Laois County Council

RECEIVING WATER IMPACT ASSESSMENT

ABBEYLEIX

FIRST DRAFT _ WORK IN PROGRESS

Prepared on behalf of

WATER SERVICES
LAOIS COUNTY COUNCIL
County Hall
Portlaoise
Co. Laois

Version: 20th August 2008

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TABLE OF CONTENTS

1. INTRODUCTION

1.1 Background

Abbeyleix is a medium-sized town located 14 km south of Portlaoise on the National Primary Route from Dublin to Cork (N8). This report provides a Receiving Water Impact Assessment for the Waste Water Treatment Plant (WwTP) serving this town. This facility discharges waste water treated to secondary level into the Gloreen Stream, a tributary of the River Nore. The Nore main channel is a designated salmonid water under the European Communities (Quality of Salmonid Waters) Regulations of 1988 (S.I. No. 293, 1988), implementing the Freshwater Fish Directive (78/659/EEC). The main channel of the River Nore is also protected as a component of the River Nore and River Barrow candidate Special Area of Conservation (SAC) under the Habitats Directive (92/43/EEC). The NPWS site synopsis for this site is provided in Appendix 1.

This report has been prepared under the Waste Water Discharge (Authorisation) Regulations, 2007, using Section F of the Environmental Protection Agencies Waste Water Discharge Licensing Application Guidance Note (EPA 2008). The purpose of the report is to assess whether the existing waste water discharges from the plant are having a significant adverse impact on the receiving waters, or any Natura 2000 Site.

This report was prepared during July/August 2008 by Ecofact Environmental Consultants Ltd. on behalf of the Water Services Section of Laois County Council.

1.1 Legislation

The current report was prepared with consideration to the following water quality legislation:-

- Waste Water Discharge (Authorisation) Regulations 2007 (SI No. 684 of 2007);
- Urban Wastewater Treatment Regulations, 2001 (S.I. No. 254 of 2001);
- Water Policy Regulations (S.I. No. 722 of 2003) and Water Policy Regulations (Amendment) (S.I. No. 413 of 2005) implementing the EU Water Framework Directive (2000/60/EC);
- European Communities (Water Policy) Regulations, 2003 (SI No. 722) implementing the Water Framework Directive (WFD) 2000/60/EC;
- Local Government (Water Pollution) Acts, 1977 (Water Quality Standards for Phosphorus) Regulations, 1998. (S.I. No. 258 of 1998), and Local Government (Water Pollution) (Amendment) Act, 1990. (Act No. 21 of 1990);
- European Communities (Quality of Salmonid Waters) Regulations, 1998 (S.I. No. 293 of 1988) implementing Freshwater Fish Directive (78/659/EEC);
- Quality of Bathing Waters Regulations, 1992, and Quality of Bathing Waters Regulations (Amendment), 1996. (implementing Bathing Water Directive, 76/160/EEC);
- European Communities Quality of Surface Water Intended for the Abstraction of Drinking Water Regulations, 1989. (Implementing the Surface Water Directive, 75/440/EEC);
- Water Quality (Dangerous Substances) Regulations, 2001.(Implementing the Dangerous Substances Directive, 76/464/EEC);
- Protection of Groundwater Regulations, 1999. (S.I. No. 41 of 1999);
- Water Quality (Dangerous Substances) Regulations, 2001 (S.I. No. 12 of 2001).

In addition, cognisance was also made to the following legislation relating to nature conservation and fisheries:-

- The European Communities (Natural Habitats) (Amendment) Regulations 2005 (S.I. No. 378/2005), The European Communities (Natural Habitats) (Amendment) Regulations 1998 (S.I. No. 233/1998), and the European Community (Natural Habitats) Regulations 1997 (S.I. No. 94/1997) (implementing Council Directives

92/43/EEC and 97/62/EC on the conservation of natural habitats and of wild fauna and flora);
- Wildlife Act, 1976 (S.I. No. 39 of 1976) and the Wildlife (Amendment) Act, 2000 (S.I. No. 71 of 2001);
- Fisheries (Amendment) Act, 1997, (S.I. No. 23 of 1997) and Fisheries (Consolidation) Act, 1959 (S.I. No. 14 of 1959);
- The EU Birds Directive (79/409/EEC).

1.2 Methodology

This report has been prepared under the Waste Water Discharge (Authorisation) Regulations, 2007, using Section F of the Environmental Protection Agencies Waste Water Discharge Licensing Application Guidance Note (EPA, 2008). The current study was carried out as a desk study, and a field assessment. The literature review and field sampling programme was designed primarily as a descriptive study to provide information on the existing environmental status of the surface water area under investigation. An integrated assessment approach was employed. This approach merges biological (effects) and physical/chemical (causes) using a combination of field and desk study evaluations.

2.2.1 Desktop Review

A desktop review was carried out to identify features of surface water importance within the study area and surrounding region. A review of areas designated (or being considered for designation) for nature conservation was carried out by consulting the National Parks and Wildlife Service (NPWS). These included Special Areas of Conservation, Special Protection Areas for birds (both internationally important) and proposed Natural Heritage Areas (of national importance). The locations of any designated salmonid waters, recreational and bathing waters and nutrient sensitive areas within the study area were identified though consultation with the Environmental Protection Agency (EPA). Likewise the presence of any important recreational or commercial fisheries was identified thought consultation with the Southern Regional Fisheries Board (SRFB).

Technical files and previous reports prepared for the WwTP were supplied by Laois County Council for review in the current assessment. These reports included the catchment report for the town of Abbeyleix, prepared as part of the National Urban Waste Water Study. Also, monitoring information on the discharges from the WwTP and the receiving waters were obtained from Laois County Council and used in this assessment. A review of the published literature, including the Laois County Development Plan 2006-2012, was undertaken in order to collate data on aquatic species and habitats of conservation concern in the study area. A range of additional sources of information including scientific reports produced by, and information on the websites of the EPA, NPWS, Laois County Council, and other agencies were also reviewed. A full bibliography of information sources reviewed is given in the references section. Ordinance Survey Maps and OS aerial photographs were also reviewed during the desk assessment.

2.2.2 Field Survey Work

The field survey comprised a systematic walk over of the WwTP site, outfalls and receiving waters. A kick sampling assessment of benthic macroinvertebrates was undertaken a point located upstream (control) and downstream (receptor) of the primary discharge to supplement information collected during the desk study. The exact location and description of these sites is provided in Table 1.

The kick-sampling assessment followed the EPA standard methodology (Toner *et al*, 2005). This procedure involved the use of a 'D' shaped hand net (mesh size 0.5 mm; 350 mm diameter) which was submerged on the river bed with its mouth directed upstream. The substrate upstream of the net was then kicked for one minute in order to dislodge invertebrates, which were subsequently caught in the net. This procedure was undertaken at three points across the watercourse, where depth/access allowed. Stone washings and

vegetation sweeps were also undertaken to ensure a representative sample of the fauna present at each site was collected. All samples of invertebrates were combined for each site and live sorted on the river bank for 20 minutes. Specimens retained were preserved in ethanol for later identification. Identification was undertaken in the laboratory using high-power and low-power binocular microscopes.

Specimens were identified using the standard keys which are listed in the bibliography section. The abundances of organisms present was assessed as follows: Present (1 or 2 individuals), Scarce/Few (<1%), Small Numbers (<5%), Fair Numbers (5-10%), Common (10-20%), Numerous (25-50%), Dominant (50-75%) and Excessive (>75%)

The Quality Rating (Q) System (Toner *et al*, 2005) was used to obtain a water quality rating for each site. The use of this particular biotic index allows the comparison with data published by the EPA. This method categorizes invertebrates into one of five groups, depending on their sensitivity to pollution. The higher the biological diversity and the greater the abundance of invertebrate species sensitive to organic pollution, the higher the water quality is assumed to be, and the higher the 'Q value' assigned to that sampling station. The revised BMWP scheme (Walley and Hawkes, 1997) is another biotic index of water quality that was used in the current appraisal. In this system, each family recorded in the sample is assigned a habitat specific score. This score depends on the pollution sensitivity of the invertebrate family together with the characteristics of the site where the invertebrates were found. A higher BMWP score is considered to reflect a better water quality and a score over 100 is indicative of very good water quality.

Table 1 Location of the 2008 survey sites.

	Gloreen d/s	Gloreen u/s
Location	Immediately upstream of Gloreen Bridge (at EPA Station 0200)	Tullyroe, 25 meters upstream of WwTP outfall
NOS Grid Reference	S42079 85172	S 42678 85124

2.2.3 Assessment Methodology

Impact significance is a combined function of the value of the affected feature (its water quality, fisheries or aquatic ecology importance), the type of impact and the magnitude of the impact. It is therefore necessary to identify the value of surface water features within the study area in order to evaluate the significance and magnitude of possible impacts. To achieve this, the results of the desk and field assessment were evaluated to determine the significance of identified features located in the study area on an importance scale ranging from international-national-county-local. The criteria used are shown in Table 2.

The means of assessing impact significance was based on the Institute of Ecology and Environmental Management's "*Guidelines for Ecological Impact Assessment in the United Kingdom*" (IEEM, 2006) and the EPA's "*Waste Water Discharge Licensing Application Guidance Note*" (EPA, 2008). The significance of impacts was assessed on a combined basis of the value of the feature being affected and the magnitude of the impact.

2.2.4 Appropriate Assessment

A Stage One Screening/Test of Significance Assessment was carried out to identify the effects of the discharge(s) upon the nearest Natura 2000 sites and consider whether these impacts are significant. The Department of the Environment, Heritage and Local Government has not published guidelines for undertaking Appropriate Assessment in Ireland. The current screening assessment was carried out using the following guidance:

- Managing Natura 2000 Sites: the provisions of Article 6 of the 'Habitats' Directive 92/43/EEC, Office for Official Publications of the European Communities, Luxembourg (EC 2000);

- Assessment of Plans and Projects Significantly Affecting Natura 2000 Sites: Methodological guidance on the provisions of Article 6(3) and (4) of the Habitats Directive 92/43/EEC, Office for Official Publications of the European Communities, Luxembourg (EC 2001);
- Guidance for Competent Authorities when dealing with proposals affecting SAC freshwater sites, Scottish Natural Heritage, Perth (SNH, 2006); and
- Guidance document on Article 6(4) of the 'Habitats Directive' 92/43/EEC – Clarification of the concepts of: alternative solutions, imperative reasons of overriding public interest, compensatory measures, overall coherence, opinion of the commission. Office for Official Publications of the European Communities, Luxembourg (EC 2007).

Table 2 Criteria used in assessing the importance of surface water features (taken from NRA, 2004).

Rating	Qualifying Criteria
A	Internationally Important Sites designated (or qualifying for designation) as SAC* or SPA* under the EU Habitats or Birds Directives. Undesignated sites containing good examples of Annex I priority habitats under the EU Habitats Directive. Major salmon river fisheries Major salmonid lake fisheries.
B	Nationally Important Sites or waters designated or proposed as an NHA* or statutory Nature Reserves. Undesignated sites containing good examples of Annex I habitats (under EU Habitats Directive). Undesignated sites containing significant numbers of resident or regularly occurring populations of Annex II species under the EU habitats Directive or Annex I species under the EU Birds Directive or species protected under the Wildlife (Amendment) Act 2000. Major trout river fisheries. Water bodies with major amenity value. Commercially important coarse fisheries.
C	High Value, Locally Important Sites containing semi-natural habitat types with high biodiversity in a local context and a high degree of naturalness or significant populations of locally rare species. Small water bodies with known salmonid populations or with good potential salmonid habitat. Sites containing any resident or regularly occurring populations of Annex II species under the EU habitats Directive or Annex I species under the EU Birds Directive. Large water bodies with some coarse fisheries.
D	Moderate Value, Locally Important Sites containing some semi-natural habitat or locally important for wildlife. Small water bodies with some coarse fisheries value or some potential salmonid habitat. Any water body with unpolluted water (Q-value 4-5).
E	Low Value, Locally Important Artificial of highly modified habitats with low species diversity and low wildlife value. Water bodies with no current fisheries value and no significant potential fisheries value.

1.3 Consultation

Preparation of this report included consultation with the following agencies and state bodies:-

- Laois County Council (Laois Co. Co.);
- National Parks and Wildlife Service (NPWS);
- Environmental Protection Agency (EPA);
- Southern Regional Fisheries Board (SRFB);
- South Eastern River Basin District Office (SERBDO);
- Department of Communications, Marine and Natural Resources (DCMNR);
- Marine Institute (MI);
- BirdWatch Ireland (BWI);
- Botanical Society of the British Isles (BSBI);

2. SCHEME DESCRIPTION

2.1 Introduction

The Abbeyleix WwTP is located approximately 0.5km to the west of Abbeyleix in the townland of Tullyroe. The existing outfall is to the Gloreen Stream (or Ballyroan River), a tributary of the River Nore. The outfall is approximately 450m long and the approximate location of the discharge to the stream is 700 metres downstream of Ballydire Bridge and is close to the confluence of the Gloreen Stream and its tributary, the Ballydire Stream. The location of the Abbeyleix WwTP and the outfall is shown in Figure 1.

According to Nicholas O'Dwyer (2002), Abbeyleix WwTP was commissioned in approximately 1970 and comprises of preliminary works and secondary treatment. Preliminary treatment comprises of manual screens and manual grit removal from a grit channel. Secondary treatment comprises of aeration in an extended aeration tank using a surface aerator, followed by settling in a secondary clarifier. Final effluent discharge is to the Gloreen stream. Since the 2002 report was prepared, a new packet plant extension was added to the facility.

2.2 Design

Nicholas O'Dwyer (2002) reported that the design capacity of the plant in 2002 was 1,300 p.e. with an estimated load of 2,500 p.e. The Abbeyleix Sewerage Scheme was upgraded since the 2002 report as part of the Laois Grouped Towns and Villages Scheme. There are plans to further upgrade this plant.

