment, indicate that the risk of nutrient loss from diffuse sources is low. This does not infer however that inappropriate spreading of slurry or fertiliser will have no effect on water quality.

## Summary

Water quality in the Ara varied from "unpolluted" to "moderately" polluted, both with respect to biological and physico-chemical quality.

Storage deficits on a number of farms in the southern part of the catchment present a real risk of farmers having to spread slurries at inappropriate times.

There were a significant number of large intensive farms with large storage deficits.

A large porportion of the farmyards surveyed could improve their current farmyard management resulting in a reduced risk of nutrient loss from yards.

## Dawn (Ballyshonnock) Introduction

Ballyshonnock Lake catchment (Suir catchment) was chosen as a special study area due to the lake's importance as a drinking water source serving Waterford City and its environs (population served 50,000). The lake has a history of eutrophication and nuisance blue-green algal blooms. Waterford Co.Co. carried out the survey work in this catchment with advice and assistance from the Three Rivers Project.

The Ballyshonnock Lake catchment is contained within the Dawn sub-catchment and is located 15km west of Waterford City. It covers 30 hectares and was formed in 1971 when the Dawn River was impounded. In addition to the Dawn River inflow to the lake, there are three minor feeder streams.

### Agriculture in the catchment

The catchment area is 1,130 hectares. There were 12 farmyards within the catchment. Landuse is dominated by pasture (78%), with 9.6% tillage, 3.4% forestry, and 9% other landuses, such as roads and water bodies.

### Water quality monitoring

Grab samples were taken at monthly intervals from the lake and its four feeder streams including the Dawn River. In addition, an auto-sampler set to take time-related samples on a daily basis, was installed on the Dawn River immediately u/s of the lake. A water level recorder was installed at the Dawn River station, where a v-notch weir was already in place since the early 1970's. This allowed nutrient loads to be calculated.

All of the feeder streams, with the exception of the Dawn River, had annual median MRP levels of < 0.03mg/l, indicating satisfactory water quality, although occasional high values were recorded.

The monitoring site on the Dawn River had an annual median MRP of 0.06mg/l. Interestingly, the highest MRP value was a quarter of that recorded in the feeder streams.

The lake water had Total Phosphate annual mean levels of 0.028mg/l and 0.035mg/l in 2000 and 2001 respectively. There was a significant difference in maximum chlorophyll levels, 20 in 2000, and 51 in 2001, possibly influenced by weather conditions.

The automatic sampling program indicated that a sharp increase in MRP and ammonia levels occur during rainfall events. An increase from the typical "baseline" values of 0.01mg/l to peaks of about 0.2mg/l occurred during the three rainfall events examined.

### Results of farm surveys

Soil phosphorus levels were generally low, with 110 samples at soil P index 2 or less. There were no samples at soil P index 4 (Figure 8).

Farm slurry and soiled water storage data was available for all 12 farmyards, and is summarised in Figure 9. There seems to be a considerable storage deficit, with 5 farms having less than 10 weeks storage, and no farm having more than 16 weeks storage. This data is currently being analysed in more depth in order to ascertain how much extra storage is required and how much is accounted for by "clean water" and thus can be diverted.



These issues are being dealt with as part of the NMP's currently being prepared for each farmer in the catchment. Six of the farms had yard management issues, which will also be dealt with as part of BFMPs.

### Summary

The farm surveys were beneficial in providing useful information, and also raising awareness among farmers in the catchment about water quality and pollution control issues. Good co-operation was forthcoming from the majority of the farmers visited.

There appeared to be a significant storage deficit on farms in the catchment, with many of the farms having yard management issues likely to lead to discharge of soiled water to catchment watercourses.

Soil P levels were low, so nutrient losses were likely to be due to poor management practices rather than losses from soil and therefore BFMP's are likely to be of immediate benefit.

As shallow lakes are very sensitive to relatively low amounts of phosphorus, the yardstick of annual median MRP used for rivers probably underestimated the

significance in lake feeder streams of the increased phosphorus (twenty times base-line levels) which occurred during rainfall events.

Ideally all feeder streams should have flow measurement, and flow or time-based automatic sampling, so that P-loads can be accurately measured. However where this is not possible, then annual mean or maximum MRP may be more useful yardsticks for assessing phosphorus contributions to lakes.

## Yellow (Blackwater)

### Introduction

The Yellow (Blackwater) catchment, a tributary of the Blackwater (Kells) occupies 2500 hectares and is situated to the east of Willkinstown village in Co. Meath, on the north-eastern edge of the Boyne catchment.

The catchment is predominantly rural with Willkinstown village being the only urban area.

### Agriculture in the catchment

Agricultural land occupied 98% of the catchment. Tillage (mainly winter wheat and main crop potatoes) accounted for 48% of the agricultural landuse with the remainder in pasture. The area in forestry was less than 1%. A total of 70 farmers participated in the project with an average farm size of 41ha (Table 18). Of the participating farmers, 35% were members of REPS. NMP's were issued to all non-REPS farmers participating in the scheme.

### Water quality monitoring

In the catchment, 11 grab-sample sites were monitored weekly, with an auto-sampler located at the d/s site sampling on a time related basis. Median MRP concentrations exceeded 0.03 mgP/l at nine of the eleven sites in 2000. All sites exhibited high concentrations of maximum MRP and levels >0.15 mgP/l were recorded at 8 sites.

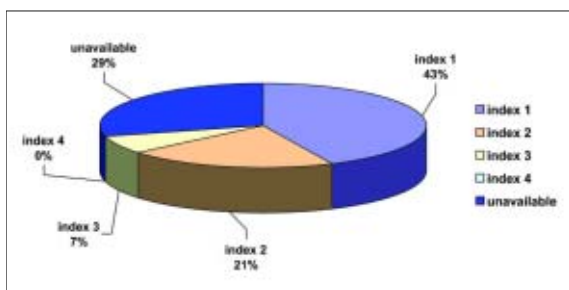


Figure 8 Soil P Index

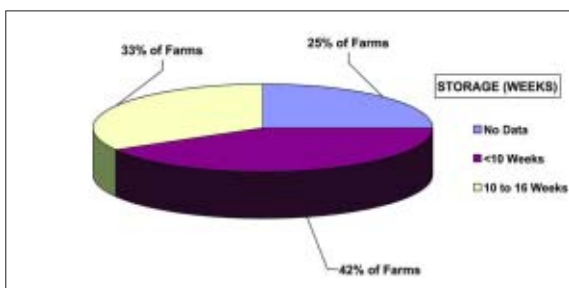


Figure 9 Farm Effluent Storage Capacity, Ballyshonnock

Results also showed median MRP concentrations were higher during periods of low flows (summer) indicating possible point sources u/s in the catchment, likely to be farmyards.

Results from biological Q ratings were consistent with the physico-chemical results and were indicative of "slight" to "moderate" pollution throughout the area.

## Results of farm surveys

The majority of non-REPS farms did not have dedicated storage facilities but utilised FYM (Farmyard Manure) heaps in fields. Of the farms with dedicated storage facilities 75% had some level of storage deficit (Tables 19, 20).

Also 21% of yards surveyed were classified as poor in relation to management/quality of the yard. Although there were only a small number of yards in the catchment, problems arising from lack of storage or poor quality/management suggests that the potential risk of pollution from these sources is significant.

Only 10% of the soils sampled in the catchment had a Soil P Index of 4 (high) and these samples were spread throughout the catchment and therefore did not indicate any specific problem area (Table 21). Hydrological risk was predominantly low throughout the catchment (Table 22). Land with low soil P indices and low hydrological risks presents a low risk of nutrient runoff if fertiliser is spread correctly.

## Summary

Annual median MRP concentrations exceeded 0.03 mgP/l at 9 of the 11 sites in 2000.

MRP concentrations were greater during low flow periods at a number of sites, indicative of point source pollution.

One poorly managed farmyard is having a major effect on the river, particularly during low flows.

Although there were only a small number of farmyards in the catchment many of those yards had problems with storage or quality/management.

Agricultural Enterprises	Av. Stocking Rate (LU/ha)	Av. Area (Ha)
All Farms	1.6	40.7
Dry	1.5	26.3
Tillage	n/a	76.5
Dairy	2.0	40.2

Table 18 Yellow, stocking rates and areas

Category	Non- REPS	REPS
Participating Farms	46	24
Yards in Catchment	28	15
No. Slurry Systems-Adequate	2	Not Surveyed
No. Slurry Systems-Inadequate	6	Not Surveyed
No. FYM Systems-Adequate	7	Not Surveyed
No. FYM Systems-Inadequate	4	Not Surveyed

Table 19 Farm effluent management systems Yellow Catchment

Slurry Storage Deficit (M <sup>3</sup> )	No. of Farms
0	2
0-50	3
50-150	0
150-300	0
300-450	2
>450	1

Table 20 Yellow, storage deficits (non REPS)

Soil P Index	% of Samples
1	30
2	32
3	28
4	10

Table 21 Yellow, Soil P

Hydrological risk category	% Catchment
High	5
Medium	17
Low	78

Table 22 Yellow, Hydrological risk

# Moynalty (Annesbrook)

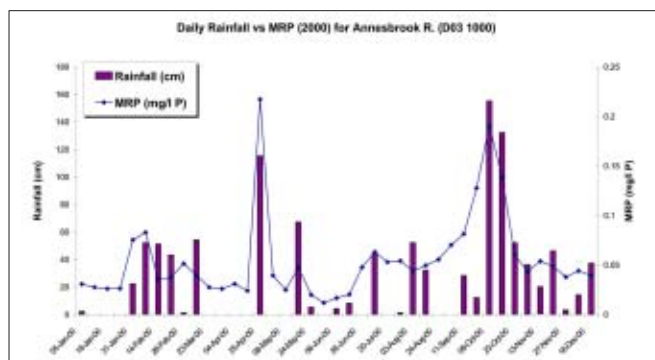
## Introduction

The Moynalty, a major tributary of the Blackwater (Kells) rises south of Baileboro and flows along the county border between Cavan and Meath. A tributary of the Moynalty, the Annesbrook, was selected for investigation as a representative area of the Upper Moynalty which has a history of poor water quality over a number of years with agriculture as the suspected primary source.

The Annesbrook catchment is predominantly rural consisting mainly of grasslands (94%) and a small area of tillage (1.4%). The catchment drains an area of 1,100 hectares. General farm surveys were carried on a "whole" farm basis rather than the more intensive "field by field" approach adopted in the Pilot Study Areas.

Agricultural Enterprises	Av. Stocking Rate (LU/ha)	Av Area (Ha)
All Farms	1.4	46.2
Dry	1.3	31.1
Tillage	n/a	15.8
Dairy	1.8	67.3

**Table 23** Annesbrook, stocking rates and areas



**Figure 10** Daily Rainfall vs MRP, Annesbrook

## Agriculture in the catchment

The average farm size was 46ha with an average stocking rate of 1.4 LU/ha (**Table 23**). Dairy farms had an average size of 67 ha and average stocking rate of 1.8 LU/ha whereas drystock farms averaged 31 ha and 1.3 LU/ha. 38% of the farms in the catchment were involved in REPS (**Table 24**).

## Water quality monitoring

There was 1 water quality monitoring site on the Annesbrook u/s of the Moynalty. This site was sampled weekly. Level readings were also taken from a staff gauge at the site.

MRP concentrations were found to be higher during high flows (winter) in this catchment, also there was a relationship between rainfall events and elevated nutrient concentrations in receiving surface waters (**Figure 10**). This would be indicative of diffuse pollution mainly resulting from land spreading of slurries or FYM.

## Results of farm surveys

In the Annesbrook 35% of the non-REPS farms surveyed had a storage deficit (**Table 25**), including farms with no dedicated storage. In addition, 38% of the yards had connectivity to surface waters and 60% of these had storage and/or yard management/quality problems.

Soil sampling was not carried out by the Project as part of the general farm survey, however existing soil test data was collected from 20 participating farms. From this data it could be seen that 66% of the samples had soil P index 2 or less (**Table 26**). Hydrological risk was not calculated on this catchment.

A phosphorus balance was produced using information collected on stock numbers, feed, imported/ exported fertiliser (including organic) and milk or cereals produced. The results showed a phosphorus surplus in the catchment of 10.5 kg/ha/yr in 2000.

Given that there was a P surplus in the catchment and the soil P conditions were generally low, it suggests that the soils in the catchment have a low ability to retain P and thus are at risk of losing P to ground or surface waters.

## Summary

There were a large number of farms in the catchment with poor storage capacity and/or poor yard management.

There was some association of increased MRP concentration at water quality sites with rainfall events suggesting diffuse source pollution problems.

Water quality problems would seem to emanate from both diffuse and point sources. Probable point sources in this case would be poorly managed farmyards and discharges from septic tanks.

## Clonshanbo Introduction

The study area is situated in the catchments of the Clonshanbo and Baltracey Rivers in North Kildare, on the north-western edge of the Liffey catchment.

This river system is almost entirely slow flowing and falls only 12 metres in 7km from source to outfall of study area. The landuse in the catchment comprises of mixed agriculture, an amenity forest and numerous private residences.

Five possible reasons for poor water quality were investigated:

1. Topographical and hydrological characteristics of the catchment ( low gradients and slow moving watercourses), causing possible deposition and retention of sediments.
2. Usage of phosphorus fertilisers (organic and inorganic) on agricultural farmland.



Category	Non- REPS	REPS
Participating Farms	20	12
Yards in Catchment	12	Not Surveyed
No. Slurry Systems-Adequate	5	Not Surveyed
No. Slurry Systems-Inadequate	7	Not Surveyed
No. FYM Systems-Adequate	9	Not Surveyed
No. FYM Systems-Inadequate	5	Not Surveyed

**Table 24** Farm effluent management systems Annesbrook Catchment

Slurry Storage Deficit (M <sup>3</sup> )	No. of Farms
0	5
0-50	1
50-150	3
150-300	3
300-450	0
>450	0

**Table 25** Annesbrook, storage deficits (Non-REPS farms)

Soil P Index	% of Samples
1	18
2	48
3	28
4	6

**Table 26** Annesbrook, Soil P

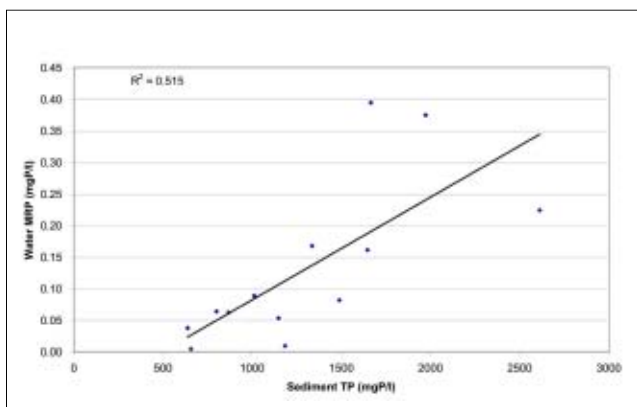
3. Potential point sources from farmyards with inadequate storage or poor farmyard management.
4. Desorption of phosphorus from sediments in the riverbeds.
5. Potential point sources from septic tanks (groundwater & surface water).

## Landuses in the Catchment

All the major farming practices were represented in the Clonshanbo. Dry stock farming utilised 58% of the land, subdivided into stud farms (16%) and sheep and cattle (84%). Tillage and silage ground each represented approximately 10% of the landuse, dedicated dairying 2%, forestry 12% and the remainder (8%) made up from roads, scrub and private gardens.



*A stream in Clonshanbo catchment heavily affected by algal growth. Nutrients, clear water and sunshine combine to cause algal growth.*



**Figure 11** Sediment TP vs Water MRP

## Water quality monitoring

There were 6 "grab sample" monitoring sites in the catchment. The d/s site was also monitored biologically. Both physico-chemical and biological monitoring has occurred at this site for a number of decades and results have shown consistent "moderate" pollution (Q3).

Median MRP concentrations varied throughout the catchment from 0.115 mgP/l at the water quality site on the northern branch of the system to 0.039 mgP/l at the site d/s of the amenity forest.