Nicholas O'Dwyer (2002) described the Abbeyleix plant as a conventional extended aeration process, designed for a population equivalent of 1,300 P.E. with a BOD load of 70.2 kg/day (54g/h/day) and a hydraulic load (DWF) of 234m^3/day (180 l/h/day). Nicholas O'Dwyer (2002) noted that there was no storm water screening or detention tanks at Abbeyleix and wastewater flows in excess of 10.5 l/sec discharged without screening to the Gloreen Stream. It was concluded therefore that the treatment plant was serving a population equivalent of approximately 2,500 and was therefore considered to be biologically overloaded and also subject to hydraulic overloading on a regular basis.

Nicholas O'Dwyer (2002) reported that in 2002 sludge (approximately 710m^3/year) was produced at the Abbeyleix WwTP with an estimated solids concentration of 1%. Final disposal of sludge from the plant is to Portlaoise WWTP for further treatment. The Sludge Management Plan for County Laois (August 2001) designated Portlaoise as the main hub centre for sludge treatment in County Laois. Bio-solids arising from the treatment of municipal wastewater sludge are promoted for use as a fertilizer in agriculture in County Laois.

2.4 Discharge Standards

According to DOHLG (2004), the Abbeyleix WwTP was discharging a treated effluent outside the Urban Waste Water Treatment Regulations (2001). It was noted in this report that at 5.7 kg/day the discharge was outside the assimilative capacity of the receiving waters in terms of BOD. It was found at that time that there was limited phosphorous assimilation capacity in the receiving waters.

DOHLG (2004) concluded that if the loading to the plant increased beyond its current level, it is unlikely to achieve the required standards without undertaking modifications to the treatment plant and its operation. To comply with the requirements of the Local Government (Water Pollution) Act 1977 (Water Quality Standards for Phosphorus) Regulations, 1998, it was noted that it would be essential that the phosphate load being discharged into the river was not increased beyond the current levels. It was recommended that for a plant of this scale the total phosphorus concentration in the treated effluent discharge should not exceed 2mg/l based on the Urban Waste Water Treatment Regulations (2001). At plant throughputs at the time of the DOELG (2004) report this represented a P load of 0.7 kg P/day being discharged

from the plant into the river. Based on anticipated future loads to the WwTP, total phosphorus discharges would be 1.5 kg P/day (DOELG, 2004). Based on the estimated future waste water loads to the WwTP, the treated effluent would discharge 18.1kg BOD/day (subject to WwTP expansion and upgrading), which it was noted would still be outside the assimilative capacity of the receiving waters.

Since the time of the DOHLG (2004) report the Abbeyleix Plant was upgraded to include an additional package treatment plant with a Rotating Biological Contactor (RBC). The upgrade was undertaken to ensure that the plant was operating within the design standards required under the Urban Waste Water Treatment Regulations (2001). The plant will also be upgraded again in the near future to ensure that these standards can continue to be met in the future.

2.4.1 Effluent Standards proposed for Discharge to the Gloreen Stream

The final effluent standards adopted for treatment process selection and preparation of preliminary designs and layouts for the proposed upgrading of the Abbeyleix WwTP (Nicholas O'Dwyer, 2002) are summarised in Table 3.

Table 3 Proposed effluent Standards for Gloreen Stream (from Nicholas O'Dwyer, 2002).

	Stage 1 (4,500 p.e.)		Stage 2 (6,000 p.e.)	
Parameter	**Concentration (mg/l)**	**% Removal**	**Concentration (mg/l)**	**% Removal**
BOD	13	≥ 95.5	9	≥ 97.7
S.S	18	≥ 90	13	≥ 92
Total Phosphorous	0.9	≥ 92	0.6	≥ 94.6
Total Ammonia	3.8	≥ 91	2.6	≥ 96

The requirements of Urban Wastewater Treatment Directive **91/271/EEC** for treatment plants serving a population equivalent of more than 2000 are:

- Biochemical Oxygen Demand (BOD5) 25mg/l O_2
- Chemical Oxygen Demand 125mg/l O_2
- Suspended Solids (p.e. >10 000) 35mg/l
- Suspended Solids (p.e. 2000 - 10 000) 60mg/l

The following additional requirements apply for discharges to areas that are deemed to be sensitive:

- Total Phosphorus (10 000 – 100 000 p.e.) 2mg/l
- Total Phosphorus (over 100 000 p.e.) 1mg/l
- Total Nitrogen (10 000 – 100 000 p.e.) 15mg/l
- Total Nitrogen (over 100 000 p.e.) 10mg/l

2.6 Monitoring

Monitoring of the water quality of the outfall from the old plant and the extended plant is undertaken by Laois County Council on an approximate monthly basis. Water quality is also monitored in the Gloreen Stream both upstream and downstream of the primary discharge. The parameters measured in the water samples are; Ammonia, Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Conductivity, Nitrates, Ortho-phosphate, pH and Suspended Solids.

Figure 1 The location of the Abbeyleix WwTP and the outfall, along with EPA and Laois County Council monitoring locations, Ecofact 2008 kick sampling sites and sensitive receptors.

3. RECEIVING ENVIRONMENT

3.1 Hydrology

3.1.1 The Nore catchment

The River Nore rises on the eastern slopes of the Devil's Bit Mountain in Co. Tipperary and at first flows east through Borris-in-Ossory and then turns south through Co. Kilkenny, passing through Ballyragget, Kilkenny City and Thomastown before meeting the tide at Inistoge. The river has a total length of 118km, a catchment area of 2,359km^2, and an annual mean discharge of 40m^3 sec^{-1} (Lucey 1998, McGarrigle 2002). The Nore, for a large part of its course, traverses limestone planes of Carboniferous age and then Old Red Sandstone below Thomastown and before joining the Barrow, runs over Ordovician shales. The river is, for the most part floored with, or influenced by Carboniferous limestone and this is reflected in its natural characteristics (Lucey 1998). According to O'Reilly (2004) '*The river has a fairly steep gradient but the flow is checked by numerous weirs.* He also notes that *'the surrounding land is used for mixed farming; mostly pasture and dairy with some tillage and bloodstock'.*

The River Nore is a designated salmonid water under the EU Freshwater Fish Directive and designated Special Area of Conservation under the EU Habitats Directive. It has 36 tributaries, the largest of which are the Kings, the Erkina, and the Dinin.

3.1.2 The Gloreen Stream

The Gloreen stream (or Ballyroan River) (EPA code 15/B/01), is a minor tributary of the Nore which joins the River Nore between Poormansbridge and Waterloo Bridge, approximately 8km upstream of Durrow. The stream is approximately 14 km long and drains a catchment area of approximately 30 km^2.

The Gloreen River rises in the townland of Ballypickas Lower, approximately 3 km east of Abbeyleix. It flows north for over 4 km, near the western side of Ballyroan town. At this stage, the Gloreen Stream is a 2nd order stream which has been fed by three streams draining Cullenagh Mountain. These mountain streams are of high gradient and drain an area mainly under commercial forestry. Downstream of Ballyroan, the stream flows for approximately 6 km generally in a south west direction until Ballydine Bridge on the R430 regional road. In this reach of the river, it is crossed by two 3rd class roads (including Sallagh Bridge) and the N8 national primary road. At this stage, the river is also met by three 1st order streams, one of which drains a forested area. From Ballydine Bridge, the Gloreen Stream flows west for approximately 2 km to meet the River Nore. In this lower reach, it is fed by one second order stream that flows by the northern outskirts of Abbeyleix town. Downstream of the confluence with this stream to where it joins the River Nore, the Gloreen Stream is rated as a 3rd order stream. The Gloreen Stream does not pass through Abbeyleix town but flows to within 1 km of the northern side of the town.

The catchment is composed of varied soil types including bogs, grey brown podzolics and surface water gleys. The underlying rock is Visean limestone and calcareous shale in the lower reaches of the stream with Namurian shale, sandstone siltstone and coal also occurring in bedrock of the upper reaches of the catchment (Source: GSI). The Gloreen stream is a moderate gradient stream, rising at an elevation of 175m and entering the River Nore at an elevation of 80 meters.

There is one hydrometric station in the Gloreen Stream catchment at Ballydire Bridge (upstream catchment 25 km^2). This station is located approximately 0.6 km upstream of the WwTP outfall pipe. The Long Average Flow at this site has been estimated to be 0.6 m^3 sec^{-1}, while the 95 Percentile Flow is 0.052 m^3 sec^{-1}.

3.2 Water quality

Water quality results (chemical and biological) for the Gloreen River and adjacent stretches of the River Nore are discussed below. The overall water quality results from the Nore catchment (2001-2003) is provided in Table 4. Table 5 summaries the EPA water quality results for the period 2001-2003 for the Nore at Poorman's Bridge (upstream of Gloreen confluence) and Watercastle Bridge (downstream of Gloreen confluence). Table 6 provides a summary of EPA water quality results for the same period for the Gloreen Stream at Ballydine Bridge (upstream of Abbeyleix WwTP) and Gloreen Bridge (downstream of Abbeyleix WwTP). The EPA historical Biological Quality Ratings (Q Values) for the Nore River at Poorman's Bridge and Watercastle Bridge are provided in Table 7, while Table 8 gives the EPA Biological Quality Ratings (Q Values) for the Gloreen stream (EPA Code 15/B/01). Site 0150 on the Gloreen Stream is located upstream of the WwTP outflow, while Station 0200 is located downstream of this outfall. The results of the Laois County Council water quality monitoring programme for the Gloreen Stream at Ballydine Bridge (upstream of Abbeyleix WwTP) and Gloreen Bridge (downstream of Abbeyleix WwTP) during 2007 and 2008 are summarised in Appendix 3.

3.2.1 The River Nore

The Nore is a Designated Salmonid river under EU Freshwater Fish Directive (78/659/EEC). The River Nore has a significant length of channel in which water quality is considered to be unsatisfactory. For example, during the most recent published EPA biological water quality study (2004) just less than 50% of the river channel length was rated as Class A unpolluted (see Table 4). The EPA has reported widespread eutrophication in the river in recent years, with just 8 of the 23 locations examined having satisfactory water quality conditions. Numbers of the freshwater pearl mussel and white clawed crayfish (both protected species) have declined recently with an unexplained collapse of the Nore crayfish population occurring in August 2004 (Clabby *et al* 2006).

Table 4 The overall water quality results from the Nore catchment - EPA hydrometric area 15. The surveyed channel length is shown in km with the four corresponding biological quality classes - A - Unpolluted, B - Slightly polluted/eutrophic, C - Moderately polluted and D - Seriously polluted. Data is taken from EPA biological surveys during the year 2001-2003 (adapted from Toner *et al* 2005).

Catchment	Class A	Class B	Class C	Class D	Total (km)
Nore (km)	249	217.5	47.5	4.0	518
Nore (%)	48	42	9	1	100

The nearest EPA stations on the River Nore to the Gloreen Stream confluence are Poorman's Bridge (Site Code 0900), which is located approximately 1km upstream of the confluence with the Gloreen Stream and Watercastle Bridge (Site Code 1100), located approximately 3.5km downstream of the Gloreen confluence. The Poorman's Bridge site was rated as being Q3-4 (Slightly polluted) during the 2004 and 2001 surveys. The Watercastle Bridge site was rated as being Q4 (Slightly polluted) during the same period. Chemical water quality results from the same period also suggested a slight improvement in water quality conditions between the two sites (Toner *et al* 2005).

EPA monitoring data for the River Nore (Table 5) over the period 2001 to 2003 was assessed to determine baseline chemical water quality in the river and the corresponding water quality status downstream of the confluence with the Gloreen River, which receives the discharge from the Abbeyleix WwTP.

The baseline water quality on the River Nore at the upstream monitoring station was found to be affected by elevated levels of total Ammonia, Nitrate and Orthophosphate. The sampling station downstream of the Gloreen River confluence was found to have elevated levels of total Ammonia, Nitrate and Orthophosphate while the DO levels at both stations were found to have minimum values below the prescribed limit. The upstream station was found to have higher median total Ammonia values and higher BOD values than the downstream station, while Nitrate and Colour values were significantly higher downstream. Orthophosphate values significantly exceeded prescribed limits but no differentiation was noted upstream or

downstream. Un-ionised Ammonia at both stations was within the prescribed limit, although levels reached a slightly higher maximum at the downstream station; while BOD levels also conformed to limits and reached a higher maximum upstream. Chloride, pH and temperature were all within the expected natural range with no significant variation upstream or downstream.

A detailed discussion for each parameter at the upstream and downstream monitoring locations on the River Nore is presented below.

3.2.1.1 Total Ammonia

The EPA considers that total Ammonia levels above 0.1mg/l N in a water course can indicate sewage or industrial contamination (EPA, 2001). Maximum total Ammonia values upstream and downstream of the confluence with the Gloreen River were found to be above this prescribed limit at 0.15mg/l and 0.18mg/l respectively. This indicates slightly higher levels of total Ammonia in the River Nore at the downstream station. However, this is not borne out by the median data which indicates higher total Ammonia median values in the upstream site. Median values for both sites are below the EPA limit of 0.1mg/l N.

3.2.1.2 Un-ionised Ammonia

The Salmonid Waters Regulations (1998) set out a limit of 0.02mg/l for un-ionised Ammonia. Both the upstream and downstream stations on the River Nore were found to be compliant with this limit. The monitoring station downstream of the Gloreen River confluence recorded a slightly higher maximum value than the upstream station; however the median values for both stations were the same.

3.2.1.3 BOD

A BOD limit is set at 5mg/l by the Salmonid Waters Regulations (1998) where this value is to be conformed to by 95% of samples. The median values for the upstream and downstream stations on the River Nore were found to be within this limit at 0.9mg/l for both sites. The monitoring station upstream of the Gloreen River confluence recorded higher maximum values than those at the downstream site. Maximum values for both stations were within the 5mg/l limit.

3.2.1.4 Chloride

As sewage contains high levels of chloride, elevated levels of this parameter may indicate pollution by sewage effluent. Natural background levels range from 15-35mg/l, while a variation in 5mg/l from station to station may indicate sewage discharge, especially when ammonia is also elevated (EPA, 2001). The Chloride median and maximum results for the downstream station were found to be higher than the upstream station, but by an order of 1-2mg/l and well within the natural background levels expected for a large watercourse.

3.2.1.5 Dissolved Oxygen

The Salmonid Waters Regulations (1998) require that the Dissolved Oxygen (D.O.) concentrations in rivers must be ≥ 9mg/l for at least 50% of the monitoring period. If these levels “fall below 6mg/l, the local authority must prove that there will be no harmful consequences for the balanced development of the fish population”. The median D.O. values for the upstream and downstream sites on the River Nore were both satisfactory at 10mg/l. Both the upstream and downstream stations recorded minimum D.O. levels below the required limit value, with a greater shortfall noted at the site upstream of the Gloreen River confluence.

3.2.1.6 Nitrates

The concentration of nitrate in rivers is an important quality indicator, as it is responsible for enriching effects in the aquatic environment. The EU maximum and guideline limits for nitrate

in abstracted water for human consumption are respectively 11.30mg/l and 5.65mg/l N. A maximum level of 2 mg/l N has been deemed appropriate for protecting the most sensitive freshwater species. However, a lower level, i.e. <1.7 mg/l N, has been suggested nationally as the quality requirement for sustainable pearl-mussel water bodies (Lucey, 2007).

Minimum, median and maximum Nitrate values were found to be higher at the monitoring station downstream of the Gloreen River confluence. The downstream median value was found to be 21% higher than at the upstream station. The 2mg/l N limit was exceeded by the median value at the downstream site and also by the maximum values for both the upstream and downstream locations. The recommended limit for the protection of pearl-mussels (<1.7mg/l), which are present in the River Nore directly downstream, was exceeded by the median values at both sampling stations. This indicates that Nitrate levels are putting significant pressure on the sustainability of the River Nore ecosystem.

3.2.1.7 Orthophosphates

The phosphorus loads permitted in a river are governed by the Phosphorus Regulations (S.I. 258 of 1998). These regulations require water quality to be maintained or improved by reference to the biological quality rating (of rivers) or trophic status (of lakes) that the EPA assigned in the 1995-97 review period or at the first occasion thereafter. This represents the baseline water quality data.

The minimum Orthophosphate (measured as MRP) concentrations for the upstream and downstream stretches of the River Nore, under the regulations, are 0.03mgP/l (MRP values are taken from EPA (2001)). The EPA minimum and median Orthophosphate values for both the upstream and downstream stations are within the prescribed limits, while the maximum upstream and downstream values were found to exceed the limit, at 0.5mg/l. The Orthophosphate values for the upstream and downstream stations are the same.

3.2.1.8 PH

The Salmonid Waters Regulations (1988) set limits for pH values at ≥ 6 and ≤ 9. The median and maximum pH values for the upstream and downstream sites on the Gloreen River were found to be 8.1 and 8.3 respectively. The minimum pH value at the downstream station was found to be 0.1 unit higher than the upstream station. The minimum, maximum and mean pH values upstream and downstream of the outfall were found to be within the prescribed limits.

3.2.1.9 Temperature

Temperatures in Irish waters undergo seasonal fluctuations but may highlight thermal pollution from industrial or sewage effluent. Water temperature also affects the solubility of oxygen in water. The temperature range from minimum to maximum at both upstream and downstream monitoring stations is within the expected annual range (i.e. below 25°C).

3.2.1.10 Colour

The median values for colour in the upstream and downstream stations on the River Nore were found to be the same. However, the minimum and maximum values at the downstream station were found to be significantly higher (elevated by 300% and 20% respectively).

3.2.2 The Gloreen Stream

3.2.2.1 Existing information

Biological water quality in the Gloreen Stream (or Ballyroan River 15/B/01) has been monitored by the EPA (and their predecessors) since 1980, as part of their rollover survey of Irish Rivers. The most recently published study was published in 2005 (Toner *et al*, 2005) when three stations were monitored in the river. Stations both upstream (Ballydine Bridge, Station 0150, and Sallagh Bridge, Station 0100) and downstream (Gloreen Bridge, Station 0200) of the Abbeyleix WwTP outfall are monitored. The Ballydine Bridge and Gloreen Bridge

sampling stations are just over 1km apart and the existing outfall is approximately halfway between them. The most recent EPA published study rated the Gloreen Stream as 'Class B, Slightly polluted (Q3-4)' upstream of the Abbeyleix WwTP discharge at Ballydine Bridge and 'Class C, Moderately Polluted (Q3)' downstream of the Abbeyleix WwTP discharge at Gloreen Bridge. Since 2001, biological water quality at Ballydine Bridge has improved from a Q3 to a Q3-4 rating. However, the Gloreen Bridge station (downstream of Abbeyleix WwTP) has consistently been rated as Q3 since 1995 (See Table 8). The trend of declining water quality between the Ballydine Bridge and Gloreen Bridge sampling stations is also reflected in the chemical water quality data provided for the period 2001-2003 in Toner *et al* (2005). The Gloreen Stream is rated by the EPA as being "at risk of not achieving good status" (Source: EPA Envison).

Laois County Council monitor water quality in the Gloreen Stream at the same stations located upstream and downstream of the Abbeyleix WwTP discharge. The results of the most recent monitoring of the waste water effluent streams entering the river were provided by Laois County Council for use in the current assessment. This data extends from the period February 2007 to July 2008. A statistical summary of this data is provided in Appendix 2.

Laois County Council monitoring data for the Gloreen stream over the period January 2007 to June 2008 was assessed to determine baseline chemical water quality in the river and the corresponding water quality status downstream of the Abbeyleix WwTP discharge. The results of the monitoring programme are set out in Appendix 3 to this report.

Baseline water quality upstream of the discharge point was found to be compromised, with Ammonia, Dissolved Oxygen (DO), Orthophosphates, Total Phosphorous and Nitrates above statutory or guideline limits, irrespective of the WwTP discharge downstream.

However, it was found that the monitoring station on the Gloreen River, downstream of the Abbeyleix WwTP discharge, recorded elevated results for all parameters when measured against the background levels in the river (with the exception of Chemical Oxygen Demand (COD)). Dissolved Oxygen (DO) levels were found to be lower at the downstream sampling station. Parameters where statutory or guideline limits were exceeded at the downstream station included Ammonia, DO, Orthophosphates, Suspended Solids, Total Phosphorous and Nitrites.

A detailed discussion for each parameter at the upstream and downstream monitoring locations on the Gloreen River is presented below.

BOD: A BOD limit is set at 5mg/l by the Salmonid Waters Regulations (1998) where this value is to be conformed to by 95% of samples. The mean values for the upstream and downstream stations on the Gloreen River are within this limit at 1.44mg/l (+/-0.25) and 2.44mg/l (+/-0.51) respectively. However, these results do indicate a significant increase in BOD downstream of the discharge with an elevation of 69% calculated from the mean values. Maximum values for both stations were within the 5mg/l limit.

Conductivity: The Freshwater Fish Directive (78/659/EEC) does not set out limits for Conductivity. However the Surface Water Regulations (1989), for designated drinking waters, set a limit value at 1,000 for A1 waters. Although Conductivity levels were found to be low at both upstream and downstream sites on the Gloreen River it can be seen that results are higher for the downstream station, indicating an elevation in total dissolved solids. The mean results for Conductivity from the upstream and downstream sites were 658.82 µS/cm (+/-39.59) and 683.18 µS/cm (+/-41.86) respectively. This corresponds to an increase of 3.7% downstream of the discharge.

Ammonia: The EPA considers that levels above 0.1mg/l N indicate sewage or industrial contamination (EPA, 2001). This level has been taken as the limit for the Gloreen River in the absence of a definition of the species of Ammonia analysed. Ammonia levels downstream of the discharge point were found to be elevated when compared with the upstream samples. The mean upstream Ammonia values were 0.17mg/l (+/-0.17), while the downstream values were 0.37mg/l (+/-0.13). This equates to a significant increase of 101%. The maximum values

at the upstream and downstream sites exceeded the prescribed limit set by the EPA, as did the mean values for both sites (See Figure 2).

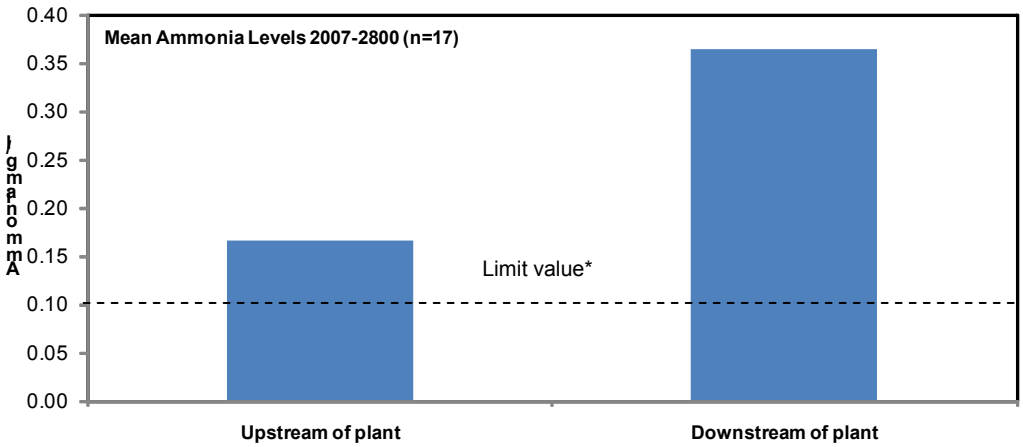

Figure 2 Mean Total Ammonia levels in the Gloreen Stream during the period February 2007 to July 2008 (n=17 observations). Data supplied by Laois County Council. *Limit value is taken as 0.1 mg/l which is given in EPA (2001) as the level at which contamination is indicated. A level of 0.3 mg/l would contain harmful amounts of un-ionised ammonia. Un-ionised ammonia is particularly harmful to fish and other aquatic life. It is likely that harmful amounts of unionised ammonia can also occur at total ammonia concentrations of less than this depending on the ambient water temperature and pH.

Dissolved Oxygen: The Salmonid Waters Regulations (1998) require that the Dissolved Oxygen (D.O.) concentrations in rivers must be ≥ 9mg/l for at least 50% of the monitoring period and if these levels "fall below 6mg/l the local authority must prove that there will be no harmful consequences for the balanced development of the fish population". The mean D.O. values for the upstream and downstream sites on the Gloreen River were 9.29mg/l (+/-0.81) and 8.93mg/l (+/-0.91) respectively. This reflects a drop in D.O. levels of 3.86% at the downstream site. Both the upstream and downstream stations recorded D.O. levels below the required limit value, with a greater shortfall noted at the site downstream of the outfall discharge.

Nitrates: The concentration of nitrate in rivers is an important quality indicator, as it is responsible for enriching effects in the aquatic environment. The EU maximum and guideline limits for nitrate in abstracted water for human consumption are respectively 11.30mg/l and 5.65mg/l N. A maximum level of 2 mg/l N has been deemed appropriate for protecting the most sensitive freshwater species. However, a lower level, i.e. <1.7 mg/l N, has been suggested nationally as the quality requirement for sustainable pearl-mussel water bodies (Lucey, 2007).

Mean upstream values for the Gloreen Stream were found to be 4.3mg/l (+/-0.7), while the mean downstream Nitrate values were 4.39mg/l (+/-0.64). Both these values are greater than twice the recommended limit and indicate a very slight increase in Nitrates (2.1%) at the sampling station downstream of the discharge. Maximum levels recorded were 6.57mg/l and 6.17mg/l at the upstream and downstream stations, respectively, indicating fluctuations in Nitrate levels upstream of the discharge, independent of the WwTP effluent. Overall Nitrates in the Gloreen River upstream and downstream of the wastewater discharge were found to be at significantly elevated levels, with the maximum values for both sites greater than three times the maximum EPA limit.

Orthophosphates: The phosphorus loads permitted in a river are governed by the Phosphorus Regulations (S.I. 258 of 1998). These regulations require water quality to be maintained or improved by reference to the biological quality rating (of rivers) or trophic status (of lakes) that the EPA assigned in the 1995-97 review period or at the first occasion thereafter. This represents the baseline water quality data.

The minimum Orthophosphate (measured as MRP) concentrations for the upstream and downstream stretches of the River Gloreen, under the regulations, are 0.03mgP/l and 0.045mgP/l respectively (MRP values are taken from EPA (2001)). These also take into account a target Q-rating of Q4 and Q3-4 for the upstream and downstream stations respectively.

From the Laois County Council monitoring data it can be seen that the mean Orthophosphate values for both the upstream and downstream stations exceed the prescribed limits for this river. The mean Orthophosphate levels on the Gloreen Stream upstream of the discharge were found to be twice the limit, while the mean values downstream of the discharge were almost three times higher than the limit. The minimum value recorded for the downstream station was also higher than the limit at 0.05mg/l. The mean orthophosphate levels at the upstream and downstream stations were 0.06mg/l (+/-0.03) and 0.13mg/l (+/-0.04) respectively. The mean levels at the downstream station were found to be 53.8% higher than at the upstream station (See Figure 3).