## Causes of poor water quality

### Topographical and Hydrological characteristics of the Clonshanbo

This is very slow moving river system with areas that are prone to flooding and display characteristics that would typically be found in a lake system (long retention time and poor ability to flush through). This renders the watercourses in the area prone to nutrient enrichment by even relatively small amounts of nutrients due to poor self-purification capacity. This river characteristic is considered the primary factor influencing water quality in the Clonshanbo.

### Usage of P fertilisers

Farming in the catchment was generally low intensity with a large number of stud farms. Soil sampling carried out as part of the farm survey showed that over half of the land had low soil P indices (56% less than or equal to P index 2) (Table 27).

A total of 16,476 kg of P was required by crops in the catchment and approximately 19000 kg of P was used, this gave an excess of P fertiliser used of approximately 2733 kg. Tillage and dairy had similar levels of excess P usage (approximately 10 kgP/ha), but tillage represented a greater area of landuse (Tillage 200 ha, dedicated Dairy 36 ha).

There were also a number of small low intensity farms using excessive levels of P fertilizer with poor environmental and economic returns. A number of these farms were situated in areas of high hydrological risk and therefore may present a significant source of diffuse pollution.

### Farmyards

The average storage deficit in the catchment based on a 16-week requirement was 29%. Over 18% of the yards could attribute much of their storage deficits to extraneous water entering storage facilities. Eighteen percent of the yards also had direct connectivity to streams and therefore must be considered as high potential risks especially during the winter period when the animals are in-housed.

### P from Sediments

Sediment samples were taken at 15 sites throughout the Ryewater catchment, the Clonshanbo being part of this catchment, and were analysed for a number of determinands (TP, MRP, manganese, calcium, total organic carbon, sulphate, and iron) in order to establish if increased levels of nutrients in sediments correlated with an increased level of nutrients in river water.

Five of the samples were chosen from a river system within the Clonshanbo Study Area that had large deposits of sediments and one was in close proximity to a farm that may contribute to the nutrient levels in the water.

MRP levels in water samples and TP levels in associated sediments showed a relatively low level of correlation ( $r^2 = 0.5$ ), however a general trend of increased MRP concentrations in water with increased concentration in sediment TP was discerned (Figure 11).

The large amount of TP in river sediment would not be considered common in a head-water catchment. Sediments may have acted as a sink for P but at certain times (temperature increase, dissolved oxygen levels changes etc.), they can become a source of P.

As there is a lack of other likely sources of P in the catchment during low flow conditions, sediments must be considered a significant contributor to the high concentrations of P found in the river during low flows.

### Septic Tanks

A preliminary investigation was carried out to see if nutrients from septic tanks were influencing the concentration of nutrients in the Clonshanbo River through groundwater/surface water interaction. This investigation included an assessment of groundwater contribution to the baseflow in the river during dry weather conditions and an assessment of the nutrient and faecal bacteria content of groundwater using water analysis from existing wells in the area. Previous studies suggest that phosphorus movement in groundwater is limited.

Soil P Index	% of Areas
1	14
2	42
3	24
4	20

Table 27 Clonshanbo, Soil P

Agricultural Enterprises	Av. Stocking Rate (LU/ha)	Av. Area (Ha)
All	1.9	35
Mixed	1.6	113.4 (1 farm only)
Drystock	1.8	31.8
Dairy	2.4	37.8

Table 28 Clonshanbo, stocking rates and areas

Category	No.
Participating Farms	36
Yards in Catchment	22
No. Slurry Systems	7
No. FYM Systems-Adequate	12
No. FYM Systems-Inadequate	10

Table 29 Farm effluent management systems Clonshanbo Catchment

The results of this investigation indicate that the river is fed by groundwater but that phosphorus concentrations in groundwater in the area are low and are unlikely to be a significant source of phosphorus to the river. However, the contribution of nutrients from septic tanks to surface waters by direct discharge or from inefficient percolation areas can not be ruled out, particularly due to the impervious nature of soil in the area.

### Summary

Many farmyards have problems both in terms of infrastructure and management, and therefore are potential contributors to the nutrient levels in the rivers.

Preliminary groundwater investigations indicated that septic tanks were not having any significant effect on P levels in the river, via groundwater interaction, though direct discharges from septic tanks can not be ruled out.



Increase nutrient levels cause algal blooms, particularly in lakes and slow moving rivers.

Losses from agriculture were the primary contributors to the nutrient levels in both the river and river sediments. The current water quality problems are caused by a combination of catchment characteristics, agricultural nutrient usage, farmyard effluents, and river sediments. Pollution abatement strategies will only be successful if they address all of these issues.

Phosphorus released from sediment must be considered a significant contributor to the high concentrations found in the river.

### Farm Storage Deficits Costings

Over 200 farms were surveyed in 5 sub-catchments during the Three Rivers Project and 81 of these farms had yards that were surveyed in detail. Of these farmyards, 54% had some storage deficit that ranged from 10 m<sup>3</sup> on a small stud farm to 2576 m<sup>3</sup> on a large dairy and beef farm. The later deficit was mainly attributed to extraneous water entering the storage facility.

Over 50% of the farms could attribute their storage problems to extraneous water entering storage facilities to a greater or lesser extent. In many cases this was the most significant factor. Thus, it was found by the Project that control of rain water falling onto dirty yards and into storage facilities due to poor guttering, channelling, or allowing animals access to yard space they do not require was the first step in rectifying a problem yard.

	Costings (€)	Area (ha)
<b>Average</b>	26,453	43
<b>Max</b>	77,140	170
<b>Min</b>	1,200	5
<b>Total No. with yards in catchments with deficits</b>	44	
<b>Total Cost</b>	1,163,935	

Table 30 Costings for rectifying storage deficits

Prices obtained from the "Management Data for Farm Planning 2000" - Teagasc and "Guideline Costs for Planning: Farm Structures 2000" - DAFRD were used to calculate costs to rectify storage problems in the surveyed farmyards. The range of costs varied from €1,200 on one farm that required roof guttering to €77,140 on a farm that required a new slatted shed. The average cost per farmyard with a storage deficit was €26,453 and the total cost required to rectify the storage problems on the farms surveyed was €1,243,287 (**Table 30**).

The average cost of rectifying storage deficit in the Clonmore and Ara sub-catchments (Suir) was €31,371 and in the Yellow sub-catchment (Boyne), the average cost was €31,028. In the Clonshanbo sub-catchment (Liffey), the average cost was €10,574 per yard.

The Clonshanbo featured low intensity farming with many stud farms having little or no storage deficits. The farms on the Suir and Boyne catchments were generally intensive, cattle based enterprises and subsequently had a greater number of farms with storage problems.

## Discussion Agricultural Investigations

Investigation of the contribution to nutrient loads from various sectoral activities in the three catchments showed agriculture to be the largest source of Total Phosphorus (57-63% of the catchment totals). Thus it is vital to address the sources and pathways of nutrient losses from agriculture in order to bring about water quality improvement.

The main source of nutrient loss leading to poor water quality was diffuse pollution. These losses were generally linked to rainfall events indicating that their likely sources are either runoff of organic and inorganic fertilisers applied to land, or other sources such as dirty farmyards or overflowing storage tanks.

Even when soil P levels were low, conditions of poor water quality existed indicating that direct runoff of nutrients from poor application practices was likely to be a more significant factor than the soil P concentrations.

The project investigation identified a number of facts regarding management of farm slurries:

A significant number of surveyed farms (62% over all of the catchments) showed storage deficits.

In many cases, poor segregation of clean and dirty yard areas allowed large volumes of clean surface water to enter storage systems, reducing capacity.

Many farms were recorded as having no storage deficit due to the fact that they had no dedicated slurry storage, instead, depending on field heaps and in-housing storage of FYM. Thus farms with inadequate FYM storage and handling facilities were assessed in terms of management, and rated accordingly.

30 % of farmyards were rated as "poor" in terms of management or quality of infrastructure.

REPS farmyards were generally found to have higher standards of management and quality of infrastructure.



Uptake of BFMP principles on the agricultural catchments was generally very good with approximately 80% of farmers participating.

Farmers were generally very pleased with the high quality standard of service received and the nutrient management plans produced.

To fully assess the effect of BFMP's on water quality, investigative sampling should continue for approximately 5 years.

## Recommendations

The use of the Three Rivers Project methodology was recommended for the management of point and diffuse agricultural sources of nutrients to address water quality problems. These could include the provision of an expanded short term monitoring network, allied with pro-active visits to catchment farms to assess yards and slurry management systems.

Continue with the implementation, auditing and monitoring of BFMP's. This will prevent nutrient losses from diffuse sources (fields) by Nutrient Management Planning and from farmyards by the implementation of farmyard recommendations.



In the Ballyshonock catchment, continue the stream and lake monitoring programme. Link the Dawn River automatic sampling with the flow recorder to obtain flow-related samples and P-load information.

Promote the correct operation and maintenance of septic tanks in rural areas. This should start at the planning stage with identification of areas unsuitable for the use of conventional septic tank systems, advice can be given to new developers on the correct installation of systems, as well as existing owners regarding the use of septic tanks.

### **Other medium to long term recommendations that should also be considered include:**

Phased implementation of BFMP in areas identified as High Priority in terms of the implementation of management strategies (see Part 3). The initial focus to be on farms that are not participants in REPS. Visits should also be made to farms currently in REPS to audit their compliance with REPS plans. BFMP's should initially address inadequacies in farm storage and infrastructure, followed by NMPs based on the hydrological risk of the land and prevailing soil/weather conditions. Eventually, all farms should have an annually reviewed farm plan.

A Statutory Code should be introduced to ensure compliance with good agricultural practices and promote sustainable farming.

Grant aid for pollution prevention measures on farms to be made more accessible.

Teagasc recommendations for P applications to peat soils should be re-examined and re-issued having regard to the low ability of these soils to retain P.

The REPS scheme should be expanded to include large or high intensity farms. Additional emphasis should be placed on the review and audit of farms and REPS plans by certified agricultural advisors. Certification of advisors should also be reviewed annually to ensure continued high standards of advice.

The practice of storing FYM in areas such as fieldheaps, yards and unsuitable farm buildings should be reviewed, and appropriate guidance issued within a Code of Practice to address common shortfalls in management practices, identified during the Project investigations.

## Forestry Investigation Kings River Introduction

The Kings River catchment was chosen as a Study Area because of the overall significance of forestry in the upper Liffey catchment and the limited information available on the effects of commercial forestry activities on a river system in terms of nutrient inputs.

A project area of 5,496 hectares was selected from the overall Kings River catchment, extending from the upper catchment boundaries down to an area known locally as Knocknadroose, some 5km south-east of where the Kings River enters Pollaphuca Reservoir.

## Landuses in the Catchment

Landuse in the study area is dominated by commercial forestry, with large expanses of mountain moorland, an area of the Wicklow National Park, and a small degree of agriculture (predominantly sheep-rearing). Upper reaches of mountainside are moorland, with forestry further down the slopes.

Coillte owns approximately 1570 hectares of the catchment (28% of the total), and dedicated agricultural land amounts to less than 5% of the catchment. There are also areas of private forestry (mainly commercial partnerships with Coillte). The mountain moorland, although not dedicated farmland, is managed on a "commonage" basis but has seen none of the degradation of vegetation and subsequent erosion of soil experienced in a number of the western counties, although there is significant localised erosion, possibly caused by recreational use.

## Water quality monitoring

The initial WQ monitoring network in the Kings Study Area comprised of 8 weekly grab sample sites and 1 auto-sampler (AS) site sampling on a daily basis. These sites covered the majority of the major tributaries and were d/s of active forestry blocks. The water quality in the study area was of an unpolluted nature with very low concentrations of nutrients.



*Forestry operations can potentially have adverse impacts on water quality.*

The d/s site in the study showed annual median P levels of 0.006 and 0.014 mg/l for MRP and TP, respectively.

Biological Q-ratings indicated "unpolluted" water quality, except at three sites where a "slightly polluted" rating was found. It was concluded that these depressed Q-ratings were not due to nutrient inputs. It is possible that acidification was the cause of these poor results, however, further investigation would be required to confirm this.

## Nutrient Loads

The phosphorus load was calculated as 0.14 and 0.65 Kg/Ha/yr for MRP and TP, respectively, using flow-proportional auto-sampling techniques. The MRP load was calculated using laboratory analysis outside the recommended timeframe of 24 hours and is presented as an indicative value only, but was nonetheless considered reliable.

## Forestry Operation Monitoring

Monitoring of the forestry operations took place on a fortnightly basis with measurements taken of the distance that silt traps were from streams, distance of re-stocking from streams, and the development of new roads and accompanying drainage.

It was found by the Project that Coillte adhered to the guidelines in the "Code of Best Forestry Practice" in regards surface water impacts and were conscientious to avoid any pollution of receiving streams during the various operations. Results from target monitoring a forestry "clear fell" by weekly grab sampling showed that nutrient concentrations in surface waters post harvest were similar to winter background levels.

It should be noted that Coillte did not use any form of fertiliser in this catchment during the period of monitoring by the Project. Whether fertiliser will be used by Coillte in this area in the future has not yet been ascertained.

## Summary

Based on grab sampling only, no significant difference was found between water quality u/s and d/s of forested areas, nor was there any significantly adverse effect found due to forestry operations.

Nutrient export monitoring in "flashy" catchments should be done using auto-samplers collecting on a flow related basis due to the probability that weekly grab sampling is missing significant events. A further study using auto-samplers is recommended before a direct relationship between forestry operations and adverse water quality effects can be ruled out.

Phosphorus export loads from this Study Area were comparable to loads produced from low to medium intensity agricultural areas. This was due to high flow rates rather than high nutrient concentrations.

Adherence to codes of practice can result in forestry operations having a minimal input of nutrients to watercourses. Total loads of nutrient can be however, significant from upland catchments due to high rainfall leading to spate conditions mobilising large volumes of solids. Good chemical water quality was not always reflected in corresponding Q-values. It is suspected that this was due to upland acidification, although the extent to which commercial forestry activity affected this is unknown.

## Recommendations

Monitoring with auto-samplers u/s and d/s of forestry operations to identify more accurately the nutrients exported from these operations.

The use of pH probes on auto-samplers to identify/exclude forestry as a contributor to acidification of upland waters.

Independent auditing to ensure compliance with Code of Best Forestry Practice.

# Urban Investigation Camac

## Introduction

Urban development covers a significant area of the Liffey Catchment (i.e. 6% compared to approximately 1% in both the Boyne and the Suir catchments). A study of the impact of various types of urban development (residential, industrial, infrastructure (roads), and developing areas) on water quality was undertaken in the largely urbanised Camac catchment in South County Dublin.

The Camac is 24km in length, and has a catchment area of 59km<sup>2</sup>. The fall of the river from its source at Mount Seskin to the Liffey outfall is approximately 330m. The population of the catchment is approximately 117,000 (Census of 1996), although recent development has seen this figure increase significantly.

## Landuses

Landuse characteristics in the Camac catchment differ significantly from its source to its confluence with the Liffey. The upper 7km of river length is largely rural with the remaining catchment comprising suburban residential conurbations, highly industrialised areas or new developments. The river also drains two major roads, the Western Parkway Motorway (M50) and the N7, Naas Road (Table 31).

## Water Quality Monitoring

The water quality monitoring network was designed to sample 4 landuse types in the catchment: "new development", "residential", "industrial" and "urban". There were 10 grab-sampling points sampled weekly on the Camac with 8 of these sites biologically monitored on a yearly basis.

An auto-sampler was also utilised in 4 different locations in the catchment to monitor

drainage from the stormwater system of a residential sub-catchment, an industrial sub-catchment, motorway drainage, and a development site on a daily basis. The auto-sampler was installed at each of these locations for 2 months to sample low flows and 2 months to sample high flows.

## Water Quality

### Results

#### Biological

Biological monitoring results at all sites below Saggart MWWTP were indicative of "moderate" to "serious" pollution.

The site above Saggart Village was the only unpolluted site on the system but results from the 2000 survey have shown a decrease in Q ratings indicative of "slight" pollution.