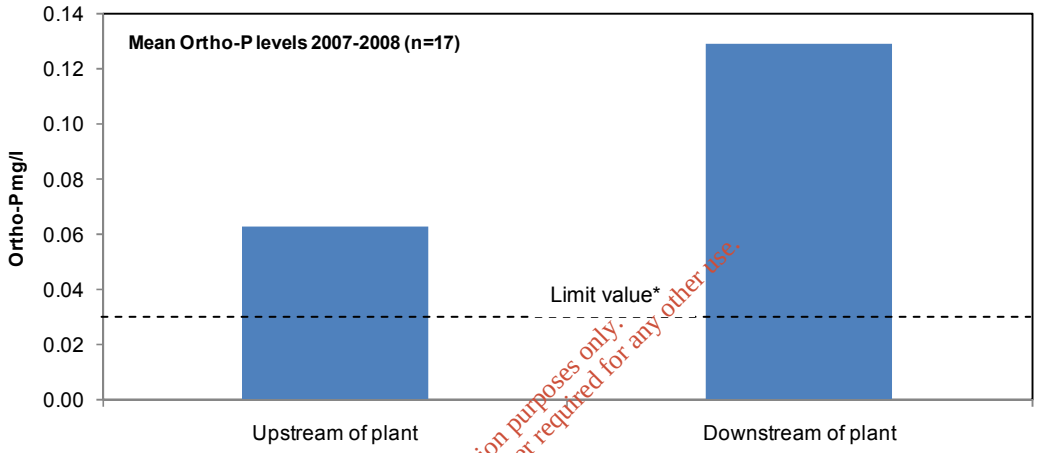

Figure 3 Mean Ortho-Phosphate levels in the Gloreen Stream during the period February 2007 to July 2008 (n=17 observations). Data supplied by Laois County Council. *Limit value is taken as 0.03 mg/l which is the interim statutory M.R.P. (broadly equivalent to Orthophosphate) annual median standard for rivers (EPA, 2001).

PH: The Salmonid Waters Regulations (1988) set limits for pH values at ≥ 6 and ≤ 9. The mean pH values for the upstream and downstream sites on the Gloreen River were found to be 8.07 (+/-0.09) and 8.02 (+/-0.06) respectively. The pH values downstream of the wastewater outfall were found to be slightly lower than the upstream station. The minimum, maximum and mean pH values upstream and downstream of the outfall were found to be within the prescribed limits.

Suspended Solids: The Salmonid Waters Regulations (1988) set a limit of 25mg/l for suspended solids. The mean suspended solids values for the upstream and downstream stations on the Gloreen River were found to be 8mg/l and 16.5mg/l respectively, both of these values are within the prescribed limit. However, this corresponds to an increase of approximately 100% in suspended solids in the river downstream of the discharge. The maximum suspended solids values for the upstream station were within the 25mg/l limit at 13mg/l while the downstream station slightly exceeded the limit at 26mg/l. It is important to note that the suspended solids values are derived from only two sampling surveys and therefore do not represent an accurate a reflection of the background suspended solids in the river over an extended period.

Total Phosphorous: No limits are set for Total Phosphorous in the Freshwater Fish Directive (78/659/EEC); however, an indicative value of 0.062mgP/l is given for salmonid waters in order to reduce eutrophication (EPA, 2001). Sampling data for total Phosphorous was only available from two occasions on the Gloreen River, limiting the accuracy of interpreting these results.

The total Phosphorous results for both the upstream and downstream stations were found to have exceeded the indicative limit. Levels at the downstream station were significantly higher than the two readings obtained from the station upstream of the discharge outfall. The mean total Phosphorous value (2 observations only) for the upstream station was 0.09mg/l, while the downstream value was 0.21mg/l, an increase of 133%. The mean downstream value is over three times higher than the indicative limit of 0.062mgP/l.

Total Nitrogen: The Salmonid Waters Regulations (1988) do not provide limits for total Nitrogen. Total Nitrogen is not a significant nutrient in the freshwater environment in terms of limiting growth. The Surface Waters Regulations (1989) set values of between 1mg/l and 3mg/l for drinking waters; however, these do not apply directly to this study.

The mean total Nitrogen values for the upstream and downstream station was found to be 5.8mg/l and 6.5mg/l respectively, while the maximum values for both sites also highlighted elevated total Nitrogen levels downstream of the discharge. The mean values downstream of the outfall were 12% higher than the upstream sampling site. However, the minimum value at the upstream sampling station was found to be higher than at the downstream station, indicating elevations in total Nitrogen in the Gloreen River, independent of the discharge. These results represent two sampling occasions and therefore do not present an accurate depiction of the baseline total Nitrogen in the Gloreen River.

Chemical Oxygen Demand (C.O.D.): There are no limits for C.O.D. set in the Salmonid Waters Regulations (1988). The EPA (2001) comment that C.O.D. analysis is better suited to polluted waters with an oxygen demand in the region of 25mg/l. The Surface Water Regulations set a limit of 40mg/l C.O.D. for drinking waters; however this does not apply to this study.

The C.O.D data available related to a single sampling survey upstream and two samples taken downstream. An assessment of the baseline C.O.D. values in the Gloreen River cannot be derived from such sparce data. However, it can be noted that the C.O.D. values on the 24.04.2008 were lower at the sampling point upstream of the discharge (10mg/l) than at the downstream station (12mg/l); reflecting an increase of 20%.

Hardness: There are no limits for hardness in the Freshwater Fish Directive (78/659/EEC), however the EPA (2001) provide guidelines on the hardness of water. Following this classification the results for the Gloreen River would be considered to be 'Excessively Hard'. Sampling for hardness in the Gloreen River was carried out on two occasions and is not considered to represent a fully accurate picture of the baseline hardness in the river. The hardness (mg/l $CaCO_3$) was found to be elevated downstream of the outfall, when compared to the upstream results.

Nitrites: The Salmonid Waters Regulations (1988) set a limit of 0.05mg/l NO_2, while the EPA (2001) state that levels in unpolluted waters are normally below 0.03mg/l, with values greater than this indicating sewage pollution. It is this more stringent limit that is taken in this assessment.

Nitrite analysis was only carried out on two occasions in the Gloreen River, limiting an assessment of the baseline conditions existing upstream and downstream of the discharge site. Both the upstream and downstream minimum and mean values were found to exceed the above limit, with levels significantly higher at the station downstream of the discharge outfall. The mean Nitrite level downstream of the discharge was found to be 53% higher than the upstream value.

Table 5 Summary water quality results 2001-2003 for the Nore at Poorman's Bridge (upstream of Gloreen confluence) and Watercastle Bridge (downstream of Gloreen confluence). Source Environmental Protection Agency (Toner *et al* 2005). Parameters considered to be elevated are shown in bold (based on criteria given in EPA 2001).

Chemical parameter	Station 1 (0900) Poorman's Bridge (U/S)			Station 2 (1100) (D/S) Watercastle Bridge		
	Min	Med	Max	Min	Med	Max
pH	7.7	8.1	8.3	7.8	8.1	8.3
Temperature (^{o}C)	2.4	10.9	18.4	2.1	11.2	18.3
Dissolved O_2 (mg $O_2 1^{-1}$)	**7.8**	10.0	13.1	**8.4**	10.0	13.1
B.O.D (mg $O_2 1^{-1}$)	0.4	0.9	2.7	0.3	0.9	2.4
Chloride (mg Cl 1^{-1})	13	15	18	14	16	20
Total Ammonia (mg N 1^{-1})	<0.03	0.03	**0.15**	<0.01	0.02	**0.18**
Un-Ionised Ammonia (mg NH_3 1^{-1})	<0.001	0.001	0.002	<0.001	0.001	0.003
Oxidised Nitrogen (mg N 1^{-1}) - Nitrate	1.0	**1.9**	**2.8**	1.4	**2.3**	**3.3**
Ortho-Phosphate (mg P 1^{-1})	0.01	0.02	**0.05**	0.01	0.02	**0.05**
Colour (Hazen units)	5	60	125	15	60	150

Table 6 Summary water quality results 2001-2003 for the Gloreen Stream at Ballydine Bridge (upstream of Abbeyleix WwTP) and Gloreen Bridge (downstream of Abbeyleix WwTP). Source: Environmental Protection Agency (Toner *et al* 2005). Parameters considered to be elevated are shown in bold (based on criteria given in EPA 2001).

Chemical parameter	Station 1 (0150) Ballydine Bridge (U/S)			Station 2 (0200) Gloreen Bridge (D/S)		
	Min	Med	Max	Min	Med	Max
pH	7.8	8.2	8.3	7.8	8.0	8.1
Temperature (^{o}C)	5.1	11.4	15.4	5.4	11.3	15.6
Dissolved O_2 saturation (%)	89	93	108	69	90	102
Dissolved O_2 (mg $O_2 1^{-1}$)	9.4	10.3	**12.3**	7.0	9.8	12.0
B.O.D (mg $O_2 1^{-1}$)	0.7	1.2	**5.7**	1.0	2.0	**8.8**
Chloride (mg Cl 1^{-1})	**18**	20	23	**20**	24	34
Total Ammonia (mg N 1^{-1})	0.01	0.06	0.50	0.06	**0.25**	**1.8**
Un-Ionised Ammonia (mg NH_3 1^{-1})	0.001	0.001	0.011	0.001	0.007	**0.045**
Oxidised Nitrogen (mg N 1^{-1})	2.5	4.4	**6.2**	3.0	4.4	**6.3**
Ortho-Phosphate (mg P 1^{-1})	**0.02**	**0.05**	**0.12**	**0.05**	**0.11**	**0.39**
Colour (Hazen units)	15	40	125	15	40	125

Table 7 Biological Quality Ratings (Q Values) taken from the Nore River at Poorman's Bridge and Watercastle Bridge. These sites are located upstream and downstream of the Gloreen River confluence to which the Abbeyleix WwTP discharges.

No	Sampling station location	Location	'71	'75	'79	'84	'87	'91	'95	'98	'01	'04
0900	Poorman's Bridge 240775 185967	1km upstream of confluence with Gloreen stream	-	-	-	4	4-5	4	4	3-4	3-4	3-4
1100	Watercastle Bridge 241165 184062	5 km downstream of Gloreen stream	5	5	4-5	4	4	4-5	3-4	3-4	4	4

Table 8 EPA Biological Quality Ratings (Q Values) for the Gloreen stream (EPA Code 15/B/01). Site 0150 is locate upstream of the WwTP outflow, while Station 0200 is located downstream of this outfall.

No.	Sampling station location	NOS grid reference	1980	1982	1984	1987	1991	1995	1998	2001	2005
0100	Sallagh Bridge	244363 187557	-	-	-	3	3-4	4	3-4	4	3-4
0150	Ballydine Bridge	243149 185605	-	4	4	3-4	4	3-4	3-4	3	3-4
0200	Gloreen Bridge	242068 185179	3	2-3	2-3	3	4	3	3	3	3

3.2.2.2 Results of the current assessment

In order to supplement the existing water quality data available for the Gloreen Stream, two EPA kick sampling assessments were undertaken by on the stream during August 2008. One site was located at Gloreen Bridge at the same site that is sampled by the EPA (i.e. Site 0200). This site is a receptor site and is located downstream of the Abbeyleix WwTP outfall. The second site was located at Tullyroe, upstream of the Abbeyleix WwTP outfall, but downstream of the confluence of the Ballydine stream which was observed to be visibly polluted during the first site visit during July 2008. The source of pollution to this stream is not known. However, Laois County Council confirmed that they do not discharge any wastewater into this stream and suggested that private septic tanks may overflow into this watercourse.

This site was therefore a true control, representing the background water quality in the Gloreen Stream, directly upstream of the WwTP discharge. The EPA station located at Ballydine Bridge (Station 0150) is located upstream of both the Ballydine stream and WwTP inputs.

Tullyroe control site

This site supported 14 families of macroinvertebrate and yielded 185 macroinvertebrate individuals. The freshwater shrimp was numerous, making it the most abundant organism recorded at this site. Larvae of the large dark olive mayfly and blackfly larvae were both common. Fair numbers of blue-winged olive mayfly larvae were recorded. Stonefly larvae of the needlefly *Leuctra fusca* were present, as were larvae of the northern caddisfly and an indeterminate species of Goerid caddisfly (family Goeridae). Small numbers of caseless sandfly larvae *Rhyacophila* sp. were recorded. The river limpet *Ancylus fluviatilis* and green chironomid larvae were scarce.

The crawling water beetle *Brychius elevatus* and the riffle beetle *Elmis aenea* were both present while larvae of the riffle beetle *Helmis sp.* were scarce. Aquatic earthworms in family Lumbricidae and nematode worms were also present at this site.

Group A pollution indicators were absent at this site while the Group C organism *G. deubeni* was numerous. This site is therefore deemed to be 'Class C, Moderately Polluted (Q3)' using the EPA Q determination scheme. A score of 82.3 was attained using the BMWP scale for riffles, implying that the river at this point is 'Clean but slightly impacted'. The ASPT for this site was 6.33.

Gloreen Bridge receptor site

A total of 10 macroinvertebrate families were recorded in the sample of 259 macroinvertebrates found at this site. The pollution tolerant freshwater shrimp *Gammarus deubeni* was the most abundant organism and was excessive. The most diverse group were the mayflies where three species were recorded at larval stage; large dark olive *Baetis rhodani* (small numbers), blue-winged olive *Ephemerella ignita* (scarce) and iron blue dun *Baetis muticus* (present).

The only representatives of trichopterans (caddisfly) were larvae of the cased northern caddisfly *Potamophylax sp.* which was found in small numbers and caseless larvae of the sandfly *Rhyacophila dorsalis* which was scarce. True fly/dipteran larvae recorded were those of the blackfly and the cranefly *Dicranota sp.* These dipterans were scarce and few, respectively. The hog louse *Asellus aquaticus* and roundworms (Nematoda) were also scarce. Small numbers of the leech *Erpobdella octoculata* were recorded at this site.

Using the EPA freshwater biological monitoring system (Toner et al., 2005), this stretch of the river is deemed to be 'Class C, Moderately Polluted (Q3)'. This is due to excessive Group C freshwater shrimp, the absence of Group A organisms and heavy siltation. The BMWP score for this riffled site was calculated to be 48.9. This part of the river is therefore interpreted as being 'Moderately Impacted'. The ASPT (average score per taxon) for this site was 5.43.