*Drainage from new road schemes should be carefully controlled to prevent pollution.*

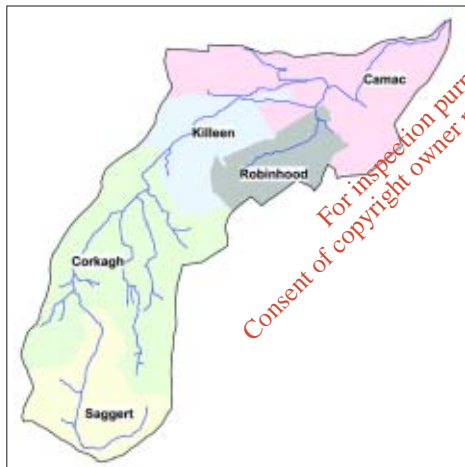
Landuse Type	Area (ha)
Rural	3734
Residential	1144
Industrial	883
Developing	137
Naas Rd & M50 (Infrastructure)	76

**Table 31** Landuse Types

### Physico-chemical

Median MRP (mg/l) concentrations were elevated at all sites from below the Saggart MWWTP to the outfall at the Liffey. It would be expected that if the MWWTP was the main nutrient source to the river that tributaries entering the main Camac channel would have had some dilution effect. However, as can be seen from **Figure 12** this is not the case and nutrients from tributaries and other sources entering the main Camac channel contributed significantly to nutrient concentrations.

Auto-sampler data from the industrial, residential, and infrastructure monitoring has shown significant levels of nutrients originating from "wash off" of hard surfaces after rainfall events.



**Figure 13** Camac Sub-catchments

### Sectoral Loads

Coefficients of nutrient concentrations in runoff from different urban landuse types were developed using auto-sampler monitoring data (**Table 32**).

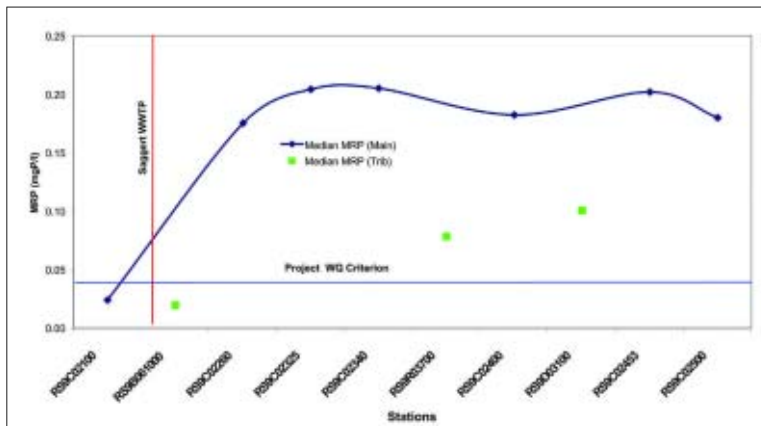
The catchment was divided into five sub-catchments (**Figure 13**) corresponding to the catchments of 5 key monitoring sites. The MRP contribution from the urban land use types within those sub-catchments was determined using the derived co-efficients and are shown in **Table 33**.

### Management Strategies

The Camac River receives pollution from a wide variety of sources. Local Authorities are currently investigating point and diffuse sources of pollution in the catchment. Some, like the Saggart MWWTP, are immediately apparent and are being addressed, i.e. this plant is currently being decommissioned and the sewage routed to the city MWWTP at Ringsend.

Dublin City Council (DCC) is presently investigating a source affecting the Camac between Killeen Road and Landsdowne Valley and appropriate measures will be introduced to alleviate the problem once investigations are complete.

Both DCC and South Dublin County Council (SDCC) are investigating mis-connections to surface water sewer systems from households but have yet to target houses in the Camac Catchment.



**Figure 12** MRP Concentrations, Camac Catchment

Surveys in other areas (by DCC and SDCC) have revealed that 6-9% of the houses investigated have mis-connections. Both Local Authorities have had significant success in persuading households to reconnect dishwashers, washing machines, etc. to the appropriate foul sewer system.

## Sustainable Urban Drainage Systems (SUDS)

SUDS are an alternative to conventional piped surface water drainage systems and provide an integrated approach towards urban runoff management.

SUDS are surface water drainage methods that take account of the quantity, quality, amenity and habitat enhancement issues.

SUDS minimise the impacts of urban runoff by capturing runoff as close to the source as possible and then release it slowly.

The use of SUDS to control runoff also provides the additional benefit of removing pollutants in the drainage water by settling out solids and in some cases providing biological treatment.

Many of the new development in SDCC areas are on "greenfield" sites and are more suitable for the full range of SUDS than sites within existing developments. Attenuation ponds have already been installed in all the major developments, Citywest, Parkwest and Baldonnell Business Park. These ponds have been developed as landscape features and greatly enhance the aesthetic and amenity value of these developments.

Sector	TP Coefficient kg/ha/yr	MRP Coefficient kg/ha/yr	TON Coefficient kg/ha/yr
Residential	0.72	0.28	3.43
Rural	0.13	0.05	4.50
Industrial	2.90	0.20	36.50
Infrastructure	9.30	0.90	7.70
Developing	0.78	0.11	5.00

**Table 32** Coefficients for various sectors in the Camac catchment

MRP Loads (kg/yr)	Saggart	Corcagh	Killeen	Robinhood	Landsdowne	Total
Load @ WQ Station	51	2661	238	308	1976	5234
Rural	47	88	19	13	3	169
Residential	0	24	96	22.9	163	306
Industrial	0	60	54	271	443	828
Developing	0	15	0	0	0	15
Infrastructure	0	23	25	1.2	1.2	50
Total	47	210	194	308	609	1368
Undefined	4	2451 <sup>1</sup>	44	0	1367 <sup>2</sup>	3867

<sup>1</sup> Load from Saggart MWWTP

<sup>2</sup> Suspected point source currently been investigated by the Local Authority.

**Table 33** Sectoral MRP Loads for Sub-catchments

## Summary

Runoff from urban landuse can have a significant negative impact on the nutrient status of receiving waters. The study indicates that nutrients loads from urban runoff can be similar to or greater than nutrients exported from agricultural areas.

The MWWTP at Saggart contributed approximately 50% of the MRP annual load to the Camac River. Decommissioning of this plant should result in a major improvement in water quality in the Camac.

Industry and Infrastructure are the largest sectoral contributors of TP, MRP and TON to the Camac (excluding the MWWTP).

Auto-sampler monitoring indicates that much of the nutrient loss to the river from Residential, Infrastructure, Developing and Industrial landuse sectors was event based, i.e. triggered by rainfall events.

The introduction of SUDS in new developments should mitigate much of the potential negative impact on water quality and flood control from these developments. The retrofitting of SUDS in existing developed areas, where conditions are suitable, would also bring about similar benefits.

Control of pollution from other sources currently being investigated by Local Authorities should result in a significant improvement in water quality.



*Forestry Operations in the Kings River Catchment.*

Examples include domestic and industrial mis-connections and unsatisfactory overflows from the foul sewerage system.

The Camac catchment can be considered as "moderately" to "seriously" polluted throughout its length with mitigating inputs and self purification in the main channel being cancelled out by nutrient loads from tributaries and discharges. Half of the MRP load was attributed to Saggart MWWTP, with sewerage, infrastructure, and industry and urban runoff accounting for a majority of the rest.

## Recommendations

### Short Term (0 to 2 years)

Investigation and remove all foul mis-connections to the surface water sewer network.

Encourage storm water management in all current and future developments (e.g. implement SUDS).

Monitoring of licensed activities (Section 4, and 16) to ensure the licensing requirements are being adhered to.

### Medium Term (2 to 5 years)

Investigation and remove all storm water mis-connections to foul networks.

Identify all combined sewer overflows and minimise impact through the development of drainage area plans and by upgrading sewerage infrastructure (holding tanks etc.).

### Long Term (5 to 10 years)

As above.

Consider retrofitting of SUDS in developed urban areas especially where redevelopment is occurring.

Local Authorities have already commenced some of the above recommendations. However further resources are required to ensure more rapid implementation of all recommendations.



BOYNE



LIFFEY



SUIR

# Three Rivers Project

## Priority Catchments



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# Priority Catchments

## Introduction

There are considerable water quality problems throughout the 3 Project catchments, and if left unchecked, conditions are likely to deteriorate in the future. The causes vary between sub-catchments and include both point and diffuse sources.

The most efficient use of the limited resources available to Local Authorities and other statutory bodies to improve water quality is to initially focus those resources in sub-catchments with the greatest water quality problems. By focusing management measures in these areas the greatest potential improvement in water quality can be achieved.

The Three Rivers Project has proposed a method to prioritise sub-catchments based primarily on water quality monitoring results. Monitoring results for the year 2000 were used in this instance as results for 2001 may have been insufficient due to foot and mouth restrictions.

Sub-catchments were ranked from "high priority" through "low priority" to "satisfactory" based on:

MRP loading per unit area of land.



*Knowledge of nutrient loads within a river system is a vital management tool.*

Compliance with Project water quality criteria for annual median MRP concentrations.

Q ratings at each monitoring station.

Local Authorities may wish to adjust these priorities based on sensitivity, risk mapping and available resources.

## Nutrient Loads

Nutrient loads per unit area of land were calculated for all significant tributary catchments using monitored nutrient concentrations and river flows. The objective of these calculations was to identify areas of the overall river catchment that were contributing high loads and to rank these areas accordingly. Nutrient export co-efficients were also used to generate "sectoral" loads, for each sub-catchment. The total catchment loads are shown in **Table 34**.

### Boyne Catchment-Nutrient Loads

Annual MRP and TON loads were calculated for 32 sub-catchments in the Boyne. The total MRP load discharged from the Boyne at Obelisk Bridge (freshwater limit) was 71 tonnes/yr. based on April 2000 to April 2001 project data. This is equivalent to 0.29 kg/ha/yr. The Total Phosphorus load was 161 tonnes/yr, which compares with the annual load for the Boyne calculated by the EPA (1999) of 141 tonnes/yr. The TON load discharged was 3245 tonnes during the measurement period, or 12.9 kgs/ha/yr.

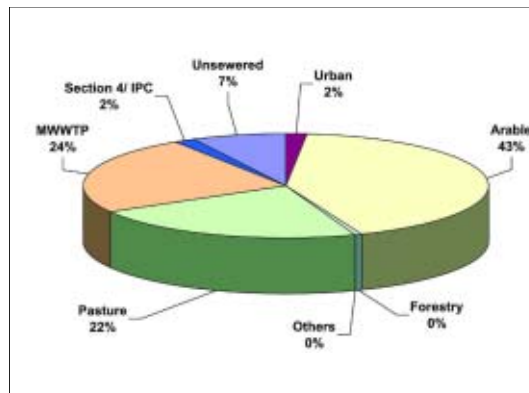
The highest MRP loads to the Boyne main channel were from its largest tributary, the **Blackwater (Kells)** with 18.6 tonnes/yr. making up 26% of the catchment load. The highest MRP loads per unit area were from the **Moynalty River** and its tributaries, the **Upper Blackwater (Kells)**, the **Skane** and the **Knightsbrook**.

On the Boyne main channel, the annual MRP load at Ashfield Br (B04 600), which includes discharges from the **Yellow, Kinnegad** and **Glash** Rivers, was 0.24kg/ha/yr. U/s of Trim MWWTP, the MRP load was 0.67 kg/ha/yr.

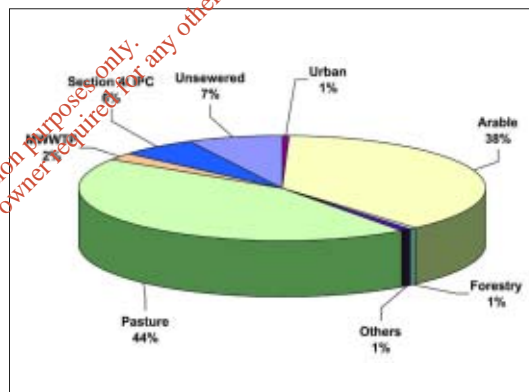
The sectoral TP loads for the Skane, Moynalty, and the Knightsbrook are shown in **Figures 14, 15 and 16**. These are estimated using landuse data and Project nutrient export co-efficients, combined with loads from point sources where known. On the **River Skane (Figure 14)**, 65% of the TP load is contributed from agricultural sources, with arable land contributing twice the TP than pasture. In the **Moynalty system (Figure 15)**, the agricultural input is 91%, with arable contributing almost half of that total. Unsewered populations (i.e. septic tanks) contribute 7%.

The **Knightsbrook (Figure 16)** exported a slightly lower incidence of TP from agricultural sources (79%), with arable land contributing almost half of the total. In this catchment, MWWTPs contribute 11%, septic tanks 7% and urban runoff 2%, showing that these sources had a small, but significant contribution to the overall TP load.

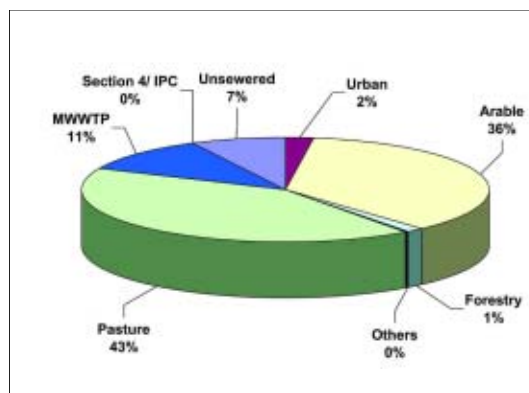
Catchments with higher than the catchment average annual TON loads were the **Moynalty, Blackwater (Kells), Yellow (Blackwater), Lislea** (discharging to Lough Ramor), **Castlejordan, Blackwater (Longwood)** and the **Boyne main channel**. It is interesting to note that the catchments exporting elevated loads of MRP or TON are not always the same.



**Figure 14** TP Load, Skane Catchment



**Figure 15** TP Load, Moynalty Catchment



**Figure 16** TP Load, Knightsbrook Catchment

### Liffey Catchment-Nutrient Loads

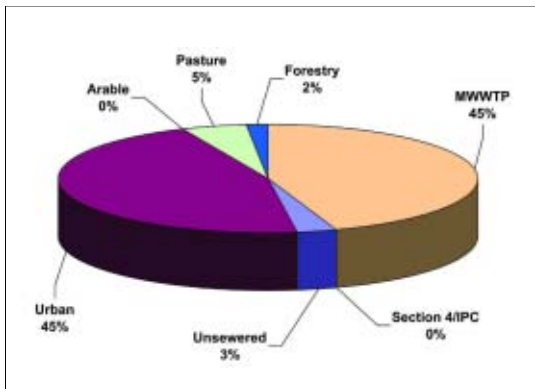
MRP and TON loads were calculated for 34 sub-catchments in the Liffey. The total MRP load for the Liffey catchment during the measurement period was estimated as 52 tonnes/yr. with an average MRP loading of 0.48 kg/ha/yr. in the April 2000 to April 2001 period. The TP load during this period was measured as 78.8 tonnes/yr at Islandbridge, with an additional 7.2 tonnes/yr being added by the Camac catchment below this sample site. The total TON load discharged by the Liffey was estimated at 1150 tonnes/year with an TON average loading of 10.4 kg /ha.

The catchments with the highest MRP loads were the **Liffey main channel** d/s of Osberstown and Leixlip MWWTPs. Both MWWTPs have recently undergone significant upgrading and the water quality results reflect this. Of four catchments with the highest loads, wastewater treatment plants (MWWTPs) u/s influence three of these (Osberstown, Leixlip and Saggart MWWTPs).

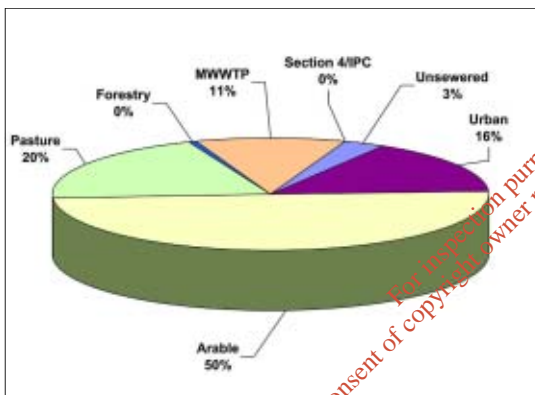
On the **Camac** catchment (**Figure 17**), the TP load contributed by MWWTPs is 45% of the catchment total. A further 3% is contributed by septic tank sources. Another large contribution is from urban runoff, however, generating 45% of catchment TP. This shows the potential beneficial impact SUDS could have on this, and similar, catchments in reducing pollution.

The **Griffeen** catchment (**Figure 18**) is dominated by arable inputs that contribute half of the TP load, pasture (20%) and urban drainage (16%) are other significant inputs. TP from sewage sources also contribute a total of 14%, made up mainly of discharges from MWWTPs.

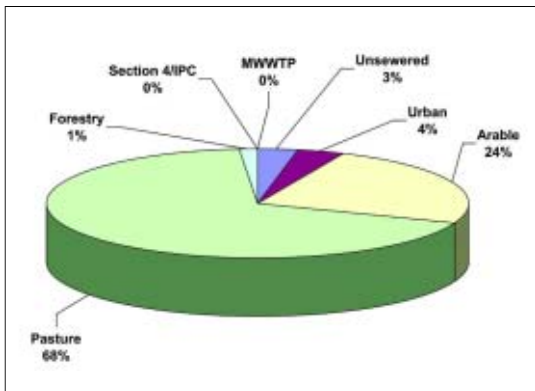
The **Ryewater** (**Figure 19**) is dominated by TP exports from agricultural sources with pasture contributing almost 70% of the total, and arable land 24%.



**Figure 17** TP Load, Camac Catchment



**Figure 18** TP Load, Griffeen Catchment



**Figure 19** TP Load, Ryewater Catchment

MRP loads from primarily agricultural catchments ranged from 0.15 to 0.3 kg/ha/yr. Similar loading was produced by an "active" forest region where low levels of nutrient concentrations were recorded but where very high flows resulted in relatively high nutrient loads.

There was considerable variation in the TON loads per hectare throughout the Liffey catchment, ranging from 0.27 kg/ha/yr on the **Kings River** to 102 kg/ha/yr d/s of Leixlip. Six sub-catchment sites had TON loads of 20kg/ha/yr or greater, three of which were on the main channel and three on tributaries.

Catchments discharging elevated MRP and TON loads were not always the same, and the **Painestown** catchment on the upper Morrell which flows through the village of Kill is one of the few catchments that has significantly high TON and MRP loads. There is an overflow on the sewage pumping station and one combined sewer overflow in the village which are likely to be significant nutrient sources.

**Suir Catchment-Nutrient Loads**

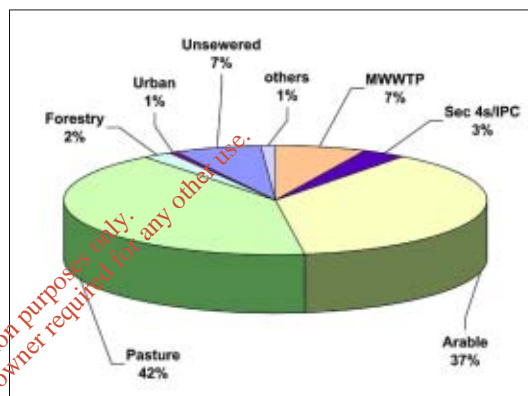
MRP and TON loads were calculated for 41 catchments in the Suir. The total MRP load for the Suir was measured (Sir Thomas's Bridge, Clonmel) at 79 tonnes/year for the measured period with an average load of 0.37 kg/ha/yr. However, the sample point is u/s of a number of important tributaries including the **Anner, St Johns, Blackwater** and **Fidaghta**. When these tributaries are accounted for, the total MRP exported by the entire Suir catchment rises to 147 tonnes/yr (0.47 kg/ha/yr).

The total TON load for the Suir at Sir Thomas's Bridge was 2887 tonnes/yr (13.4 kg/ha/yr) rising to 5168 tonnes/yr (17.0 kg/ha/yr) when the sub-catchments d/s of Sir Thomas's Bridge were accounted for.

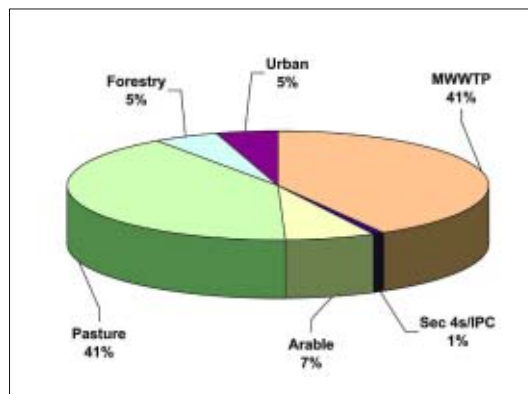
The **Blackwater** sub-catchment has the highest MRP loading contributing 18.4 t/yr (7.6% of the total load or 1.44 kg/ha/yr to the Suir main channel. There are two small wastewater treatment plants (Mullinavat [p.e.300] & Dangan [p.e. 40]) and 2 IPC licences discharging to the system.

Elevated MRP loads were also discharged to the Suir from the **Multeen, Ara, Anner** and **Aherlow** catchments.

The **Anner (Figure 20)** shows the influence of agriculture with the biggest contributors of TP to the catchment being of arable areas and pasture (both 42%). Sewage sources contribute 7%, with septic tank sources slightly exceeding those from MWWTPs.



**Figure 20** TP Load, Anner Catchment



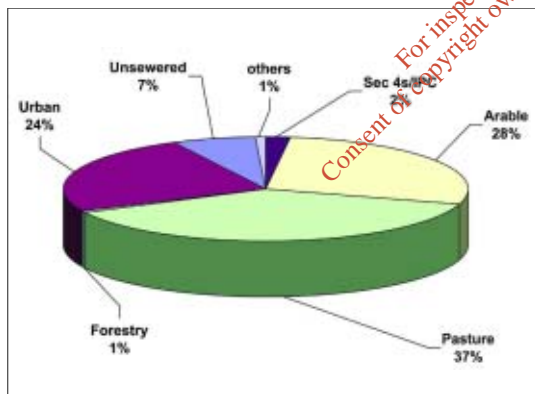
**Figure 21** TP Load, Ara Catchment

In the **Ara** catchment (**Figure 21**), the main sources of TP were MWWTPs (38% mainly the MWWTP at Tipperary Town), and agriculture, as identified in the pilot study area u/s of the plant. Pasture contributes 41% of the catchment TP load.

On the **Shroughnagoween**, a branch of the Ara, MRP loads of 1.67kg/ha/yr were also found and agriculture is suspected as the main source.

Agriculture (65%) and urbanisation (24%) affect the **St Johns** catchment (**Figure 22**). Suspected inputs from industrial sources are not demonstrated in the TP sectoral load chart.

Catchments with high TON loads include the **Ara, Aherlow, Blackwater, Drish, Tar and Clodiagh**. On the **Suir main channel** high TON loads were recorded d/s of Cahir Park and at New Bridge although nutrient loads decline at Knockgeragh. Again, catchments with elevated MRP loads did not necessarily discharge high TON loads.



**Figure 22** TP Load, St Johns Catchment

The nutrient status of the 3 Rivers Project catchments is summarised in **Table 34**.

## Priority Catchments

All water quality monitoring sites were classified as "satisfactory" or "unsatisfactory".

Satisfactory sites had annual median MRP concentrations of less than or equal to 0.03 mgP/l and Q ratings greater than or equal to Q4.

The unsatisfactory sites i.e. failing one or both criteria were then scored and ranked according to the Q value of the site, median MRP concentration, and MRP load (kg/ha/yr) from the u/s catchment as "high", "medium" or "low" priority.

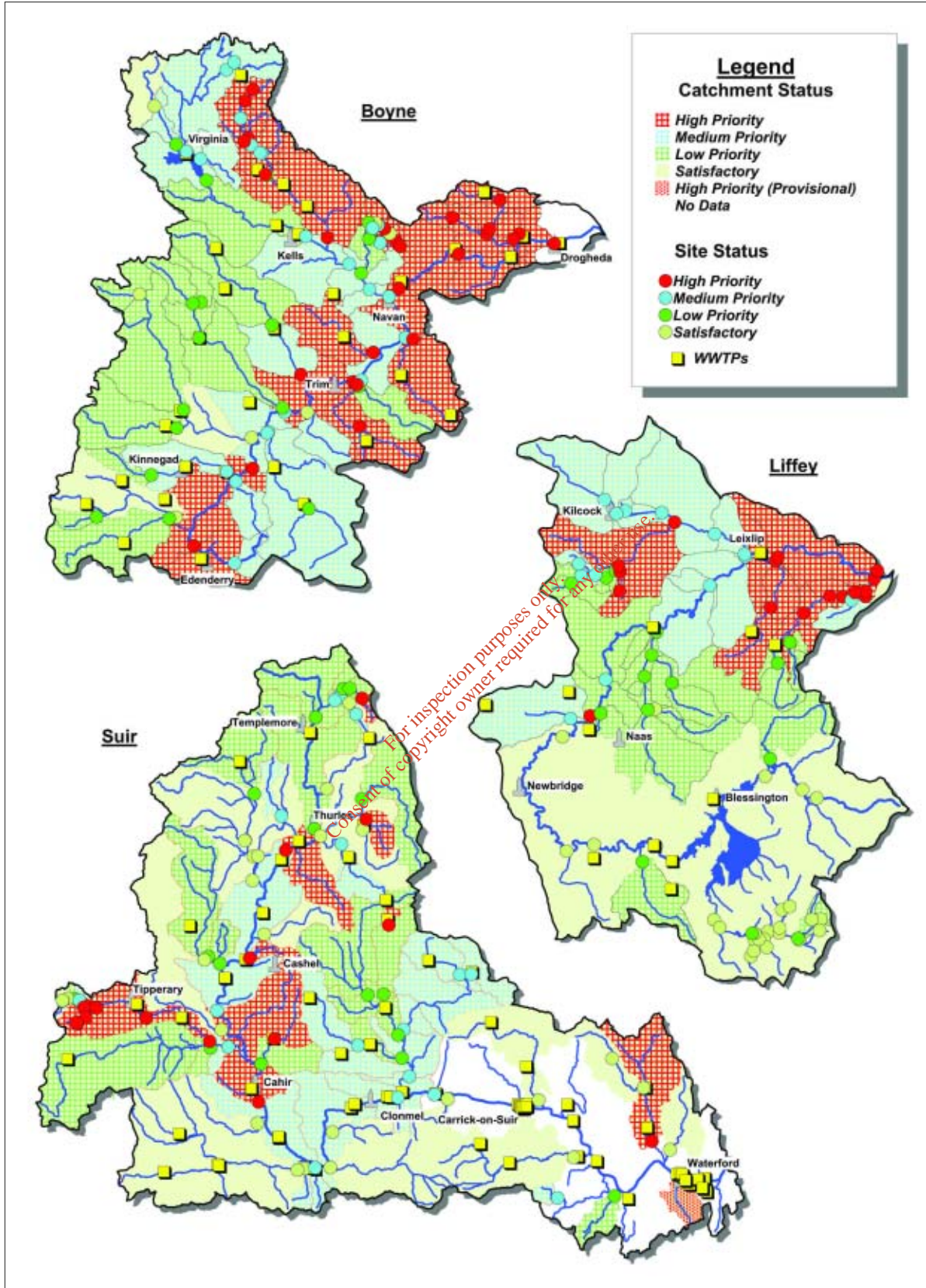
Based on the number of unsatisfactory sites on each river stretch and their "priority value", tributaries/sub-catchments were classed as areas of high, medium or low priority.

Where only one monitoring station was situated on a sub-catchment, usually just above the confluence with the main channel or larger tributary, the sub-catchment was classified based on the priority of that site. This is consistent with the approach taken by the EPA when classifying river stretches based on Q ratings.

Priority catchments for the Boyne, Liffey and Suir are shown in **Map 10** and high priority catchments are listed in **Table 35**.

Catchment	Measured TP Tonnes/yr.	TP Kg/ha/yr. (Average)	Measured MRP Tonnes/yr.	MRP Kg/ha/yr. (Average)	Measured TON Tonnes/yr.	TON Kg/ha/yr. (Average)
Boyne to Obelisk Br.	161	0.65	72	0.29	3245	13.0
Liffey to Islandbridge	78.8 (86*)	0.70	52	0.48	1150	10.4
Suir to St. Thomas's Br.	189	0.56	79 (147**)	0.37 (0.47**)	2887 (5168**)	13.4 (17.0**)
*Island Bridge PLUS Camac						
**Sir Thomas's Bridge PLUS load from d/s catchments						

**Table 34** Nutrient Loads, Three Rivers Catchments



Map 10 Priority Catchments and Sites

### Boyne (High) Priority Catchments

Of 76 monitoring sites in the catchment only 6 (8% of sites) were classed as "satisfactory" using the above method. These sites are on the **Deel**, **Castlejordan**, and **Nadreegeel Stream**.

The **Upper Moynalty** with 6 high priority sites was ranked as the worst tributary in terms of water quality. The **Mattock/Devlin's** has 5 sites, **Knightsbrook** (2 sites), and the **Boyne main channel** (7 sites) classed as high priority. Rivers with one high priority site at the confluence were the **Skane** and the **Clady**.

The **Moynalty**, where agriculture is likely to be the major source of nutrient inputs, demonstrated consistent poor water quality throughout, with priority sites at Lurganbane Bridge and Wilton Bridge on the main channel. The nutrient loads calculated for the main channel range from 0.42 to 0.82kg/ha/yr and Q ratings indicate "slight" to "moderate" pollution.

There are several high priority sites along the **Boyne Main Channel** and in particular towards the headwaters. At Kinnafad Bridge, which was "seriously polluted" in 2000, the median MRP concentration was 0.26 mg/l. The major influence at this site is Edendery MWWTP although there are also water quality problems u/s of the plant at Clonkeen (Q3-4).

The **Knightsbrook** at Dangan Bridge was rated a high priority site. Dangan Bridge is d/s of Summerhill MWWTP (600 p.e.) and the confluence of the Dangan River, which originates from the vicinity of Basketstown Landfill.

The **Mattock/Devlin's** catchment is a largely rural area with a MWWTP at Collon (350 p.e.).

However, as there was poor water quality throughout this tributary the main source of nutrients was again likely to be agricultural. Definitive reasons for the poor water quality require further investigation. Although the Mattock Q ratings have improved since 1997 the river remains in an unsatisfactory condition.

Similarly the **Skane** at Dowdstown Br was unsatisfactory, in terms of MRP and D.O. Dunshaughlin MWWTP (2500 p.e.) and Kilmessan MWWTP's discharge to the Skane. The Skane also has an elevated MRP load of 0.37 kg/ha/yr. EPA data confirmed that u/s stations on this river were moderately polluted.

The monitoring site at the bottom of the **Clady** was ranked no. 11 of the unsatisfactory sites in the catchment. "Moderately" polluted, it had a median MRP of 0.09 mg/l and contributed an estimated load of 0.41 kg/ha/yr to the Boyne. There is a MWWTP at Dunderry (200 p.e.), which is suspected as the cause of elevated nutrient levels.

Based on the identification of unsatisfactory sites/hotspots, 6 "(high) priority" catchments were identified:

- Moynalty
- Devlin's/Mattock
- Knightsbrook
- Boyne main channel
- Skane
- Clady

### Liffey (High) Priority Catchments

64% of the monitoring sites on the Liffey had some degree of pollution as indicated by Q ratings or median MRP criteria ("unsatisfactory sites"). It should be noted that the presence of a high density of unsatisfactory monitoring sites on the Camac Pilot Study Area influences the overall percentage of "polluted" sites.