Table 9 Classification of macroinvertebrate species recorded at each site in terms of their pollution sensitivity (EPA methods).

Pollution indicator group	Gloreen Bridge receptor site				Tullyroe control site			
	Number	% of total	Families	% of families	Number	% of total	Families	% of families
Group A (Most sensitive)	0	0	0	0	0	0	0	0
Group B (Less Sensitive)	13	5	2	18.2	4	2.2	3	21.4
Group C (Tolerant)	234	90.4	6	54.5	178	96.2	9	64.3
Group D (Very Tolerant)	12	4.6	3	27.3	3	1.6	2	14.3
Group E (Most tolerant)	0	0	0	0	0	0	0	0
Total	259	100	11*	100	185	100	14	100

* a total of 10 different families were recorded but family Baetidae was represented by two species in both Group B and Group C.

Table 10 Functional group characteristics of the two survey sites. Dominant FFG (%) (Dominant group and its mean relative %); P/R (ratio of Scrapers to total collectors + shredders, a surrogate for ratio of gross primary production to community respiration); Heterotrophy vs Autotrophy based on a P/R threshold of > 0.75 = autotrophic) (Rabenil *et al*, 2005).

Functional Group	Tullyroe control site		Gloreen Bridge receptor site	
	Numbers	%	Numbers	%
Filtering Collector	31	16.76	10	3.86
Gathering Collectors	46	24.86	23	8.88
Predator	14	7.57	11	4.25
Scraper	6	3.24	0	0
Shredder	88	47.57	215	83.01
Total	185	100	259	100
P/R	0.036		0	
Heterotrophy Vs Autotrophy	Highly heterotrophic		Highly heterotrophic	

Table 11 Juvenile salmonid food index. Predictable invertebrate supply is the ratio of behavioral drifters (filtering and gathering collectors) to accidental drifters (scrapers, shredders and predators). Based on a threshold of >0.50 for predictable supply (Rabenil *et al*, 2005).

Site	Behavioral drifters/accidental drifters	Predictable Vs Unpredictable
Tullyroe	0.713	Predictable
Gloreen Bridge	0.147	Unpredictable

3.2.3 Monitoring data for the WwTP discharge

Appendix 2 provides a statistical summary of the water quality monitoring results for the two treated effluent streams from the Abbeyleix WwTP during the period February 2007 to March 2008. This data is collected by Laois County Council.

The maximum BOD values for both the new and old outlets significantly exceed the 25mg/l limit, while the mean discharge value from the new outlet were 44% higher than the above limit during the monitoring period. The mean BOD value from the old outlet falls within the above limit.

The Urban Wastewater Treatment Directive (91/271/EEC) sets a limit of 125mg/l for COD. This was found to be significantly exceeded by both the new and old outlet discharges when the maximum values were assessed (402mg/l and 420mg/l respectively) for the monitoring period. The mean value for the new outlet also exceeded the limit by 18%.

The suspended solids limits set by the Urban Wastewater Treatment Directive (91/271/EEC) are 60mg/l. For the Abbeyleix plant, the maximum levels of this parameter recorded during the study area (288mg/l and 384mg/l respectively) were considered to be excessively elevated. The mean discharge values for both outlets also exceeded the above limits by 46% and 54% respectively.

Total Phosphorous and Total Nitrogen values were only available for the old outlet. The total Phosphorous limit of 2mg/l was exceeded by the minimum, mean and maximum value, while the mean value exceeded the limit by 92%. The total Nitrogen limit is 15mg/l and this was also exceeded by maximum values from the old outlet, while mean values exceeded this limit by 17.7%.

3.2.4 Dangerous substances

An assessment of the presence of dangerous substances in the River Gloreen upstream and downstream of the Abbeyleix WwTP, along with an assessment of the presence of such substances in the discharge, is provided in Appendix 3. This assessment is based on sampling undertaken by Laois County Council on two occasions during 2007 and 2008. Levels of these substances recorded in the samples are compliant with required limits, with the exception of zinc levels in the sample taken from the combined outfall on the 08/05/2008. This sample had a zinc level of 113.1 μg/l. This level is considered to be elevated (see Appendix 3). The standard for zinc is 50 μg/l for hard waters (such as the Gloreen Stream). The number of samples assessed for dangerous substances is considered to be limited and further sampling to assess the ambient levels of these substances in the effluent is recommended.

3.2.5 Assimilation capacity of receiving waters

The primary regulatory guideline for effluent standards is the EU Urban Wastewater Treatment Regulations, 2001 which is implemented in Ireland through S.I. 254 of 2001 and the Water Quality Standards for Phosphorus (S.I. 258 of 1998). The Urban Wastewater Treatment Regulations requires the provision of secondary treatment for all discharges to freshwaters and estuaries from towns with a population equivalent of between 2,000 and 10,000. While the requirements of the Urban Wastewater Treatment Regulations are set,

water quality requirements are dependent on the background values and the 95 percentile flow in the river (i.e. assimilation capacity).

The **BOD** Waste Assimilation Capacity (WAC) is defined as:

$WAC = (C_{max} – C_{back}) \times F_{95} \times 86.4$ kg BOD/day
Where: C_{max} = maximum permissible BOD concentration (= 4 mg/l)
C_{back} = background (upstream) BOD concentration
F_{95} = 95 percentile flow (m^3/s)
86.4 = conversion factor

From the data presented in Appendix 3, the background value for BOD for the Gloreen Stream is taken as 1.4 mg/l. Therefore the BOD WAC = (4-1.4) x 0.052 x 86.4 = 11.68 kg BOD/day

Phosphorus

The phosphorus loads permitted in a river are governed by the Phosphorus Regulations (S.I. 258 of 1998). These regulations require water quality to be maintained or improved by reference to the biological quality rating (of rivers) or trophic status (of lakes) that the EPA assigned in the 1995-97 review period or at the first occasion thereafter. This represents the baseline water quality data. In the case of the Gloreen Stream the Q value rating upstream of the existing treatment plant at Abbeyleix was determined as Q3-4 in 1995 and downstream received a Q index of Q3 (Toner et al, 2005). The minimum target ratings and associated Phosphorous (measured as MRP) concentrations for the upstream and downstream stretches of the River Gloreen Phosphorous under the regulations are given in Table 12. Associated MRP values are taken from EPA (2001).

Table 12 Phosphorus Regulations Target Ratings and Concentrations for the Gloreen Stream.

	Existing Q rating	Target (Q) Rating	MRP Median (mg P/L)
U/S	3 –4	4	0.030
D/S	3	3-4	0.045

Using the Waste Assimilation Capacity calculation the allowable MRP concentration equates to the following loads to the river:

At 95%ile flow : 0.07 kg MRP/d
At Long Average Flow : 0.8 kg MRP/d.

Ammonia

The Gloreen Stream is a spawning and nursery river for salmon and trout so must be considered to be a salmonid river although not designated as a Salmonid Water under the Freshwater Fish Directive. The Gloreen Stream does flow into the River Nore which has such a designation. A guideline for the maximum allowable ammonia concentration in a Salmonid River is 0.82 mg/l. Using the WAC formula and a background value of 0.05mg/l Nicholas O'Dwyer (2002) derived an effluent load assimilation capacity of 3.46 kg/d. However background ammonia levels have apparently increased since the 2002 study and the current effluent ammonia assimilation capacity is estimated at 2.92 kg/d.

Available dilution in the Gloreen Stream

For a 95%ile flow in the Gloreen Stream, the available dilution has been estimated as being 4,492 m^3 day^{-1} (Nicholas O'Dwyer, 2002). For an estimated 4,500 p.e. flow of 900 m^3 day^{-1} this would equate to a dilution factor of 5.0. For an estimated 6,000 p.e. flow of 1,350 m^3 day^{-1} this would equate to a dilution factor of 3.3.

3.3 Sediment quality

A spillage of Polychlorinated biphenyls (PCBs) occurred in the Nore at Kilkenny in the 1980's (Lucey, 1998), and localized contamination of sediments still persists. There are no reports of any other significant sediment contamination in the Nore catchment. No other information on sediment quality in the Nore catchment was found during the current assessment.

3.4 Areas designated for nature conservation

Sites of international conservation importance are designated Special Protection Areas (under the Birds Directive) or Special Areas for Conservation (under the Habitats Directive). Together, SPAs and SACs make up the Natura 2000 network of wildlife sites. The nearest SAC to the Abbeyleix WwTP is the 'River Barrow and River Nore' SAC (site code 002162). This SAC is located approximately 2 km downstream of the primary discharge, at the confluence of the Gloreen Stream and the River Nore.

The site is a selected for alluvial wet woodlands and petrifying springs, priority habitats on Annex I of the E.U. Habitats Directive. The site is also selected as a cSAC for old oak woodlands, floating river vegetation, estuary, tidal mudflats, Salicornia mudflats, Atlantic salt meadows, Mediterranean salt meadows, dry heath and eutrophic tall herbs, all habitats listed on Annex I of the E.U. Habitats Directive. As well as habitats, the cSAC has been selected due to the presence of invertebrate, fish and mammal species which are listed under Annex II of the EU Habitats Directive, including freshwater pearl mussel (*Margaritifera margaritifera* and its hardwater form *M. m. durrovensis*), freshwater crayfish (*Austropotamobius pallipes*), Atlantic salmon (*Salmo salar*), twaite shad (*Alosa fallax fallax*), the three Irish Lamprey species - sea (*Petromyzon marinus*), brook (*Lampetra planeri*) and river (*Lampetra fluviatilis*), the Desmoulin's whorl snail *Vertigo moulinsiana* and Eurasian otter (*Lutra lutra*).

The Nore is the only site in the world where the hard water form of the pearl mussel *M. m. durrovensis* occurs. The Nore is one of only a handful of spawning grounds in the country for twaite shad. However, this species spawns in the lower reaches of the river. Other important animal species are also found in the Barrow/Nore cSAC. These include Daubenton's bat (*Myotis daubentoni*), badger (*Meles meles*), Irish hare (*Lepus timidus hibernicus*) and frog (*Rana temporaria*), all species listed in the Irish Red Data Book. The rare Red Data Book fish species smelt (*Osmerus eperlanus*) occurs in the estuary. Two other freshwater Mussel species, *Anodonta anatina* and *A. cygnea* are also found in the Nore (Lucey, 1998).

Sites of national importance for wildlife are designated as Natural Heritage Areas (NHAs) under the Irish Wildlife Act 2000. There are two Natural Heritage Areas located within 5km of the WwTP. The first of these is the River Nore/Abbeyleix woods complex NHA (site code 002076). This NHA lies within the River Barrow and River Nore SAC area and its boundary is also located 2.5 km downstream of the discharge (i.e. at the Gloreen stream confluence with the Nore). This NHA is designated for its ancient broadleaved woodland. The second NHA is Lisbigney bog (site code 000869). This NHA is located approximately 5km south of the WwTP and is not within the catchment area affected by the discharge from the Abbeyleix WwTP. This bog is designated for the whorl snail *Vertigo moulinsiana* and the Annex I habitat *Cladium* fen. Areas designated for nature conservation located within five kilometers of the Abbeyleix WwTP are listed in Table 13.

Table 13 Sites designated for nature conservation within 5km of the discharge of the WwTP in Abbeyleix town.

Name	Site Code	Distance from site	Status	Notes
River Barrow and River Nore	002162	2km west	SAC	This SAC is designated for 12 Annex I habitats e.g. floating river vegetation and tall herb fringes, and 12 Annex II species including white clawed crayfish *Austropotamobius pallipes*, river lamprey *Lampetra fluviatilis*, brook lamprey *Lampetra planeri* and sea lamprey *Petromyzon marinus* freshwater pearl mussels *Margaritifera margaritifera* and Nore freshwater pearl mussel *Margaritifera M. durrovensis*, Atlantic salmon *Salmo salar* and otter *Lutra lutra*. The Abbeyeix WwTP discharges into the Gloreen Stream. This then flows into the River Nore 2.5km downstream of the WwTP. The River Nore forms part of the River Barrow and River Nore SAC.
River Nore / Abbeyleix woods complex	002076	2km southwest	NHA	This site runs inside the larger River Barrow and River Nore SAC. It is an important site for ancient broadleaved woodland. The WwTP in Abbeyeix town discharges into the Gloreen Stream. This then flows into the River Nore 2.5km downstream of the WwTP. The River Nore forms part of the River Barrow and River Nore SAC.
Lisbigney bog	000869	5km south	NHA	This site is designated for the whorl snail *Vertigo moulinsiana* and the Annex I habitat *Cladium* fen. This NHA is not in the catchment area affected by the Abbeyleix WwTP.

3.5 Protected aquatic flora and fauna

The status of fauna listed in the European Union Directive on the Conservation of Natural and Semi-Natural Habitats and of Wild Fauna and Flora (Habitats Directive, 92:43:EEC) in the Nore catchment is presented in Table 14.

Table 14 Status of fauna listed in the Habitats Directive (92:43:EEC) in the Nore catchment (adapted from Lucey 1998).

Common name	Scientific name	Main channel	Tributaries
Pearl mussel	*Margaritifera margaritifera*	Rare	Rare
White-clawed crayfish	*Austropotamobius pallipes*	Common	Common
Brook lamprey	*Lampetra planeri*	Rare	Rare
River lamprey	*Lampetra fluviatilis*	Rare	Rare
Sea lamprey	*Petromyzon marinus*	Rare	Rare
Twaite shad	*Alosa fallax*	Rare	Absent
Atlantic salmon	*Salmo salar*	Common	Common
Eurasian Otter	*Lutra lutra*	Common	Common

3.5.1 Pearl mussels

Freshwater Pearl-Mussel (*Margaritifera margaritifera* and its hard water variety *M. margaritifera durrovensis*), occur in the River Nore SAC. The River Nore is the only site in the world designated for *M. m. durrovensis* (Moorkens 1999). The species is now on the International Union for the Conservation of Nature and Natural Resources (IUCN) Red List of threatened animals. It is also listed under Annexes II and V of the Habitats Directive (92:43:EEC) and Appendix 3 of the Bern Convention. It is legally protected in Ireland under Statutory Instruments No. 112, 1990 and No. 94, 1997.

This species is now confined to a stretch of the River Nore between Watercastle and Attanagh Bridge on the River Nore. The population is considered to be on the verge of extinction (Moorkens & Costello 1994; Costello *et al* 1997). From studies carried out between 1990 and

1994, it was estimated that the total mussel numbers in the Nore had fallen from 2,000 to 420 (Moorkens and Costello 1994). In the most recent mussel counts, carried out in 2004, a total population of around 500 individuals was estimated, with no evidence of juvenile survival (Moorkens 2004). The latest results confirm that the Nore population is at a critically low level, and the indications are that it is unable to successfully recruit young.

The Pearl Mussel was once widespread in mainland Europe, Britain and Ireland. However, there has been a decline of more than 90% in European populations during the 20th century and the situation for the mussel continues to deteriorate. Recent surveys have shown that there may be only seven to ten sustainable recruiting populations left in Ireland (Moorkens 2005). Indeed, less than 10% of pearl mussel populations in Ireland are healthy enough to produce young mussels (Moorkens 2000). The majority of Ireland's pearl mussel rivers last bred successfully in the 1970's. Some of these still retain a small population of adult mussels, but they can be measured and range in age from a minority of 30 to a majority of 60 to over 100 years old.

Pearl mussels have a complicated life cycle, involving native salmon or trout. The key cause of decline in pearl mussel populations in Ireland is unsuitable habitat for juvenile mussels after they fall off the gills of host salmonids (Moorkens 2005). This stage requires the safety of remaining within the river bed gravels, before growing to a size that allows the emergence of the filtering siphons into the open water body. While the juvenile mussels remain within the river bed gravels, they filter the interstitial water within the gravels. Where the gaps between the gravel stones get clogged with fine silt, either physical (from suspended solids entering the river) or organic (from algal growth and decay prompted by nutrients in the water), the flow of water in the interstices becomes very restricted. Without adequate water movement and replacement, oxygen levels are exhausted and young mussels die. The decline in interstitial water quality in silted gravels has been detailed by a number of authors in the scientific literature. Fine sediments in gravels have been shown to increase mortality in juvenile mussels to 100%. As river quality becomes depressed, breeding stops and populations become "*functionally extinct*", i.e. older adults persist, but are not replaced by a new generation (Moorkens 2005). The mussel population eventually dies out when the older individuals die of old age. Once breeding stops, it becomes very difficult to save a population. No mussel river in this situation has yet been recovered to a fully independent, recovered and breeding colony. In this knowledge, the pearl mussel has been identified as being internationally endangered.

3.5.1.1 Water Quality requirements for Pearl Mussels

The water quality requirements for Pearl Mussels have recently been reviewed by Young (2005). The main findings of this review are as follows:-

- Juvenile mussels and glochidia are often more susceptible than adults to poor water conditions.
- Interstitial water chemistry is of crucial importance to juvenile mussels but only one study has been carried out on the requirements of juvenile freshwater pearl mussels.
- Unnaturally high levels of nutrients, conductivity, nitrates, phosphates, BOD, metals and some pesticides are detrimental to Pearl Mussels, as well as unnaturally high and low pH.
- Eutrophication is widely regarded as very damaging to mussel populations but few studies have quantified this problem.
- Biocides have frequently been shown to be toxic to mussels of all species.

Guidance on water quality requirements for Pearl Mussels has also been given in an Irish context by Moorkens (2000) and the draft guidelines provided in NPWS (2005). General recommendations for favourable Water Quality Objectives for Pearl Mussels for a number of sources are provided in Table 15.

Table 15 General recommendations for favourable Water Quality Objectives for Pearl Mussels.

Parameter	Target (Oliver 2000)	Target (Bauer 1999)	Proposed Minimum Standard (Moorkens 2000)	Proposed Standard (NPWS 2005)
Ammonia	N/A	N/A	<0.10	0.01
Nitrate (mg/l)	<1.0	<0.5	<1.7	0.125
Phosphate (mg/l)	<0.03	<0.03	<0.005	<0.005
pH (pH units)	6.5-7.2	N/A	<8.0 - >6.3	
Conductivity (µs/cm)	<100	<70	<200	
Calcium (mg/l Ca CO_3)	<10	2	N/A	
BOD (mg/l)	<1.3	<1.4	<3	
Suspended solids (mg/l)	N/A	N/A	N/A	N/A
Dissolved Oxygen (% saturation)	90-100	N/A	50% >8	

3.5.2 White-clawed crayfish

The white-clawed crayfish is the only freshwater crayfish recorded in Ireland. Populations of the species in the rest of Europe have declined dramatically and Ireland is seen as a unique stronghold for this species in a European context (Reynolds 1998). It is classified as vulnerable and rare in the IUCN Red List and is protected in Ireland under the schedules of the Wildlife Act 1976. It is also listed in Appendices II and V of the Habitats Directive (92:43:EEC). It is generally considered to be widespread in lowland lakes and rivers such as the River Nore, which are underlain by Carboniferous limestone, or its derivative - glacial drift (Reynolds 1998). There are no records of crayfish from the Gloreen Stream and this species was not recorded during the current assessment.

3.5.3 Lampreys

The brook lamprey is the smallest of the three lampreys native to Ireland and it is the only one of the three species that is non-parasitic and spends all its life in freshwater (Maitland & Campbell 1992). The river lamprey is larger in size than the brook lamprey and exhibits an anadromous[1] life cycle. The sea lamprey is the largest of the Irish lampreys. Brook lamprey and Sea lamprey are listed in Appendix II, while river lamprey is listed in both Appendices II and IV of the Habitats Directive (92:43:EEC). All three species are listed in Appendix III of the Bern Convention. All three lamprey species have been recorded from the Nore catchment (Kurtz & Costello 1999).

3.5.4 Shad

Twaite Shad and Allis Shad are among the rarest species of fish breeding in Irish freshwaters and are listed under Annexes II and V of the EU Habitats Directive. Both species are also listed in Appendix III of the Bern Convention. Shad have an anadromous life cycle and both species are thought to occur in the Nore estuary. However, it is clear that these species are confined to the lower reaches of the river and would therefore not occur in the study area.

3.5.5 Atlantic salmon

The Atlantic salmon is listed under Annexes II and V of the EU Habitats Directive and Appendix III of the Bern Convention. It an economically important species and salmon recreational and commercial fisheries occur throughout Ireland. Salmon are present throughout the Nore catchment (O'Grady & Sullivan 1987). Salmon are likely to spawn in the River Nore within the study area.

[1] *Anadromous fish spend most of their adult lives in salt water, and migrate to freshwater rivers and lakes to reproduce.*

3.5.6 Eurasian Otter

The otter *Lutra lutra* is a legally protected species under the Wildlife Act, 1976 (and Wildlife (Amendment) Act, 2000). It is listed under Annex II of the EU Habitats Directive and under Annex II of the Berne Convention. It is found throughout Ireland where it has apparently avoided the population declines that have occurred in many other countries (Hayden and Harrington 2000). Otters tend to occupy linear territories along watercourses and are rarely found far away from water. Evidence of otter activity has been recorded from the study area and this species is widespread in the River Nore catchment.

3.6 Recreational and Commercial fisheries

3.6.1 The River Nore

The fish fauna of Ireland is not as diverse as other European countries due to the impact of glaciation. Most of the fish species present in Irish river catchments, such as the River Nore, have colonized from the sea or have been artificially introduced. Native fish species in the Nore catchment include the three Irish lamprey species (brook lamprey, river lamprey, and sea lamprey) (Kurz & Costello 1999), the Atlantic salmon, (O'Grady & Sullivan 1987) and the rare Twaite Shad, (Lucey 1998) all of which are listed under the EU Habitats Directive. The European eel, brown trout, and three-spined stickleback are other common native species present in the Nore catchment; while introduced fish species include northern pike, stone loach, roach, dace, and minnow (Lucey 1998).The smelt *Osmerous eperlanus*, a species listed as vulnerable in the Red Data list (Whilde 1993), is present in the Nore estuary (King 2002).

The freshwater stretches of the River Nore main channel is a designated salmonid river under the EU Fish Directive (78/659/EEC). The Nore is an important salmon and trout fishery which was once regarded as being one of the finest salmon rivers in the country (O'Reilly 2004). It is mainly a grilse fishery though spring salmon fishing is reported to be good in the vicinity of Thomastown and Inistioge. Due to the presence of a number of weirs on the river, salmon are generally confined to the lower areas of the river until late in the year and very few salmon are now caught above Kilkenny (O'Reilly 2004). Recent installation of two new weirs at Kilkenny (in particular Lacken Weir) as part of the Kilkenny Drainage Scheme is believed to have further impacted on upstream passage of salmon in the river (Irish Examiner, 3 January 2005). Brown trout angling is important in the River Nore, and the best stocks in the entire river are reportedly found downstream of the Dinin confluence (O' Reilly 2004).

Fisheries surveys carried out by the Central Fisheries Board in the River Nore Catchment during the period 1990 and 1992 indicated that it is one of the most valuable salmonid catchments in Ireland (O' Grady and Sullivan 1994). Atlantic Salmon *Salmo salar* and Brown Trout *Salmo trutta* are distributed throughout the catchment and occur in tributary streams such as the River Gloreen. The three species of lamprey that occur in Ireland are found in the Nore catchment (Lucey, 1998, Kurtz & Costello, 1999). Sea lampreys have been recorded as far upstream as Ballyragget, and there are records of Brook Lamprey from the River Gloreen. The Nore is one of only three spawning grounds in the country for the Annex II listed Twaite Shad (*Alosa fallax*), however this species is confined to the lower reaches of the river.

3.6.2 The Gloreen Stream

The Gloreen Stream is classed as a salmon producing river by McGinnity *et al*. (2003). The Gloreen Stream is not mentioned in O' Reilly's (2004) comprehensive freshwater angling book '*Rivers of Ireland – a flyfishers guide*'.

3.7 Water abstractions

There are no Drinking Water RPAs on the River Gloreen or River Nore within 10km downstream of the study area (Source: EPA Envision). Both watercourses can however be

expected to be used by farms for animal drinking water. The nearest Drinking Water RPA is the River Dinin, which flows into the River Nore near Ballragget, County Kilkenny.

3.8 Designated recreational and bathing waters

There are no designated recreational or bathing water on the River Gloreen or River Nore (Source: EPA Envision).

3.9 Nutrient sensitive areas

The nearest nutrient sensitive area to the Abbeyleix WwTP is the main channel of the River Nore, downstream of Kilkenny Town. This designation begins downstream of the Kilkenny (Purcellinsinch) sewage outfall, to Inistioge Bridge.

4. IMPACT ASSESSMENT

4.1 Introduction

According to the EPA (2008), a discharge from a WwTP would be considered to have a significant adverse effect on the receiving waters if it were to:-

(1) Cause a deterioration in the chemical status or ecological status (or ecological potential as the case may be) in the receiving body of surface water;
(2) Cause a deterioration in the chemical status in the receiving body of groundwater;
(3) Cause the input into groundwater of hazardous substances, except where it is established that the input concerned is in a quantity and concentration so small as to obviate any present or future danger of deterioration in the quality of the receiving groundwater;
(4) Cause deterioration or result in significant and sustained upward trends in the concentrations of pollutants in groundwater in the case of pollutants that are not hazardous,
(5) Permanently exclude or compromise the achievement of the objectives established for protected species and natural habitats in the case of European sites where the maintenance or improvement of the status of water is an important factor in their protection or which is inconsistent with the achievement of environmental quality standards established under national Regulations in relation to designated bathing waters, designated shellfish waters, areas designated for the protection of freshwater fish and areas designated for nature conservation.

As there is no discharge directly into groundwater no assessment of local groundwater is made in this assessment. It is considered that through the interaction between surface and ground waters any significant impact on the receiving surface waters could also potentially result in a similar impact on local groundwater.

The receiving water for the Abbeyleix WwTP discharge is the Gloreen Stream. Due to its proximity to the discharge the River Nore could also be affected. The Gloreen Stream is a nursery stream for salmon and trout and is also likely to be used by brook lampreys and otters (both of which are listed under Annex II of the EU Habitats Directive). The Nore River is a designated salmonid river under the EU Freshwater Fish Directive and is also designated as a Special Area of Conservation under the EU Habitats Directive. The only global population of the hard water form of the freshwater pearl-mussel occurs from a point located 5km downstream of the Gloreen Stream confluence (approximately 7.5km downstream of the discharge point) and this species has particularly high water quality requirements (Moorkens 2000).

A summary of the receiving water impact assessment is provided in Table 16. The impact on identified receptors is outlined in the following sections.

4.2 Impact on water quality

4.2.1 Chemical water quality

The background water quality in both the Gloreen Stream upstream of the Abbeyleix WwTP and in the River Nore, upstream of the Gloreen confluence was found to be compromised with levels elevated above statutory and guideline limits. The Gloreen Stream was found to be moderately polluted (Q3) upstream of the Abbeyleix WwTP discharge. The macroinvertebrate community downstream of the discharge reflected similar moderately polluted conditions (Q3), with a further deterioration in diversity.