The site at Landsdown Valley Park (C020 453) on the **Camac** was ranked as the worst of the unsatisfactory sites and the Camac catchment d/s of Saggart is classed as "high priority". Three sites on the Camac have been influenced by the MWWTP at Saggart. However, this plant ceased operation at the end of 2001 and the effluent is now piped to Clondalkin and on to Ringsend MWWTP plant in Dublin. It is expected that there will be a significant improvement in water quality at these three stations. Water quality in the lower Camac is influenced by discharges from urban drainage.

Two sections of the **Lyreen** are targeted as high priority areas, the Upper Lyreen from its source to Lyreen Bridge and the Lower Lyreen from Lyreen Bridge to Maynooth. There are no known regulated point sources on these stretches which flows through a mainly rural area although the Lower Lyreen River may be influenced by overflows from the sewerage system in Maynooth.

The **Griffeen** has been classified as "high priority" and the most likely source of pollution is a MWWTP servicing the village of Newcastle although further investigation to confirm this is required. It is planned that this plant will cease operation and the sewage diverted to Ringsend MWWTP during 2002.

**The Liffey main channel** d/s of Leixlip has been classed as "high priority" with unsatisfactory sites at Lucan Bridge and Islandbridge. This stretch of the river is greatly influenced by urbanisation and sewage effluent outfalls. A new MWWTP at Leixlip was commissioned in July 2000 and future monitoring should reflect an improvement in water quality.

Much of the **Ryewater** catchment generates MRP loads per unit area greater than the average for the Liffey catchment as a whole.

The catchment is a rural area with two significant centres of population (Maynooth and Kilcock), however the principal causes of the poor water quality are unknown. This catchment has been classed as "medium priority".

In summary 5 "(high) priority" catchments were identified in the Liffey.

Main Liffey channel d/s of Leixlip  
Griffeen  
Camac  
Lower Lyreen  
Upper Lyreen from source to Lyreen Br.

### Suir (High) Priority Catchments

Some pollution was evident on 66% of the Suir sites as indicated by Q ratings or median MRP criteria (unsatisfactory sites). Of the 15 sites classed as high priority, 7 were in the **Ara** (including the Shroughnagowneen). Sources of pollution in the upper part of this catchment are primarily related to agriculture with poor slurry and manure storage being identified as a significant source. The entire Ara catchment was classed as "high priority".

The site d/s of the MWWTPs in Tipperary town is classified as good quality (Q4) and the site d/s of Bansha is classified as "slightly" polluted (Q3-4). However the MRP concentration at both of these sites is high with very high MRP loading, resulting in the "high priority" classification at these sites. The upgrade of Tipperary Town MWWTP should result in a significant improvement in water quality in the future.



*Upland watercourses can export significant amounts of nutrient due to their high flows.*

The **Upper Clonmore** is a high priority catchment and formed one of the Study Areas. The catchment showed elevated MRP concentrations (0.08 mg/l), poor Q values (Q2-3, moderately polluted), and also exports a significant P load (0.36 kg/ha/yr). Water quality in this catchment is effected primarily by agricultural sources.

The **Black Stream** (Cashel) is a small water-course that flows through Cashel before entering the Suir just u/s of the confluence of the Multeen. There were elevated MRP concentrations and poor biological ratings evident on this sub-catchment (0.07 mg/l and Q3 respectively) and high nutrient export (0.81 kg P/ha/yr). Storm overflows from Cashel MWWTP are suspected as a primary cause of poor water quality in the Black Stream.

The **Clover** catchment was classed as "high priority" having a relatively high MRP load (0.54 kg/ha/yr) and an annual median MRP concentration indicative of moderate pollution at the d/s site. There may be an unregulated point source u/s of this site.

The site on the **Outeragh River** has very poor water quality with a Q value of 1 (seriously polluted) and high median MRP concentration (0.12mg/l ) although there was a low MRP load from this catchment due to the low flow. There is a MWWTP u/s of the monitoring site that may have a significant impact on water quality.

The **Clashawley** had poor water quality with a median MRP value of 0.16mg/l. There is also a considerable nutrient load from this small catchment area.

The site on the Blackwater (Kilmacow), north of Waterford has annual median MRP values and Q ratings indicative of slight pollution. This catchment exports the 5<sup>th</sup> highest P load (1.44 kg/ha/yr) in the Suir catchment and is classified as high priority.

On the **Suir main channel** two high priority sites are located d/s of Thurles and d/s of Cahir wastewater treatment plant. Both sites suffer from very high MRP loads and relatively poor water quality in terms of MRP concentration.

Unfortunately there were some catchments for which nutrient loads were not available and so it was not possible to rate them in the manner discussed above. These sites could be given a provisional ranking based on local knowledge as well as an immediate investigative sampling regime based on the use of a flow-related auto-sampler at the bottom of each identified catchment.

The **St Johns River** is the most significant of these. This catchment has very poor water quality particularly at site S03310 where median MRP value for 2000 was 0.24 mg/l. The Q value at this site for 2000 is Q1-2 and has decreased in quality to Q1 in 2001. This is a level indicative of serious pollution. The catchment u/s of S03310 has a number of industries with licensed discharges. There is also a landfill u/s of this site.

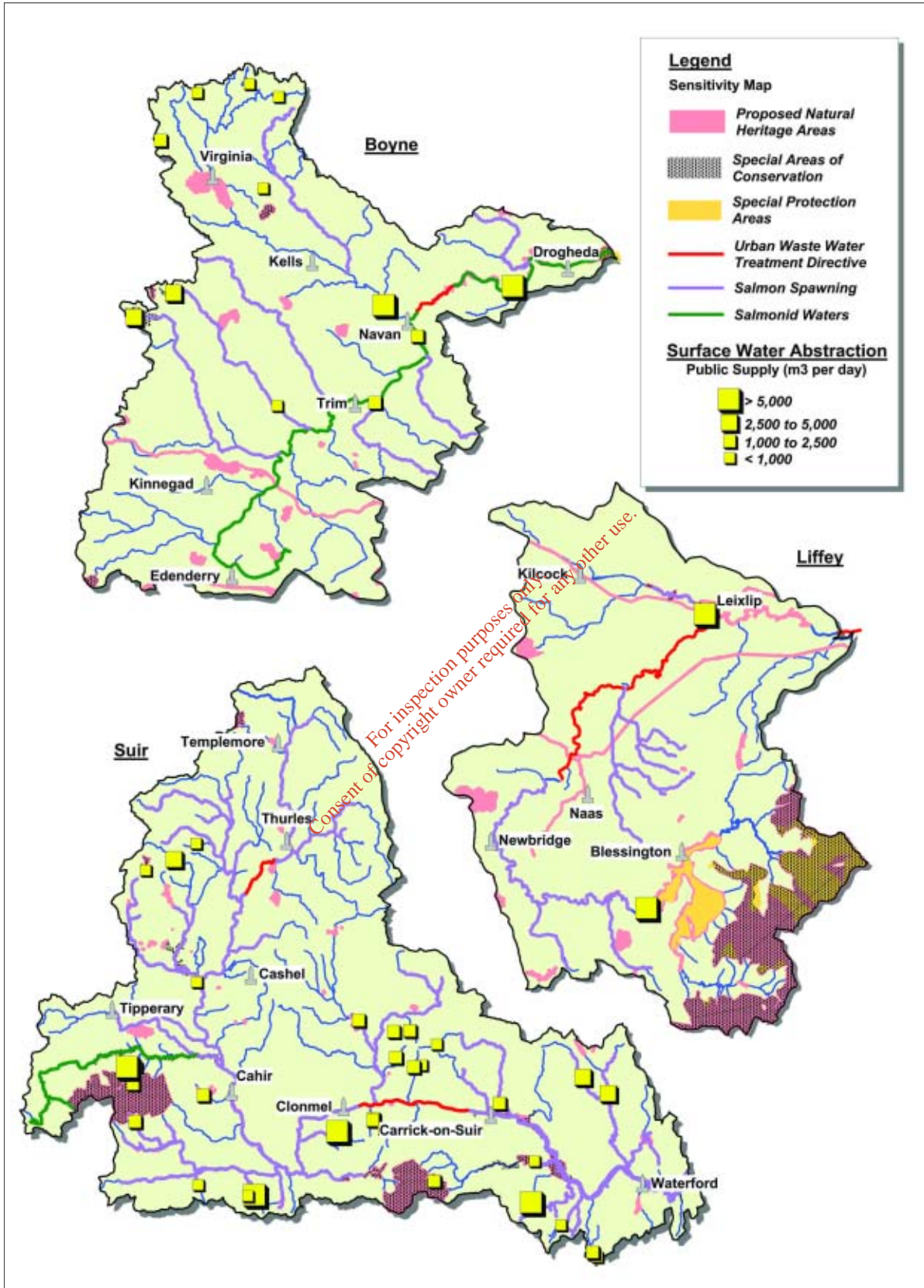
The 10 catchment areas with most serious water quality problems and thus are classified as (high) priority are:

- Ara
- Suir d/s of Thurles
- Suir d/s Cahir
- Black Stream (Cashel)
- Clover
- Outeragh
- Blackwater
- Upper Clonmore
- Clawshawley
- St Johns (Provisional Ranking)

The high priority sub-catchments are listed in **Table 35**, along with the main management issues in each sub-catchment.

Catchment	Sub-Catchment	No. of High Priority Sites	Main Management Issues
Boyne	Boyne main channel	3	MWWTP, Agriculture
	Moynalty	8	Intensive Agriculture
	Devlin's/Mattock	5	Agriculture
	Knightsbrook	2	MWWTP, Agriculture
	Skane	1	MWWTP's
	Clady	1	MWWTP's
Liffey	Main Liffey channel d/s of Leixlip	2	MWWTP's, Urbanisation
	Griffeen	2	MWWTP's
	Camac	10	MWWTP's, Urbanisation
	Main Lyreen	2	Agriculture, Urbanisation
	Upper Lyreen from source to Lyreen Br.	2	Agriculture
Suir	Ara	8	Agriculture, MWWTP's
	Suir d/s of Thurles	1	Agriculture, MWWTP's
	Blackwater (Kilmacow)	1	Agriculture
	Black Stream (Cashel)	1	MWWTP
	Clover	1	Agriculture, Septic Tanks
	Outeragh	3	Agriculture, MWWTPs
	Suir d/s Cahir	1	MWWTP, Agriculture
	Clonmore	4	Agriculture
	Clashawley	3	Agriculture
	St Johns (Provisional)	2	Industrial, Agricultural, Urbanisation

**Table 35** *High Priority Sub-Catchments, Boyne, Liffey and Suir*



Map 11 Sensitive Areas within the Three Rivers Catchments

## Additional Factors influencing prioritisation

The Three Rivers approach is based on observed water quality and is a straight-forward and transparent method of selecting priority catchments on which to focus limited management resources. Prioritisation can be updated on a regular basis and monitoring data from other sources, e.g. the EPA, can be included in the ranking process.

However, Local Authorities may wish to consider additional factors before finalising their priority catchments (**Figure 23**):

### **The sensitivity of the water body in terms of beneficial uses or ecological importance.**

Some water bodies may be considered particularly sensitive to nutrient or other pollutants due to their current or future use for water abstraction, fisheries resources, amenity or their ecological importance (**Map 11**). L.A. may consider increasing the priority of such catchments in order to protect their "beneficial use". It should be noted that whilst Project nutrient criteria are consistent with a satisfactory ecological environment with respect to eutrophic pressures and general water quality, more specific criteria, for example bacteriological, pesticide or Dangerous Substances contamination of drinking water supplies, are not considered and should be investigated on a case by case basis.

### **Potential Risk**

The potential risk that physical and landuse characteristics of the catchments present in terms of nutrient inputs are highlighted in **Table 1**. Preliminary Risk Maps identifying areas of potential high risk in terms of loss of nutrients from agricultural activities and land spreading of sludges/slurries are presented in **Part 1** of this report (**Map 2**).

While "risk" activities/landuse being carried out in high-risk areas may not as yet result in poor water quality they may in the future, if left unchecked or allowed to increase. Therefore pro-active measures may need to be considered to prevent any deterioration.

Thus L.A. may decide to limit further development of high-risk activities in these areas through planning restrictions or control potential nutrient losses through the implementation of "Best Management Practices" for risk activities.

### **Additional monitoring data and observation.**

The Three Rivers Project Monitoring network is limited in its extent in some areas, particularly where unpolluted waters were recorded in the 1995-97 National Survey carried out by the EPA. Results from other monitoring programmes may indicate deterioration in water quality on river stretches not monitored by the Three Rivers Project. In addition, L.A., Fisheries, EPA officials etc. who are constantly patrolling the catchments during the course of their duties may be aware of specific areas and activities that are impacting on water quality which need to be managed.

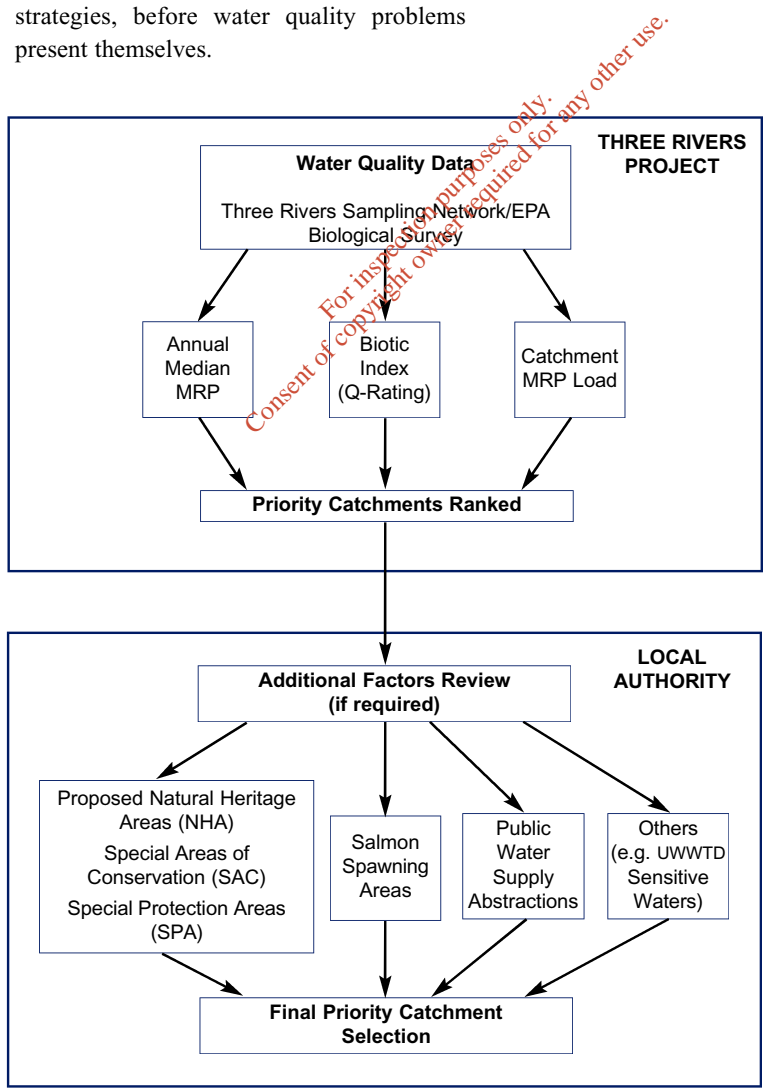
### **Available financial and manpower resources.**

All L.A. and statutory bodies have limited resources available to manage water quality. The Three Rivers Project has identified Priority catchments and the sectoral load contribution within these catchments, to identify the most significant nutrient sources and appropriate management strategies to control these sources.

The Three Rivers Project has also highlighted other criteria that allow L.A. flexibility within a dynamic structure to allocate resources to specific local priorities. Such a prioritisation method must remain flexible to reflect changes in water quality during the implementation of management strategies, and other issues such as new designations of Sensitive Waters, for example.

The appropriate Management Strategies applied in the Priority Catchments will improve areas of existing poor water quality in-line with the requirements of legislation such as the Phosphorus Regulations. The Project potential "Risk Areas" can also be the basis of targeting possible future water quality problems with the same management strategies, before water quality problems present themselves.