Based on Laois County Council Monitoring data for 2007 and 2008, the WwTP discharge was found to compound water quality deterioration downstream in the Gloreen Stream, with effluent discharges from both the old and new outlets exceeding prescribed limits. Nitrates, Ammonia, Orthophosphates, Total Phosphorous and BOD in the Gloreen Stream were all

found to be elevated downstream of the discharge in the most recent data set. The mean Orthophosphate levels on the Gloreen Stream upstream of the discharge were found to be twice the recommended limit, while the mean values downstream of the discharge were almost three times higher than this limit. Ammonia levels were above the recommended level at both upstream and downstream sites; however they were over 100% higher at the site monitored downstream, of the WwTP discharge. Although it is noted that the Ballydine Stream is also affecting water quality in this reach, the overall results suggest that the Abbeyleix WwTP discharge is having a significant adverse affect on the water quality of the receiving water.

In additional to impacts form the normal operation of the plant, potential also exists for a pollution episode to occur as a result of an accidental / emergency release. It is considered that the risk of such an event is higher in the existing Abbeyleix plant than it would be once the current plant is upgraded.

4.2.2 Biological water quality results 2008

The biological water quality assessments undertaken during August 2008 at monitoring sites located upstream (but downstream of the Ballydine Stream) and downstream of the WwTP outfall, highlight the degraded water quality of the Gloreen Stream. The diversity and abundance levels of macroinvertebrates recorded at both sites were considered to be typical of an organically polluted river. The fauna was dominated by pollution tolerant organisms and no invertebrates of conservation importance were recorded. Both the control and receptor sites on the Gloreen Stream were considered to be 'Q3, Moderately Polluted' using the EPA monitoring system. However, there was a difference in family richness between the control site (N=14) and the receptor site (N=10). This is indicative of a decline in biological water quality at the receptor site. Moreover, comparing the macroinvertebrate communities at the two sites according to pollution indicator groups by family, it was seen that the control site had a greater proportion of sensitive Group B families (21.4% vs 18.2%) and a smaller proportion of more pollution tolerant Group D families (14.3% vs 27.3%).

The macroinvertebrate community in a watercourse can be categorized according to their functional groups, based on the trophic level they occupy. The relative abundance of scrapers and filtering collectors in the riffle/run habitat is an indication of the periphyton community composition and the availability of suspended fine particulate organic material (FPOM). Scrapers increase with increased diatom abundance and decrease as filamentous algae and aquatic mosses (which scrapers cannot efficiently harvest) increase. The macroinvertebrate communities present at both sites site are dominated by invertebrates that specialise in the consumption of organic matter deriving from external inputs such as leaves and pollution sources. However, this trend was more profound at the receptor site where no scrapers were present.

Filtering collectors are sensitive to toxicants bound to fine particles and are the first group to decrease when exposed to chronic sources of such bound toxicants. This situation is often associated with point-source discharges where certain toxicants adsorb readily to dissolved organic matter (DOM) forming FPOM during flocculation. Toxicants thus become available to filterers via FPOM. At the control site, filtering collectors made up almost 17% of the macroinvertebrate community whereas the same functional group accounted for less than 4% in the receptor site.

The juvenile Salmonid food index suggested that an 'unpredictable' supply of invertebrate food was available for juvenile trout at the receptor site, threatening the status of the lower reach of the Gloreen Stream fishery. On the same index, the control site score indicates that there was a predictable supply of macroinvertebrates for juvenile salmonids.

Overall, it is concluded that the reach of the Gloreen Stream downstream of Ballydine Bridge is in a moderately polluted state and is under more ecological stress at the receptor site. The diversity and abundance levels of macro-invertebrates recorded at both sites were considered to be typical of an organically polluted river. However, the situation is significantly worse downstream of the WwTP outfall with reduced community biodiversity, increased biomass,

and increased allochotonous dependence pointing to a significant decline in ecological status at the downstream site.

4.2.2 Dangerous substances

Data was only available for two sampling occasions, one of which showed levels of Zinc from the WwTP discharge elevated above statutory limits.

4.2.3 Assimilation capacity

The assimilation capacity of the Gloreen Stream upstream of the WwTP is considered to be at its limit with respect to the elevated levels of nutrients above statutory and guideline limits. The current discharge regime from the Abbeyleix WwTP was found to be adding to the water quality problems in this river. This is particularly important in reference to the sensitive nature of the River Nore and the conservation designations downstream of the WwTP.

4.3 Impact on areas designated for nature conservation

The discharge from the Abbeyleix WwTP is not located within the boundary of any designated are, so the operation of the plant does not have the potential to cause direct impacts on any area designated for nature conservation.

The nearest SAC to the Abbeyleix WwTP is the 'River Barrow and River Nore' SAC (site code 002162), this site is designated for the conservation of protected habitats and fauna, many of which are aquatic and are highly sensitive to water quality deterioration in the River Nore. This SAC is located approximately 2 km downstream of the primary discharge, at the confluence of the Gloreen Stream and the River Nore. There is the potential for indirect water quality impacts on the SAC, occurring as a result of the operation of the Abbeyleix WwTP. Such an impact would be significant due to the presence of the endangered Nore Pearl Mussel approximately 5km downstream of the Gloreen confluence (See Section 3.4.1 below).

On the basis of the observed water quality deterioration in the Gloreen Stream and the presence of the Nore Pearl Mussel within the receiving catchment of the plant, it must be concluded that the ongoing operation of the plant has the potential to have a significant effect on the SAC itself and it is considered that a Stage 2. 'Appropriate Assessment' would be required.

4.4 Impact on protected flora and fauna

3.4.1 Pearl mussels

Pear Mussels occur in the River Nore, approximately 5km downstream of the Gloreen Stream confluence, or 7.5km downstream of the Abbeyleix WwTP discharge. The discharge from the plant and other inputs (i.e. storm water discharges) could potentially be affecting the only area designated for the protection of the hard water variety of Pearl Mussels in the world. The population is considered to be on the verge of extinction (Moorkens & Costello 1994; Costello *et al* 1997). Pearl Mussels have such high water quality requirements (see Table 9) that any negative impact on water quality in the River Nore, as a result of the discharge from the Abbeyleix WwTP and associated discharges, would be considered to be putting an internationally endangered species at risk.

3.4.2 White-clawed crayfish

White-clawed crayfish occur in the River Nore catchment but were not recorded in the Gloreen Stream. Crayfish are recognised as being tolerant of moderate pollution levels and are classed as Group C organisms in the EPA Q-Value biotic index. This species does not seem to occur in the Gloreen stream, despite suitable physical habitat.

3.4.3 Lampreys

Water quality impacts downstream of the Abbeyleix WwTP outfall would not be expected to have significant negative impacts on existing brook lamprey populations, as they would tolerate such pollution. O'Connor (2007) recorded disproportionately high abundances of brook lamprey in the River Sinking (a tributary of the River Clare) in sewage sludge deposits located immediately downstream of the overloaded Dunmore sewage works in County Galway during 2006. Such pollution would however be expected to affect recruitment of this species as they are understood to require a high standard of water quality for successful spawning and ova survival. Therefore the current poor water quality status of the Gloreen Stream – particularly downstream of the WwTP discharge – has the potential to affect the favourable conservation status of this species. .

3.4.4 Shad

Shad do not occur in the study area as they are confined to the tidal reaches of the River Nore. Therefore this species is not affected by the operation of the Abbeyleix WwTP.

3.4.5 Atlantic salmon

Poor water quality will affect the conservation status of salmon in the Gloreen River; this species requires clean water (Q4) for spawning and early life stages. The juvenile salmonid food index suggested that a 'Predictable' supply of invertebrate food was available for juvenile salmonids at both sites. This shows that the ecosystem of the Gloreen Stream downstream of the WwTP is unbalanced and under significant stress and further reduction in water quality could have adverse effects on the fisheries value of the both the Gloreen Stream and the upper River Nore.

3.4.6 Eurasian Otter

Reduced water quality and ecological status downstream of the discharge of the Abbeyleix WwTP could potentially have indirect effects on otters as a result of reduced food supply.

4.5 Impact on fisheries

The Gloreen Stream is considered to be a potentially important salmonid spawning and nursery area. Salmonids are considered to be under pressure in the Nore system due to poor water quality conditions. Unsatisfactory water quality will also affect other native species within the river (i.e. brown trout). The ongoing operation of the WwTP presents the potential for ongoing impacts to water quality and further deterioration in the fish communities present within the study area. This would have significant adverse impacts on the fisheries and recreational angling taking place on the River Nore.

4.6 Impact on water abstractions

There are no Drinking Water RPAs on the River Gloreen or the downstream areas of the River Nore. Both watercourses can however be expected to be used by farms for animal drinking water. A decline in water quality in the River Gloreen downstream of the outfall would have a slight impact on farms abstracting water from the river. There would be no significant effect on farm animal drinking water supplies on the River Nore.

4.7 Impact on designated recreation and bathing areas

There are no designated recreational or bathing water on the River Gloreen or River Nore, so the existing discharges from Abbeyleix are having no impact on such designated areas.

4.8 Impact on nutrient sensitive areas

The nearest nutrient sensitive area to the Abbeyleix WwTP is the main channel of the River Nore downstream of Kilkenny downstream of the Kilkenny (Purcellinsinch) sewage outfall, to Inistioge Bridge. This area of the Nore is located over 25 km downstream of the discharge.

Table 16 Summary of receiving water impact assessment.

	Rating of receiving waters	Impacts	Significance
Water quality	Moderately Polluted	Causing a deterioration in the chemical and ecological status	Significant, adverse impact on receiving water
Designated conservation Sites	Receiving water is tributary of SAC	Likely to contribute to cumulative negative impacts on water quality in the SAC	Significant, potentially causing adverse impact on receiving water
Protected flora and fauna	Salmon, brook lamprey, otter. Pearl mussels located 7.7km downstream	Likely to affect salmon and lamprey recruitment in the Gloreen Stream. Risk to sensitive Pearl Mussel populations in Nore.	Significant, potentially causing adverse impact on receiving water
Fisheries	Receiving water is tributary of designated salmonid water	Likely to affect recruitment of salmonid fish.	Significant, potentially causing adverse impact on receiving water
Water abstractions	No abstractions	No impact	Not significant
Designated recreation and bathing areas	No such areas	No impact	Not significant
Nutrient sensitive areas	Nearest are is >25km downstream	No impact	Not significant
Conclusion			**Significant Negative Impact on the Receiving Water**

5. CONCLUSIONS

The conclusions from the receiving water impacts assessment for the Abbeyleix WwTP, Co. Laois are as follows:

- The baseline water quality in the receiving water (the Gloreen Stream) was found to be unsatisfactory upstream of the WwTP discharge, but deteriorates downstream of the discharge.
- Orthophosphate, Total Phosphorous, Ammonia, Nitrates and BOD were found to be further elevated downstream of the WwTP discharge in the Gloreen Stream.
- The Gloreen Stream was found to be at its limit in terms of assimilation capacity upstream of the WwTP discharge, with water chemistry parameters exceeding statutory and guideline limits. There is therefore no assimilation capacity for additional inputs into the river from the WwTP, for many parameters.
- The biological water quality assessment of the Gloreen Stream, carried out by Ecofact as part of the current study, found that the macroinvertebrate communities upstream and downstream of the WwTP discharge on the Gloreen Stream were impoverished indicating moderate pollution in the river. Both sites achieved the same water quality rating of Q3, but the receptor site was under significantly greater ecological stress.
- The River Nore, of which the Gloreen Stream is a tributary, is designated as a Special Area of Conservation. Many of the key conservation interests of the site are aquatic fauna sensitive to a deterioration in water quality. Of particular note in this regard is the Nore Pearl Mussel which occurs downstream of the confluence of the Gloreen Stream.
- The proximity of the Gloreen Stream confluence to the populations of sensitive freshwater pearl-mussel in the River Nore must be taken into account. This species is considered endangered internationally and is threatened by continuing water quality decline in the River Nore.
- Overall, the current assessment has concluded that the WwTP outfall and associated discharges are having a significant negative impact on both water quality and aquatic ecology of the receiving waters and has the potential to significantly adversely affect the conservation status of protected aquatic fauna in both the Gloreen Stream and River Nore SAC.

6. RECOMMENDATIONS

The requirements of the Urban Wastewater Treatment Directive 91/271/EEC for treatment plants serving more than 2000 population equivalent must be met by the Abbeyleix WwTP. The exceedances recorded in the effluent discharge from both the old and new outlets must be addressed in order to meet the required statutory limits. Further statutory limits given in the Salmonid Regulations (1988) and guidelines provided by the EPA (2001 and 2006) should be complied with, taking account of the Water Policy Regulations (S.I. No. 722 of 2003) which transposed the Water Framework Directive (2000). The Water Policy Regulations provide for the protection of the status of all waters, preventing deterioration and the achievement of at least "good status" by 22 December 2015 for all waters.

The WwTP discharge was found to be outside the assimilative capacity of the receiving waters in terms of BOD. It was also found that there was limited Phosphorous assimilation capacity in the receiving waters, with Orthophosphate levels significantly exceeding statutory limits downstream of the WwTP discharge. Ammonia levels were also found to exceed statutory limits downstream of the discharge on the Gloreen Stream. Both Phosphate and Ammonia removal are recommended for the proposed upgrade of this sewerage scheme.

The Abbeyleix WwTP is currently operating with secondary treatment of wastewater; it is recommended that this be upgraded to tertiary treatment, given the low assimilation capacity and current adverse effects on the receiving waters of the Gloreen Stream. Tertiary treatment is recommended with particular reference to the sensitivity of the River Nore SAC (of which the Gloreen Stream is a tributary) located downstream of the WwTP.

Nicholas O'Dwyer (2002) noted that there was no storm water screening or detention tanks at Abbeyleix and wastewater flows in excess of 10.5 l/sec discharged without screening to the Gloreen Stream. It is recommended that sufficient storage be integrated into the Abbeyleix WwTP to reduce the quantity of storm water entering the Gloreen Stream, separation of surface water and wastewater from the storm water will allow for a reduction in the volumes of untreated wastewater entering the Gloreen Stream.