An example of how additional factors may influence prioritisation is found in the Suir catchment. The **Aherlow** river is a designated salmonid river. The majority of the catchment is considered "high risk" in terms of nutrient loss due to its steep topography. While the Three Rivers monitoring sites at the bottom of the catchment is classed as "low priority" in terms of current water quality and the MRP load exported from the catchment, EPA monitoring in the upper reaches in 1999 indicated a deterioration in water quality in that area. Tipperary S.R. County Council may consider raising the priority of this catchment and instigate management measures to control nutrient inputs if resources are available.



**Figure 23** Selection and review of Priority Catchments



BOYNE

LIFFEY

SUIR

## Three Rivers Project

# Management Strategies



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# 4

# Management Strategies

## Introduction

A primary objective of the Three Rivers Project was the development of strategies to manage nutrient inputs to the catchments from both regulated point and diffuse sources of pollution. While the onus for ensuring compliance with regulatory requirements rests with the Local Authorities (L.A.) and statutory bodies, the responsibility for reducing nutrient inputs lies with all sectors of the community.

There is a significant, and in general adequate, suite of existing "instruments/measures" available for managing water quality in the Three Rivers catchments. However, available measures must be implemented/enforced as required and not be curtailed due to lack of resources as is currently the case in many L.A. areas.

Regular auditing of implemented management measures must be an essential part of the management strategy in order to evaluate their effectiveness and refocus where necessary. In addition, some existing legislation needs to be reviewed in light of more stringent requirements and environmental objectives required under new legislation.



## Proposed Catchment Management Structure

It is now accepted policy that water quality in Irish rivers must be managed at a river catchment or regional scale. Under the current government structure the responsibility for the implementation of water quality/status management strategies will still fall substantially on Local Authorities, because of the responsibilities and powers retained by them to govern and police the existing acts and regulations. Therefore, there is an urgent need to put in place a properly resourced catchment/regional management structure to guide and oversee the implementation of the various management strategies.

A schematic of the proposed management structure is shown in **Figure 24**.

## Implementation of Management Strategies/Measures

The Project proposes a stepped approach to the implementation of management strategies, which is outlined in **Table 36**. A suite of strategies and measures are listed in **Tables 37 to 43**. Although designed for use within the Project catchments, there may be merit in considering these methodologies, implementation structures and management strategies on a wider scale.

This method efficiently identifies the source of water quality problems through a series of steps from desktop data gathering through increasing degrees of on the ground investigation as required. The approach maximises the use of limited resources by targeting specific pollution sources and addresses the immediate issue of achieving compliance with regulations.

While the promotion of management strategies such as "Best Practice" e.g. Best Farm Management Planning and Sustainable Urban Drainage Systems should be encouraged on a catchmentwide basis, focused implementation of these strategies in specific problem sub-catchments is likely to yield the best return on limited resources.

## Proposed Strategies and Measures

In the following proposed suite of management strategies and measures, pollution sources are divided into 5 major categories and key strategies suggested to address pollution specific to these categories. Management sheets have been developed for each sub-catchment which identify the management measures which are appropriate to address pressures on water quality in that sub-catchment, (Figure 25). The implementation of management measures should be phased in terms of achieving short, medium and long term objectives and be related to

manpower resources and capital investment available.

By summarising important catchment information in a single management sheet, monitoring staff have an easily updateable reference tool to assess the effectiveness of management strategies. Management sheets can be colour coded and include maps or sectoral load information.

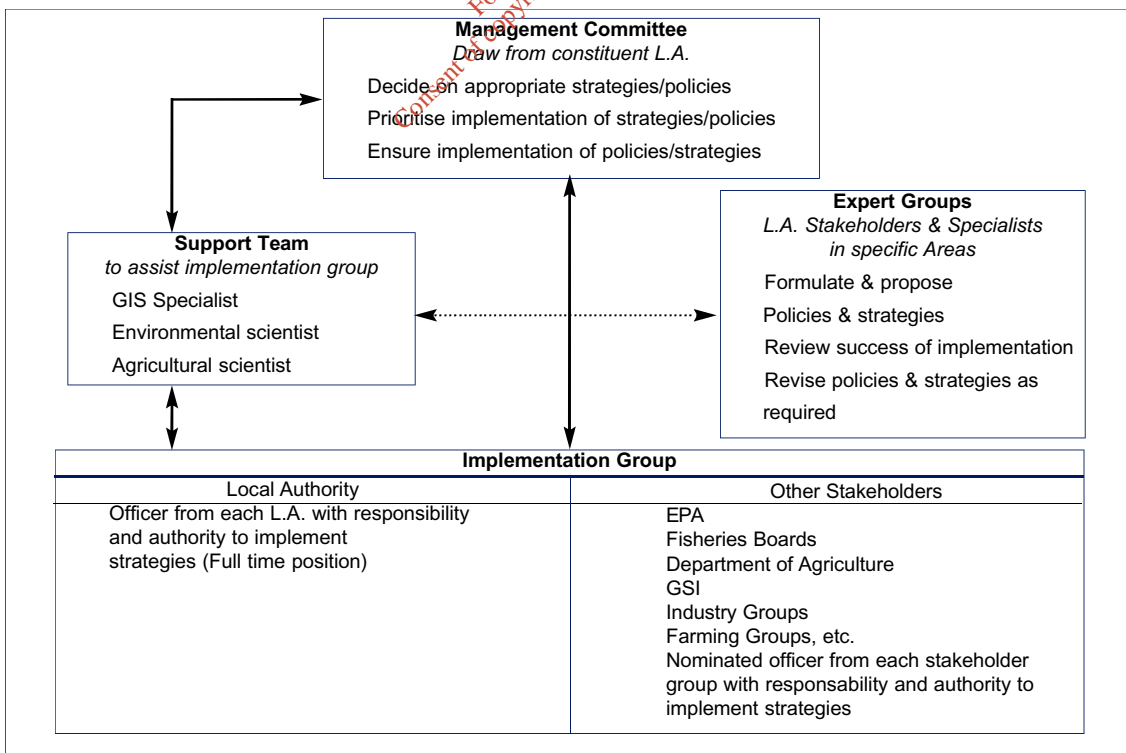


Figure 24 Proposed Management Structures: Catchment/Regional Scale

Step	Action
<b>Step 1 Gather Information</b>	<ul style="list-style-type: none"> <li>Identify <u>major</u> catchment characteristics, inputs and risk factors/pressures e.g. topography, primary landuse, soil drainage characteristics, population centres, known point sources, spread-lands</li> <li>Set-up above datasets in GIS format including: OS mapping with river network</li> <li>Generate "risk map" for nutrient loss from agricultural systems (see "Agricultural Risk Map", Part 1)</li> <li>Generate "risk map" for point sources (include population centres)</li> <li>Generate "Sensitivity" Map – water resources particularly sensitive to pollution</li> </ul>
<b>Step 2 Monitor</b>	<ul style="list-style-type: none"> <li>Identify environmental quality objectives/standards (EQOs/EQS) for each water body</li> <li>Review existing water quality and hydrometric monitoring systems including facilities monitoring</li> <li>Augment where required (see Part 1) to allow the generation of nutrient loads from sector and land areas (sub-catchments)</li> </ul>
<b>Step 3 Identify &amp; Prioritise</b>	<ul style="list-style-type: none"> <li>Analyse monitoring data to: <ul style="list-style-type: none"> <li>Identify areas and points that do not meet EQS particularly Median MRP and Q indices</li> <li>Identify/estimate loads from facilities, other point source and land areas</li> </ul> </li> <li>Rank sub-catchments using monitoring results as: <ul style="list-style-type: none"> <li>High priority</li> <li>Medium Priority</li> <li>Low Priority</li> </ul> </li> <li>Review prioritisation in relation to Sensitivity Map, Risk Map <i>and available resources</i></li> <li>Adjust prioritisation as required</li> </ul>
<b>Step 4 Implement Management Measures</b>	<ul style="list-style-type: none"> <li>If known sources (point and diffuse) are significant contributors to pollution load, implement management strategies listed in <b>Tables 37- 42</b> in <b>priority catchments</b></li> <li>If known sources are not a significant contributor further investigation into pollution sources in <b>priority catchments</b> is required as indicated in Steps 5, 6 and 7</li> </ul>
<b>Step 5 Initial Investigative Monitoring</b>	<ul style="list-style-type: none"> <li>Gather further information on pressures at a local level by consulting L.A., fisheries, Teagasc, EPA, angling clubs personnel etc. operating in the area with regard to identifying potential polluters</li> <li>Consult "Agricultural Risk Map" to identify if risk areas are present in catchment and target further investigations in these areas</li> <li>Initiate Investigative Monitoring-including a hydrometric station, auto-sampler (min. 4 months), grab sampling (min. 6 months)</li> <li>Analyse monitoring data to identify trends which might indicate source of pollution</li> </ul>
<b>Step 6 Detailed ground investigation (in tandem with Step 5)</b>	<ul style="list-style-type: none"> <li>Walk catchment to identify pollution sources including: <ul style="list-style-type: none"> <li>Intensive landuse, animal housing units and farmyards, animal access to watercourses, storm drains and sewer overflows, rural housing, storage areas, illegal discharges.</li> <li>Section 12 notices that have been served</li> </ul> </li> <li>Calculate rough "storage capacity/deficit in agricultural areas Identify "condition" of farmyards etc. &amp; distance of facility from water courses</li> <li>Identify physical "risk" characteristics of catchment e.g. poor drainage, low river gradient</li> <li>Determine most likely cause of pollution</li> </ul>
<b>Step 7 Implement Management Measures</b>	<ul style="list-style-type: none"> <li>Select appropriate management/abatement strategy from <b>Table 37- 42</b> based on identified/likely pollution source</li> <li>Cognisance should be taken as to the likely response time to different strategies, e.g. Quick response to targeting point sources, slower response to reducing inputs through "Nutrient Management Planning"</li> </ul>
<b>Step 8 High Risk/Sensitive Areas</b>	<ul style="list-style-type: none"> <li>Identify high risk and sensitive areas based on maps generated in Step 1</li> <li>Instigate appropriate management strategies to reduce risk to water bodies as resources come available</li> <li>Assess planning applications in relation to potential increase in risk to WQ in these areas</li> </ul>

**Table 36** *Stepwise methodology for implementing management strategies*

Pollution Source	Key Management Measures
<b>Municipal Wastewater Discharges</b>	<b>Review Urban Wastewater Treatment Regulations</b> in the light of Phosphorus Regulations and Nitrates Directive Threshold size, sampling frequency, parameters, discharge concentration limits
	<b>Discharge Monitoring</b> Monitoring at all MWWTP to comply with <b>Table 43</b> Determine nutrient load discharged according to the above
	<b>Discharge Limits (“River Needs”)</b> Review and revise discharge limits as necessary Set discharge limits against: <ul style="list-style-type: none"> <li>• Environmental Quality Objectives/Standards in receiving waters</li> <li>• Available dilution in receiving waters</li> <li>• Existing background quality conditions in receiving waters</li> </ul>
	<b>Maintenance and upgrades</b> Upgrade all MWWTPs to meet Urban Wastewater Treatment Regulations as a minimum Upgrade to achieve Environmental Quality Objectives/Standards in receiving water Maintain plant on a regular basis Operate to maximum efficiency with auditing of performance
<b>Trade &amp; Industrial Discharges</b>	<b>Discharge monitoring</b> Industry should submit monitoring returns to the Local Authority (L.A.). The L.A. should carry out an audit at least annually Determine nutrient load discharged Instigate monitoring of Section 16 discharges to foul sewer, in areas of poor water quality
	<b>Licensing (“River Needs”)</b> As per “Discharge Limits” above
	<b>Reduction at source (Polluter Pays)</b> Recommend the reduction of nutrient discharges at source through the application of Best Available Technology (BAT) at process plants and/or plants treating process waste Implement “Polluter Pays Principle” with incentives to minimise effluent load

**Table 37** Regulated Point Source Discharges

Pollution Source	Key Management Measures
Urban Drainage	<p><b>Forward Infrastructure Planning</b></p> <p>Forward infrastructures planning to avoid retrofitting of Sustainable Urban Drainage Systems (SUDS)</p>
	<p><b>Source Control</b></p> <p>Source control of potentially contaminated runoff by:</p> <ul style="list-style-type: none"> <li>Investigation of premises likely to or suspected of causing contaminated runoff. Examine bunding arrangements, petrol interceptors etc.</li> <li>Investigate sewer mis-connections</li> </ul>
	<p><b>SUDS</b></p> <p>Implement Sustainable Urban Drainage Systems in new developments and retrofit in existing developments, where feasible</p>
	<p><b>Planning Control</b></p> <p>Limit the potential of urban development to discharge nutrients through appropriate:</p> <ul style="list-style-type: none"> <li>Zoning</li> <li>Building Regulations</li> <li>Licensing of discharges</li> </ul>
	<p><b>Emergency Response</b></p> <p>Implement early warning and emergency response systems to manage accidental spills of contaminating substances etc.</p>
Septic Tanks	<p><b>Planning Control</b></p> <p>Limit the potential of septic tanks to impact on surface and groundwater through:</p> <ul style="list-style-type: none"> <li>Appropriate siting of tanks with reference to drainage and risk of contamination</li> <li>Appropriate level of treatment relative to the sensitivity of the area to nutrient/bacterial pollution, e.g. inclusion of reed bed treatment</li> <li>Appropriate level of inspection during construction</li> </ul>
	<p><b>Education of owners</b></p> <p>Educate owners to proper use and maintenance of their tank including:</p> <ul style="list-style-type: none"> <li>Follow planning regulations and guidelines when applying for and installing a tank</li> <li>Maintain and de-sludge tank on a regular basis</li> <li>Ensure safe disposal of sludges through a licensed contractor</li> <li>Reduce the use of anti-bacterial disinfectants</li> <li>Encourage use of phosphate free detergents</li> </ul>

**Table 38** *Unregulated Point Discharges*

Pollution Source	Key Management Measures
<p><b>Agricultural</b></p>	<p><b>Best Farm Management Plans (BFMP)</b></p> <p>Implementation of BFMP on all farms including:</p> <ul style="list-style-type: none"> <li>• Nutrient Management Plan (NMP) for managing nutrients</li> <li>• Hydrological Risk Assessment for the Application of Nutrients</li> <li>• Soil Erosion Risk Assessment</li> <li>• Farmyard Assessment and Management Plan</li> </ul>
	<p><b>Rural Environmental Protection Scheme (REPS)</b></p> <p>Encourage participation in REPS and other similar schemes by all eligible farm enterprises</p>
	<p><b>Cross Compliance</b></p> <p>Implementation of “cross compliance” between direct payment schemes and environmental farming practices by the Department of Agriculture and Food</p>
	<p><b>Legislative Control</b></p> <p>Serving of Section 12 Notices under the Water Pollution Act on farms holding substances that are potential pollutants</p> <p>Implementation of the Waste Management Act with regard to the spreading of industrial or municipal sludges on farmland</p>
	<p><b>Agricultural Bye-laws</b></p> <p>Implementation of bye-laws under the Water Pollution Act requiring BFMP on all farms in catchments where:</p> <ul style="list-style-type: none"> <li>• Agriculture is suspected or shown to be a significant source of pollution</li> <li>• Intensive agriculture presents a potential risk due to physical characteristics of the catchment</li> <li>• High sensitivity to pollution due to the beneficial use of water resources in the catchment e.g. drinking water source</li> </ul>
	<p><b>Advice/Education</b></p> <p>Campaigns aimed at promoting the uptake of “Code of Good Practice” in farming, e.g. BFMP throughout the catchment</p>

**Table 39** *Agriculture*

Pollution Source	Key Management Measures
<b>Municipal &amp; Industrial Sludges</b>	<p><b>Sludge Management Plans</b></p> <ul style="list-style-type: none"> <li>• Development of sludge management plans under the Waste Management Act at a catchment level</li> <li>• Development of Nutrient Management Plans for all lands on which the spreading of sludge is authorised</li> <li>• Development of a “spreadland” module for a catchment Geographical Information System to enable efficient tracking and auditing of sludge spreading. Both Local Authorities and EPA to populate database with spreadlands associated with IPC and waste management licences</li> </ul> <p><b>Legislative Control &amp; Enforcement</b></p> <p>Effective auditing of waste licenses with respect to spreadlands</p>

**Table 40** *Management of Sludges*

Pollution Source	Key Management Measures
<b>Forestry</b>	<p><b>Code of Best Forest Practice</b></p> <p>Promote implementation and enforcement of the “Code of Best Forest Practice” issued by the Forestry Service and COFORD</p>
	<p>Monitor impact of forestry activities on water quality using automatic samplers, particularly the following activities:</p> <ul style="list-style-type: none"> <li>• Preparation of land for new planting,</li> <li>• Fertilisation</li> <li>• Clear felling</li> </ul> <p>Audit the implementation of codes</p>
<b>Peat Extraction</b>	<p>Engineering solutions to minimise the release of sediments from drainage and extraction activities</p>
	<p>Promote the development and implementation of a Code of Best Practice for extraction activities in consultation with L.A., EPA and Fisheries Boards</p>


**Table 41** *Specific Industry Sectors*

Abstraction Pressures	Key Management Measures
Hydro-Electric	<ul style="list-style-type: none"> <li>Abstraction modelling</li> <li>Water Resource Planning</li> <li>Increase hydrometric monitoring</li> </ul>
Potable Supplies	<ul style="list-style-type: none"> <li>Register of Abstractions</li> <li>Water Use Plan (reduce leakage &amp; improve conservation)</li> <li>Licensing (effect of abstraction on discharge consents due to reduced dilution d/s)</li> <li>Education (reduce, re-use, re-cycle water)</li> </ul>
Industrial Users	<ul style="list-style-type: none"> <li>Education</li> <li>Engineering Solutions</li> <li>Incentives to reduce losses (application of the "Polluter Pays Principle")</li> </ul>

Table 42 Abstraction Pressures

Municipal Wastewater Treatment Plant Monitoring			
Parameters	Population Equivalent (p.e.)	Sample type and Frequency	
		Up - 500	Minimum 6 times per year evenly spaced of a type sufficient to determine load
BOD (Biochemical Oxygen Demand) COD (Chemical Oxygen Demand) TSS (Total Suspended Solids) TP (Total Phosphorus) MRP (Molybdate Reactive Phosphate) TN (Total Nitrogen) TON (Total Oxidised Nitrogen)	500 - 1000	Minimum 6 times per year evenly spaced	24 hour composite samples
	1000 - 2000	Minimum 12 times per year evenly spaced	
	2000 - 25,000	Minimum 24 times per year evenly spaced	
	Over 25,000	Minimum 52 times per year evenly spaced	
Flow	Automatic – continuous monitoring, all plants >500 p.e.		

Table 43 Recommended sampling frequencies

CATCHMENT CHARACTERISTICS		
	<b>AREA:</b> 59 Km <sup>2</sup>	<b>POLLUTION LOADING</b> <b>Est.Load TP</b> (kg/ha/yr) 1.29 <b>Est. Load MRP</b> (kg/ha/yr.): 0.88 <b>Point Source P</b> (%) 60 <b>Diffuse Source P</b> (%) 40 <b>Liffey Catchment P Load Rank = 1</b>  <b>LANDUSE:</b> 62% of landuse is either farming or parkland. The other 38% is urban or developing urban.  <b>AMENITY VALUE:</b> Poor potential for angling although upper section should be suitable for salmonid spawning.  Flows through densely populated area therefore improvement of stream and bankside habitation would greatly enhance amenity value.
	<b>GRADIENT:</b> 1:46  <b>FLOW REGIME:</b> Fast Flowing and flashy in Upper Section. Slows in middle and lower sections but high runoff due large impermeable area in lower section. <b>Hydrometric Area:</b> 09 <b>EPA Refs:</b> CO2(Camac) BO6 (Brownsbarn) RO3 (Robinhood) DO3 (Walkinstown)	
	<b>HABITAT:</b> <b>Instream:</b> Fast flowing mountain stream in upper section. Some pool, riffle, glide sequences in middle section. Culverted and canalised in lower sections. <b>Bankside:</b> - Good natural vegetation on upper sections. Poor cover on lower sections. <b>Drainage Work</b> - No drainage, but bankside armour and canalisation in place in developing urban sections.	
<b>RUN OFF RISK</b> High 38% , Medium 24%, Low 38%		

Point Sources	Details
IPC Authorisations	Kayfoam Woolfson, Our Lady's Hospital Crumlin, Loctite (Ireland), Ultra Packaging Ltd, CVP Ltd, Punch Printing Inks, Sun Chemical Inks Ltd, Packaging Inks and Coatings, Galco Steel Ltd, TJ O'Mahoney and Sons Ltd, F&T Buckley Ltd (Dublin), Jamestown Metal Resources Ltd, Metal Processors, BOC Gases Ireland Ltd, Colfix (Dublin), Brittas Plastics Ltd, Irish Printed Circuits Ltd, Lufthansa Airmotive Ltd, Hitech Plating Ltd.
Section 4	Gledswood Ltd, Roadstone Belgard, Lillis O'Donnel
MWWTP	Saggart MWWTP

Abstractions	None	Details	-
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STATUTORY DESIGNATIONS	DESCRIPTION	LIMITS
EC Freshwater Fish Directive		
Phosphorus Regs.	Applies to all sub catchments	See Table A - overleaf

WATER QUALITY	EXPLANATION
Q ratings "slightly polluted" above Saggart, "moderately polluted" in middle section and "seriously polluted" in lower sections Median MRP 0.024 mgP/l at site upstream of Saggart and 0.202 mgP/l at Landsdowne Valley site.	Number of possible causes. Point sources emanating from MWWTP, Gross mis-connections, pump and sewer overflows Diffuse sources from wash down of impermeable surfaces and multiple minor mis-connections.
<b>GOAL</b> <b>Improve water quality and habitat to support a more diverse range of species</b>	

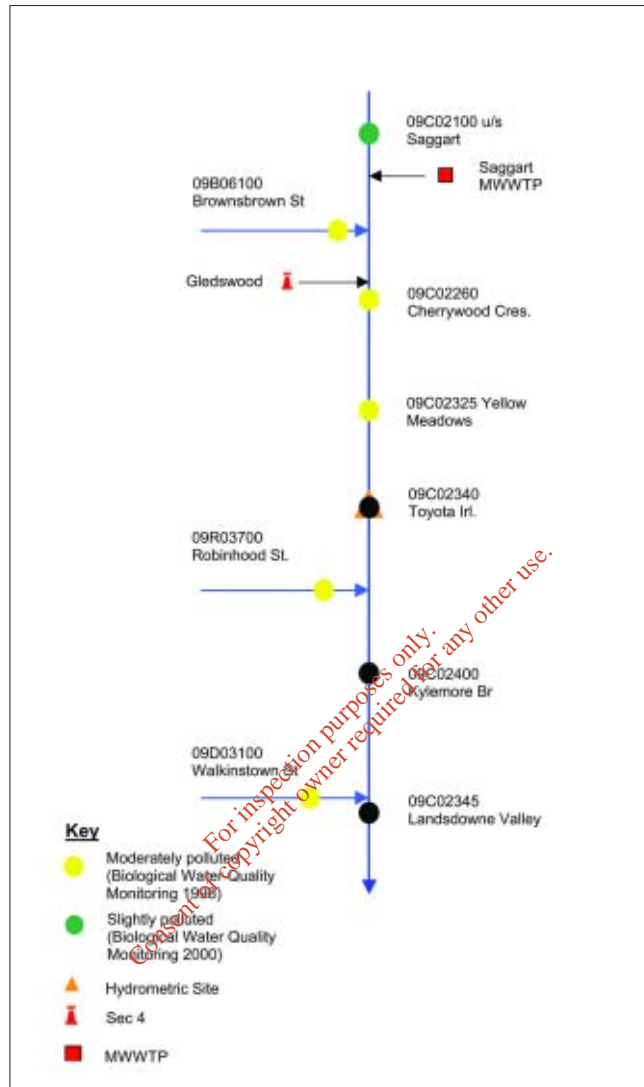
MANAGEMENT STRATEGIES		
PROBLEM	RECOMMENDATION	BENEFIT
Saggart MWWTP	To be decommissioned in November 2001.	Large reduction in nutrient loading to the middle section of the Camac.
Foul Water mis-connections.	Survey of both residential and industrial premises.	Remove mis-connections (gross/minor) to stormwater systems and public awareness to prevent future mis-connections.
Foul Sewer Overflows.	Solve throttles problems	Prevent frequent overflows.
Wash down from impermeable Surfaces.	Storage, infiltration or connect to foul.	Prevent polluted runoff.
Polluted stormwater runoff from paved areas.	Introduction of SUDS.	Reduced pollution in urban stormwater through source control, retention storage, wetlands etc.

**Table 1 Water Quality Results**

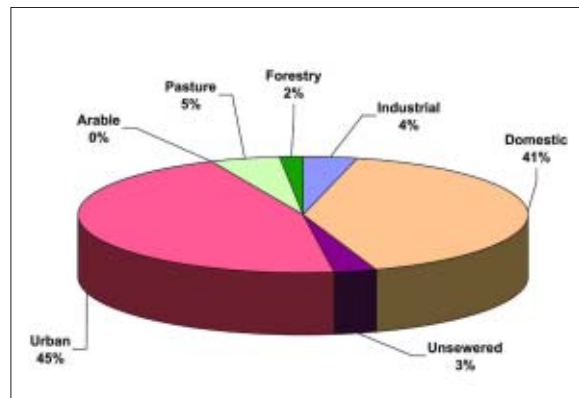
WQ Station	1997	1999	2000	Q Target	MRP 2000 mg/l	MRP Target mg/l
Camac						
C02100	4-5	4	3-4	4-5	0.03	0.02
C02260		3	3	3-4	0.24	0.05
C02325		3	3	3-4	0.30	0.05
C02340					0.27	
C02453					0.23	
Brownsbarn						
B0100		3	3	3-4	0.01	0.05
Robinhood						
R0700		2-3	2-3	3	0.10	0.07
Walkinstown						
D0100			2-3	3	0.11	0.07

HYDROMETRIC NETWORK				
River	Code	Station Name	Guage Type	Owner
Camac	09035	Toyota Ireland	Logger	SDCC
Camac	09241	Landsdowne Valley Park	Manual	DC

**Figure 25** Catchment Management Sheet, Camac Sub-Catchment (Liffey)



*River Camac Biological Water Quality*



*River Camac Sectoral TP Load*



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## Three Rivers Project

# Key Recommendations



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# Key Recommendations

## 1. Data Gaps

A. Significant shortcomings in existing datasets limiting the effective management of water resources were experienced by the Project. These relate to the age, availability or form of the information required. These gaps should be addressed as specified in **Table 44** below:

## 2. Water Quality Monitoring

A. The Project Monitoring Programme should be integrated with L.A. and EPA monitoring to provide an integrated programme aimed at the protection of all waterbodies. The Project auto-samplers located at key locations in the catchments should continue to be operated as an essential part of this programme and additional auto-samplers should be installed on a temporary basis in catchments with rapidly varying flows ("flashy") and locations particularly sensitive to eutrophication.

<b>Fisheries Monitoring</b>	The C.F.B. should devise and implement a national fishery monitoring network, with the results being published annually
<b>Abstraction</b>	Local Authorities should licence, monitor and maintain a register of all significant abstractions, accessible to interested parties
<b>National River Catchment Map</b>	Ordnance Survey should produce a National Map showing definitive river catchments
<b>Groundwater Protection</b>	The GSI should accelerate the production of Groundwater Vulnerability Plans for all areas
<b>Sludge Management</b>	A national spreadlands GIS database incorporating sludges/slurries from IPC activities, non IPC activities and MWWTP's should be established. This database should be co-ordinated by the EPA
<b>National Soil P Data-base</b>	To include results from soil samples submitted to all accredited laboratories, for inclusion into a national database
<b>Agricultural Datasets</b>	Agricultural statistics reporting to DED level should be generated as soon as possible by the C.S.O. and the Dept. of Agriculture, and updated annually  LPIS and REPS, should be compiled into 1 database and be made available to authorities managing water quality
<b>National Soils Database</b>	The County Soil Maps should be completed immediately and presented in a readily available and useable form
<b>Regulated Discharges</b>	A national database of IPC and Section 4 Licenses should be established and maintained by the EPA to incorporate license conditions, the location of facility, point of discharge and monitoring returns as a minimum

**Table 44** Recommendations regarding Data Deficiencies

**B.** The recommended upgrade of the hydro-metric networks should be completed and the primary responsibility for the network be transferred from the L.A. to the EPA, with the exception of OPW and ESB stations. The EPA should be adequately resourced to adopt these additional responsibilities.

**C.** A comprehensive programme of Dangerous Substances monitoring should be implemented and supported by a national accredited laboratory capable of analysis to the required levels of detection. In addition, a National Sampling Protocol should be determined, to ensure standardisation and best practice in taking, transportation, handling and analysis of samples.

**D.** The intensive monitoring programmes in the Agricultural Pilot Catchments should be continued to evaluate the effectiveness of the management strategies implemented in those areas.

### 3. Pilot Catchments

Best Farm Management Plans (BFMP) that incorporate both nutrient management plans and yard recommendations form an effective method of reducing diffuse pollution. These BFMP's should be linked to grant schemes to produce improvements on farms. BFMPs that have been implemented should be audited and maintained to assess their full effectiveness. The impact of practice of storage of FYM in areas such as fieldheaps or yards should be investigated further and reviewed. Additional guidance should be issued in a Code of Practice.

### 4. Catchment Envisage

An integrated GIS database containing catchment information is an essential tool for water quality management on a catchment or wider scale. Ongoing development of CE is required to fully meet the needs of the RBD's.

## 5. Public Awareness and Stakeholder Responsibility

Public Awareness Programmes should be adequately resourced and implemented on an ongoing bases to engender ownership amongst all sectors of the community of both the problems and solutions in relation to protecting water resources.

## 6. Management Strategies

**A.** Responsibility for catchment management should be transferred to a single management structure which is representative of all significant stakeholders within the catchment. This structure must be adequately resourced and authorised to implement new and existing legislation aimed at protecting water resources.

**B.** A step-wise approach to identify pressures on water quality and appropriate management measures (**see Part 4**) is recommended for the efficient use of available resources within the three catchments. There may also be some merit in considering this methodology within a national catchment management strategy.



*Properly targeted and resourced management strategies can improve quality in all watercourses.*

**C.** Best Farm Management Plans (BFMP) as implemented in the Agricultural Pilot Areas should be adopted as a standard for farming throughout the 3 catchments, and should be certified on an annual basis by an accredited planner. Introduction should be on a phased basis, implemented initially on catchments identified as being a high priority due to agricultural pressures. The implementation of "Cross Compliance" principles in relation to payment of subsidies, grant aid etc. would be an appropriate method of ensuring implementation of BFMP on a catchment basis.

Participation in REPS should be encouraged throughout the catchments. The criteria for participation should be revised to attract large or high intensity farms. Agricultural advisors should be subject to regular certification by independent auditors to ensure and maintain high quality.

**D.** The Urban Wastewater Treatment Regulations should be reviewed in relation to achieving Environmental Quality Objectives/Standards required under the Water Framework Directive and the Phosphorus Regulations.

**E.** Monitoring requirements for all MWWTPs and licensed discharges should be adequate to allow the calculation of the nutrient load discharged by the facility (**Table 43**). Existing discharge licenses should be reviewed, and new applications assessed, with respect to achieving Environmental Quality Objectives/Standards in receiving waters.

This should include IPC and Section 4 licences, and in addition, Section 16 licences discharging to foul sewer should be reviewed in areas of poor water quality.

**F.** L.A. should implement the "Polluter Pays Principle".

**G.** The Project advocated the implementation of "Best Management Practice" across all sectors including Best Farm Management Practices including Nutrient Management Planning (NMP) in the agricultural sector, Sustainable Urban Drainage Systems (SUDS) in urban areas, the Code of Best Forest Practice Activities and waste minimisation at source, for industrial installations.

## The next steps

### Water Framework Directive

The EU Water Framework Directive (WFD) was adopted in 2000 and advocates an integrated approach to managing all water bodies including surface waters, groundwaters, transitional and coastal waters. This Directive will act as an umbrella for all legislation aimed at protecting water resources in the future. Waters will be managed at River Basin District (RBD) level (a collection of river catchments). River Basin Management Plans must be prepared by 2009 and "good status" achieved for all water bodies by 2015.

### River Basin Management Projects

The River Basin Management Projects currently being commissioned by the DoELG are a key step towards the implementation of the WFD in Ireland. The Liffey and Boyne catchments will be incorporated into the Eastern River Basin District while the Suir catchment is included in the South-Eastern River Basin District.

The Three Rivers Project wishes the River Basin Management Projects every success over the coming 4 years.





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## Three Rivers Project

# Glossary & Appendices



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# Glossary

## **Agglomeration:**

An area where the population and/or economic activities are sufficiently concentrated for urban waste water to be collected and conducted to an urban wastewater treatment plant or to a final discharge point.

## **Algal Bloom:**

Proliferation of algae in water bodies as a result of changes in water chemistry and temperature.

## **Annual Median Concentration of Phosphorus:**

Determined by using the results of a minimum of ten samples taken at intervals of four weeks or longer for any consecutive twelve month period.

## **Best Farm Management Plans (BFMP):**

A method of optimising the use of nutrients on the farm, by matching nutrient needs with crop requirements, as well as ensuring general good quality farming practice and adequate, effective storage of effluents. Farms are audited and a field specific plan, as well as recommendations for yield improvements (if necessary) produced.

## **Biochemical Oxygen Demand (BOD5):**

A simple measure of the oxygen consuming capacity of a water sample resulting from the biochemical oxidation of organic matter in the water. BOD is normally measured by incubating a standard volume of water or waste water for five days at 20°C in the absence of sunlight and measuring the amount of oxygen consumed.

## **Chemical Oxygen Demand (COD):**

A measure of the oxygen consuming capacity of a water sample resulting from the chemical oxidation of the total carboniferous material in the sample.

## **Composite Sampling:**

Flow proportional or time based 24 hour samples collected at a defined point by an automatic sampler.

## **Dissolved Oxygen (DO):**

A measure of the concentration of oxygen in a liquid, usually expressed in mg/l or per cent saturation.

## **Effluent:**

Liquid wastes or slurries.

## **Environmental Quality Objectives/Standards (EQO) / (EQS):**

Descriptions of the intended use of an environmental medium; the use to which the medium is to be put defines Environmental Quality Standards required to be maintained.

## **Eutrophication:**

The changes associated with enrichment of a waterbody with inorganic plant nutrients, particularly nitrogen and phosphorus.

## **Export Co-efficient:**

A rate at which nutrients are exported from particular landuse or activity sectors.

## **Freshwater Limit:**

The limit of salt water intrusion/tidal influence.

## **Grab Sampling:**

A "one-off" sample collected manually and transported to a laboratory for analysis.

## **Geographical Information Systems (GIS):**

A set of integrated techniques for storing, retrieving, transforming and displaying spatially referenced thematic data in map form.

## **Hydrological Risk:**

A method of assessing whether rapid runoff of water will occur from certain areas, based on soil types and proximity to drains, ditches and watercourses.

## **Macroinvertebrate Q rating:**

A consequence of increasing pollution is a decrease in faunal diversity and an increase in the density of tolerant forms. It is therefore possible to relate certain faunal groupings or community types to particular levels of pollution. This relationship is conveyed by means of a numerical scale of values (biotic indices or quality (Q) values where 5 represents unpolluted waters and 1 polluted waters (see Appendix 3).

**Molybdate Reactive Phosphate (MRP):**

A measure of the most biologically available form of phosphorus in water. Sometimes also referred to as "ortho-phosphate."

**Municipal Wastewater Treatment Plant (MWWTP) :**

A sewage works operated by a Local Authority.

**Pilot Study Areas:**

A small sub-catchment selected to investigate the effect of a specific landuse and/or activity on water quality, and the effectiveness of management strategies. Special study areas had similar aims, but the level of investigation was less intensive.

**Population Equivalent (p.e.):**

The organic biodegradable waste load having a five day biochemical oxygen demand (BOD5) of 60 grams of oxygen per day is one population equivalent (i.e. the amount produced by one person).

**Primary Treatment:**

Treatment by physical and or chemical process involving settlement of suspended solids. Such treatment usually reduces the BOD5 of the influent by at least 20% and the total suspended solids by at least 50%.

**River Basin District (RBDs):**

Catchment containing one or more river systems established by the Department of Environment and Local Government as part of the implementation of the Water Framework Directive.

**Rural Environment Protection Scheme (REPS):**

A country stewardship scheme where grants are available to small farmers who adopt sustainable farming practices.

**Salmonid Waters:**

High quality waters suitable for the maintenance of viable self-sustaining populations of wild salmon and trout. These may be designated under the EC Freshwater Fish Directive if considered especially important.

**Secondary Treatment:**

Treatment of urban wastewater by process generally involving biological treatment with a secondary settlement.

**Sensitive Areas:**

Areas that by their beneficial use or ecological importance are particularly susceptible to pollution.

**Sensitive Waters:**

Designated waters under the E.C. Urban Wastewater Treatment Directive as affected by eutrophication. Qualifying sewage treatment plants discharging to these waters must meet a defined effluent quality.

**Total Nitrogen (TN):**

Total nitrogen is comprised of organic nitrogen, nitrate, nitrite and ammonia

**Total Oxidised Nitrogen (TON):**

Comprises of both nitrate and nitrite concentrations. Nitrate (NO<sub>3</sub>) being the more oxidised form Of N.

**Total Phosphorus (TP):**

Phosphorus associated with particulate matter and in solution.

**Trophic State:**

The extent of enrichment of a waterbody as assessed by the nutrient concentrations, amount of planktonic algae and macrophytes, water transparency and oxygen levels. The trophic categories oligotrophic, mesotrophic, eutrophic and hypotrophic are used to describe waters varying from un-enriched to highly enriched.

**Unsewered Population:**

Population utilising septic tanks rather than MWWTP.

**u/s & d/s:**

Upstream and downstream of a particular point on a river.

**Water Framework Directive:**

The operational tool setting objectives for water protection.

# Appendices

## Appendix 1

<b>Objective</b>	
<p>A method of hydrological risk assessment has been developed to select the most suitable fields for spreading of manures and chemical fertiliser, in order to minimise risk of nutrient losses to watercourses.</p> <p>It is based on soil drainage classes, as available from the Soil Survey of Ireland Programme, and on the hydrological connection between the field and watercourse (defined as the presence of drainage ditches or functioning sub-surface drains). The aim of the assessment is to evaluate the likelihood of rapid water movement from field to watercourse via overland or sub-surface flow.</p>	
<b>Determining the appropriate period for spreading manures and chemical fertilisers</b>	
<p>Manure and fertiliser should only be applied when the ground is sufficiently dry. The appropriate application/spreading period is based on the Soil Moisture Deficit period (SMD). Where a sufficient SMD exists (where potential rainfall exceeds evapotranspiration) the risk of overland flow occurring is very low. On average, the SMD period in counties Meath, Kildare and Tipperary is from early May to the end of September.</p> <ul style="list-style-type: none"> <li>• Farmers should consult their agricultural advisor as to the SMD period in their local area.</li> <li>• The recommendations regarding weather conditions and rates of spreading given in the "Code of Good Practice to Protect Waters from Pollution by Nitrates, 1996" should be followed on all occasions when applying nutrients to land.</li> </ul>	
<b>Risk Categories</b>	
<b>Wet Fields/Areas</b>	
<p>Wet or waterlogged areas of a farm are identified using visual inspections (e.g., position in the landscape, presence of water tolerant vegetation) and discussions with the farmer. These areas which can be described as having poor or very poor drainage are classified as <b>HIGH</b> risk in terms of potential for overland flow and are colour coded <b>RED</b>. Manures and fertilisers should only be applied to these areas within the period May 1<sup>st</sup> and September 30<sup>th</sup> (SMD period).</p>	
<b>Fields/Areas with Excessively Drained Soils</b>	
<p>Soils less than 50 cm deep on sandy, rocky, or gravely parent material are considered excessively drained. These soils have a <b>HIGH</b> risk of applied nutrients leaching to groundwater, and are also coded <b>RED</b>. Manures and fertilisers should only be applied to these areas within the period May 1<sup>st</sup> to September 30<sup>th</sup> (SMD period).</p>	
<b>Fields/Areas with Imperfect Drainage Classes</b>	
<p>These soils are described as having a <b>MEDIUM</b> risk of overland flow and nutrient losses to water and are coded <b>YELLOW</b>. Manure applications to these areas should only occur within the period May to the end of September (SMD) or where an extended period of dry weather allows, one application may be spread in April.</p>	
<b>Fields/Areas with Well or Moderately Drained Soils</b>	
<p>These soils are classed as having a <b>LOW</b> risk of overland flow (coded <b>GREEN</b>) and therefore this land is the most suitable for spreading and should be spread on first. The period of application on these areas is January 15<sup>th</sup> to September 30<sup>th</sup>, allowing for restrictions within the "Code".</p>	

### *Hydrological Risk Assessment*

## Appendix 2

<b>Step 1</b>	<p><b>Audit of farm activities</b></p> <p>Determine land ownership, identify all ditches and watercourses, area farmed, farm enterprises, land use, current management practices, fertiliser usage, imported/exported slurries, stock types and numbers, number of yards, etc.</p>
<b>Step 2</b>	<p><b>Determine Nutrient Store in Soils</b></p> <p>Develop a <b>soil-sampling program</b> based on land use and management practices determined in Step 1. Target soil sampling regime is a minimum of one sample per 4 hectares.</p> <p>Undertake sampling programme and organise for analysis of samples.</p> <p>Evaluate and map results (e.g. Soil P Index)</p>
<b>Step 3</b>	<p><b>Farmyard assessment</b></p> <p>For each yard determine:</p> <ul style="list-style-type: none"> <li>• Type and number of associated buildings (animal houses, dairy units, feed stores, etc.) and storage facilities (slurry tanks, dungsteeds, silage pits, etc.)</li> <li>• Number and type of animals housed, duration of housing period, concentrates and minerals fed during housing period, type and quantity of bedding used, etc.</li> <li>• Capacity of existing storage facilities</li> <li>• Determine roofed areas and yard areas contributing to storage facilities</li> <li>• Determine extent and condition of guttering on buildings</li> <li>• Determine contributing areas, which could be diverted away from storage facilities</li> <li>• Estimate volumes/quantities of slurry/manure/silage effluent/soiled water produced</li> <li>• Sample slurry/soiled water tanks</li> </ul>
<b>Step 4</b>	<p><b>Field-by-field hydrological risk assessment and extent of soil erosion with estimation of possible risk</b></p> <p>Note presence of ditches, connectivity with watercourses, soil drainage characteristics etc. and functioning sub-surface drains.</p> <p>Determine lands suitable for spreading manure/slurries on the farm.</p> <p><b>Determine the following</b></p>
<b>Step 5</b>	<ul style="list-style-type: none"> <li>• overall farm nutrient balance from steps 1 and 3</li> <li>• storage requirements from steps 3 and 4</li> <li>• field-by-field nutrient requirements from steps 1 and 2</li> </ul>
<b>Step 6</b>	<p><b>Prepare field-by-field NMP</b>, optimising usage of nutrients, from steps 1, 3, 4 and 5</p>
<b>Step 7</b>	<p><b>Prepare plan of suggested remedial/improvement work for yards</b>, including any additional storage facilities required.</p> <p>In discussions with farmer set target dates for implementing improvement work, identifying short, medium and longer-term goals.</p>
<b>Step 8</b>	<p><b>Prepare advice on safe storage and handling</b> of pesticides, fuel oils, sheep dip, etc., including disposal of residues, containers, etc.</p>
<b>Step 9</b>	<p>Amalgamate steps 6, 7 and 8 into <b>Best Farm Management Plan</b>.</p>
<b>Step 10</b>	<p><b>Review implementation of Plan</b>.</p>

*Step by step procedures for developing a Best Farm Management Plan*

## Appendix 3

### Assessing Water Quality

Generally, water quality is sampled both by physico-chemical and biological means. Physico-chemical sampling is where a sample of water is taken and analysed to determine the concentration of various substances in the sample. Biological sampling generally involves a kick sample, where the bottom substrate is agitated and a net used to catch disturbed organisms, known as benthic invertebrates. The types and numbers of organisms captured act as a "barometer" of the quality of the environment that they have been living in. Some organisms such as stoneflies, will only live in clean, well aerated water, whilst chironomids and leeches can tolerate poor quality, de-oxygenated water.

Biological sampling can detect intermittent pollution sources that grab sampling may miss, and can detect some forms of pollution at extremely low levels, for example, the effects of synthetic pyrethroid sheep dips.

### The EPA Assessment Method

The system used by the EPA in Ireland involves sampling of shallow, fast flowing reaches of rivers known as "riffles". The invertebrate communities captured during sampling are split into 4 groups, namely sensitive, less sensitive, tolerant and very tolerant forms. The proportions of organisms falling into each group and the water quality is assessed against the ratios expected in the unpolluted habitats of the type under investigation. Additional information is also considered such as the presence and intensity of algae or weed growth, turbidity, siltation, habitat and depth.

The results are then reported in the form of a 5-point biotic index (Q-Values) as shown below in **Table 1**.

Intermediate values are also used to describe conditions where appropriate. To provide an easily understood way of associating the various Q-ratings with actual water quality, 4 water quality classes have been produced. These are shown below in **Table 2**.

These quality classes are used in the Three Rivers Project.

Biotic Index (Q-value)	Water Quality
5 (diversity high)	Good
4 (diversity slightly reduced)	Fair
3 (diversity significantly reduced)	Doubtful
2 (diversity low)	Poor
1 (diversity very low)	Bad

*Table 1: EPA assessment method*

Quality Ratings	River Water Quality Class
Q, Q4-5, Q4	Unpolluted
Q3-4	Slightly polluted
Q3, Q2-3	Moderately polluted
Q2, Q1-2, Q1	Seriously polluted

*Table 2: EPA assessment method*



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# THREE RIVERS PROJECT PARTNERS

## THE THREE RIVERS PROJECT PARTNERS

The Three Rivers Project is sponsored by the Department of the Environment and Local Government, with 85% financial support from the European Union Cohesion Fund.

The project is jointly administered by Meath County Council, Kildare County Council and Tipperary (S.R.) County Council.

The overall project is managed by a Steering Group, which consists of representatives of the following organisations:

**Environmental Protection Agency**

**Department of the Environment  
and Local Government**

**Central Fisheries Board**

**Kildare County Council**

**Meath County Council**

**Tipperary (S.R.) County Council**

The project is being carried out in partnership with the following constituent Local Authorities in the catchment :

**Cavan County Council**

**Cork County Council**

**Drogheda Borough Council**

**Dublin City Council**

**Fingal County Council**

**Kildare County Council**

**Kilkenny County Council**

**Limerick County Council**

**Louth County Council**

**Meath County Council**

**Offaly County Council**

**South Dublin County Council**

**Tipperary (NR) County Council**

**Tipperary (SR) County Council**

**Waterford City Council**

**Waterford County Council**

**Westmeath County Council**

**Wicklow County Council**

Other participating agencies are :

**Bord na Mona**

**Coillte**

**Department of Agriculture and  
Rural Development**

**Dúchas**

**Eastern Regional Fisheries Board**

**Electricity Supply Board**

**Forest Service**

**Geological Survey of Ireland**

**Irish Cattle Traders and  
Stockowners Association (ICSA)**

**Irish Creamery Milk Suppliers  
Association (ICMSA)**

**Irish Farmers Association (IFA)**

**Local Government Computer  
Services Board**

**Office of Public Works**

**Southern Regional Fisheries  
Board**

**Teagasc**



The Three Rivers Project is 85% funded by the European Union Cohesion Fund



# THREE RIVERS PROJECT

Water Quality Monitoring & Management

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