Further monitoring for dangerous substances from the WwTP discharge is recommended, as this study found that levels of Zinc were elevated on one of the two sampling occasions carried out be Laois County Council. Additional data is required to establish the baseline levels of these dangerous substances being discharged from the Abbeyleix WwTP before an assessment of the potential impacts can be made.

It is acknowledged that Laois County Council is currently advancing the plans for the new Abbeyleix Sewerage Scheme. This scheme is presently at the preliminary report stage with consultants short listed.

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PLATES

Plate 1 August 2008 sampling site (control) approximately 25 meters upstream of the Abbeyleix WwTP outfall on the Gloreen Stream.

Plate 2 Receptor site on the Gloreen Stream, immediately upstream of Gloreen Bridge.

Plate 3 The primary discharge into the Gloreen Stream from the Abbeyleix WwTP.

Plate 4 The Ballydire Stream joins the Gloreen Stream a short distance upstream of the primary discharge from the Abbeyleix WwTP. This stream was visibly polluted during the site visits.

Plate 5 Activated sludge pond at the Abbeyleix WwTP.

Plate 6 Rotating Biological Contactor (RBC) at the Abbeyleix WwTP.

APPENDIX 1 NPWS Designated site description

SITE NAME: RIVER BARROW AND RIVER NORE
SITE CODE: 002162

This site consists of the freshwater stretches of the Barrow/Nore River catchments as far upstream as the Slieve Bloom Mountains and it also includes the tidal elements and estuary as far downstream as Creadun Head in Waterford. The site passes through eight counties – Offaly, Kildare, Laois, Carlow, Kilkenny, Tipperary, Wexford and Waterford. Major towns along the edge of the site include Mountmellick, Portarlington, Monasterevin, Stradbally, Athy, Carlow, Leighlinbridge, Graiguenamanagh, New Ross, Inistioge, Thomastown, Callan, Bennettsbridge, Kilkenny and Durrow. The larger of the many tributaries include the Lerr, Fushoge, Mountain, Aughavaud, Owenass, Boherbaun and Stradbally Rivers of the Barrow and the Delour, Dinin, Erkina, Owveg, Munster, Arrigle and King's Rivers on the Nore. Both rivers rise in the Old Red Sandstone of the Slieve Bloom Mountains before passing through a band of Carboniferous shales and sandstones. The Nore, for a large part of its course, traverses limestone plains and then Old Red Sandstone for a short stretch below Thomastown. Before joining the Barrow it runs over intrusive rocks poor in silica. The upper reaches of the Barrow also runs through limestone. The middle reaches and many of the eastern tributaries, sourced in the Blackstairs Mountains, run through Leinster Granite. The southern end, like the Nore runs over intrusive rocks poor in silica. Waterford Harbour is a deep valley excavated by glacial floodwaters when the sea level was lower than today. The coast shelves quite rapidly along much of the shore.

The site is a candidate CSAC selected for alluvial wet woodlands and petrifying springs, priority habitats on Annex I of the E.U. Habitats Directive. The site is also selected as a candidate CSAC for old oak woodlands, floating river vegetation, estuary, tidal mudflats, *Salicornia* mudflats, Atlantic salt meadows, Mediterranean salt meadows, dry heath and eutrophic tall herbs, all habitats listed on Annex I of the E.U. Habitats Directive. The site is also selected for the following species listed on Annex II of the same directive – Sea Lamprey, River Lamprey, Brook Lamprey, Freshwater Pearl Mussel, Nore Freshwater Pearl Mussel, Crayfish, Twaite Shad, Atlantic Salmon, Otter, *Vertigo moulinsiana* and the plant Killarney Fern.

Good examples of Alluvial Forest are seen at Rathsnagadan, Murphy's of the River, in Abbeyleix estate and along other shorter stretches of both the tidal and freshwater elements of the site. Typical species seen include Almond Willow (*Salix triandra*), White Willow (*S. alba*), Grey Willow (*S. cinerea*), Crack Willow (*S. fragilis*), Osier (*S. viminalis*), with Iris (*Iris pseudacorus*), Hemlock Water-dropwort (*Oenanthe crocata*), Angelica (*Angelica sylvestris*), Thin-spiked Wood-sedge (*Carex strigosa*), Pendulous Sedge (*C. pendula*), Meadowsweet (*Filipendula ulmaria*), Valerian (*Valeriana officinalis*) and the Red Data Book species Nettle-leaved Bellflower (*Campanula trachelium*). Three rare invertebrates have been recorded in this habitat at Murphy's of the River. These are: *Neoascia obliqua* (Diptera: Syrphidae), *Tetanocera freyi* (Diptera: Sciomyzidae) and
Dictya umbrarum (Diptera: Sciomyzidae).

A good example of petrifying springs with tufa formations occurs at Dysart Wood along the Nore. This is a rare habitat in Ireland and one listed with priority status on Annex I of the EU Habitats Directive. These hard water springs are characterised by lime encrustations, often associated with small waterfalls. A rich bryophyte flora is typical of the habitat and two diagnostic species, *Cratoneuron commutatum* var. *commutatum* and *Eucladium verticillatum*, have been recorded.

The best examples of old Oak woodlands are seen in the ancient Park Hill woodland in the estate at Abbeyleix; at Kyleadohir, on the Delour, Forest Wood House, Kylecorragh and Brownstown Woods on the Nore; and at Cloghristic Wood, Drummond Wood and Borris Demesne on the Barrow, though other patches occur throughout the site. Abbeyleix Woods is a large tract of mixed deciduous woodland which is one of the only remaining true ancient woodlands in Ireland. Historical records show that Park Hill has been continuously wooded since the sixteenth century and has the most complete written record of any woodland in the

country. It supports a variety of woodland habitats and an exceptional diversity of species including 22 native trees, 44 bryophytes and 92 lichens. It also contains eight indicator species of ancient woodlands. Park Hill is also the site of two rare plants, Nettle-leaved Bellflower and the moss *Leucodon sciuroides.* It has a typical bird fauna including Jay, Long-eared Owl and Raven. A rare invertebrate, *Mitostoma chrysomelas,* occurs in Abbeyleix and only two other sites in the country. Two flies *Chrysogaster virescens* and *Hybomitra muhlfeldi* also occur. The rare Myxomycete fungus, *Licea minima* has been recorded from woodland at Abbeyleix.

Oak woodland covers parts of the valley side south of Woodstock and is well developed at Brownsford where the Nore takes several sharp bends. The steep valley side is covered by Oak (*Quercus* spp.), Holly (*Ilex aquifolium*), Hazel (*Corylus avellana*) and Birch (*Betula pubescens*) with some Beech (*Fagus sylvatica*) and Ash (*Fraxinus excelsior*). All the trees are regenerating through a cover of Bramble (*Rubus fruticosus* agg.), Foxglove (*Digitalis purpurea*) Wood Rush (*Luzula sylvatica*) and Broad Buckler-fern (*Dryopteris dilatata*).

On the steeply sloping banks of the River Nore about 5 km west of New Ross, in County Kilkenny, Kylecorragh Woods form a prominent feature in the landscape. This is an excellent example of a relatively undisturbed, relict Oak woodland with a very good tree canopy. The wood is quite damp and there is a rich and varied ground flora. At Brownstown a small, mature Oak-dominant woodland occurs on a steep slope. There is younger woodland to the north and east of it. Regeneration throughout is evident. The understorey is similar to the woods at Brownsford. The ground flora of this woodland is developed on acidic, brown earth type soil and comprises a thick carpet of Bilberry (*Vaccinium myrtillus*), Heather (*Calluna vulgaris*), Hard Fern (*Blechnum spicant*), Cowwheat (*Melampyrum* spp.) and Bracken (*Pteridium aquilinum*).

Borris Demesne contains a very good example of a semi-natural broad-leaved woodland in very good condition. There is quite a high degree of natural re-generation of Oak and Ash through the woodland. At the northern end of the estate Oak species predominate. Drummond Wood, also on the Barrow, consists of three blocks of deciduous woods situated on steep slopes above the river. The deciduous trees are mostly Oak species. The woods have a well established understorey of Holly (*Ilex aquifolium*), and the herb layer is varied, with Brambles abundant. Whitebeam (*Sorbus devoniensis*) has also been recorded.

Eutrophic tall herb vegetation occurs in association with the various areas of alluvial forest and elsewhere where the flood-plain of the river is intact. Characteristic species of the habitat include Meadowsweet (*Filipendula ulmaria*), Purple Loosestrife (*Lythrum salicaria*), Marsh Ragwort (*Senecio aquaticus*), Ground Ivy (*Glechoma hederacea*) and Hedge Bindweed (*Calystegia sepium*). Indian Balsam (*Impatiens glandulifera*), an introduced and invasive species, is abundant in places. Floating River Vegetation is well represented in the Barrow and in the many tributaries of the site. In the Barrow the species found include Water Starworts (*Callitriche* spp.), Canadian Pondweed (*Elodea canadensis*), Bulbous Rush (*Juncus bulbosus*), Milfoil (*Myriophyllum* spp.), *Potamogeton* x *nitens,* Broad-leaved Pondweed (*P. natans*), Fennel Pondweed (*P. pectinatus*), Perfoliated Pondweed (*P. perfoliatus*) and Crowfoots (*Ranunculus* spp.). The water quality of the Barrow has improved since the vegetation survey was carried out (EPA, 1996).

Dry Heath at the site occurs in pockets along the steep valley sides of the rivers especially in the Barrow Valley and along the Barrow tributaries where they occur in the foothills of the Blackstairs Mountains. The dry heath vegetation along the slopes of the river bank consists of Bracken (*Pteridium aquilinum*) and Gorse (*Ulex europaeus*) species with patches of acidic grassland vegetation. Additional typical species include Heath Bedstraw (*Galium saxatile*), Foxglove (*Digitalis purpurea*), Common Sorrel (*Rumex acetosa*) and Bent Grass (*Agrostis stolonifera*). On the steep slopes above New Ross the Red Data Book species Greater Broomrape (*Orobanche rapum-genistae*) has been recorded. Where rocky outcrops are shown on the maps Bilberry (*Vaccinium myrtillus*) and Wood Rush (*Luzula sylvatica*) are present. At Ballyhack a small area of dry heath is interspersed with patches of lowland dry grassland. These support a number of Clover species including the legally protected Clustered Clover (*Trifolium glomeratum*) – a species known from only one other site in Ireland.

This grassland community is especially well developed on the west side of the mud-capped walls by the road. On the east of the cliffs a group of rock-dwelling species occur, i.e. English Stonecrop (*Sedum anglicum*), Sheep's-bit (*Jasione montana*) and Wild Madder (*Rubia peregrina*). These rocks also support good lichen and moss assemblages with *Ramalina subfarinacea* and *Hedwigia ciliata*.

Dry Heath at the site generally grades into wet woodland or wet swamp vegetation lower down the slopes on the river bank. Close to the Blackstairs Mountains, in the foothills associated with the Aughnabrisky, Aughavaud and Mountain Rivers there are small patches of wet heath dominated by Purple Moor-grass (*Molinia caerulea*) with Heather (*Calluna vulgaris*), Tormentil (*Potentilla erecta*), Carnation Sedge (*Carex panicea*) and Bell Heather (*Erica cinerea*).

Saltmeadows occur at the southern section of the site in old meadows where the embankment has been breached, along the tidal stretches of in-flowing rivers below Stokestown House, in a narrow band on the channel side of Common Reed (*Phragmites*) beds and in narrow fragmented strips along the open shoreline. In the larger areas of salt meadow, notably at Carrickcloney, Ballinlaw Ferry and Rochestown on the west bank; Fisherstown, Alderton and Great Island to Dunbrody on the east bank, the Atlantic and Mediterranean sub types are generally intermixed. At the upper edge of the salt meadow in the narrow ecotonal areas bordering the grasslands where there is significant percolation of salt water, the legally protected species Borrer's Saltmarsh-grass (*Puccinellia fasciculata*) and Meadow Barley (*Hordeum secalinum*) (Flora Protection Order, 1987) are found. The very rare Divided Sedge (*Carex divisa*) is also found. Sea Rush (*Juncus maritimus*) is also present. Other plants recorded and associated with salt meadows include Sea Aster (*Aster tripolium*), Sea Thrift (*Armeria maritima*), Sea Couch (*Elymus pycnanthus*), Spear-leaved Orache (*Atriplex prostrata*), Lesser Sea-spurrey (*Spergularia marina*), Sea Arrowgrass (*Triglochin maritima*) and Sea Plantain (*Plantago maritima*).

Salicornia and other annuals colonising mud and sand are found in the creeks of the saltmarshes and at the seaward edges of them. The habitat also occurs in small amounts on some stretches of the shore free of stones.

The estuary and the other Habitats Directive Annex I habitats within it form a large component of the site. Extensive areas of intertidal flats, comprised of substrates ranging from fine, silty mud to coarse sand with pebbles/stones are present. Good quality intertidal sand and mudflats have developed on a linear shelf on the western side of Waterford Harbour, extending for over 6 km from north to south between Passage East and Creadaun Head, and in places are over 1 km wide. The sediments are mostly firm sands, though grade into muddy sands towards the upper shore. They have a typical macro-invertebrate fauna, characterised by polychaetes and bivalves. Common species include *Arenicola marina*, *Nephtys hombergii*, *Scoloplos armiger*, *Lanice conchilega* and *Cerastoderma edule*.

The western shore of the harbour is generally stony and backed by low cliffs of glacial drift. At Woodstown there is a sandy beach, now much influenced by recreation pressure and erosion. Behind it a lagoonal marsh has been impounded which runs westwards from Gaultiere Lodge along the course of a slow stream. An extensive reedbed occurs here. At the edges is a tall fen dominated by sedges (*Carex* spp.), Meadowsweet, Willowherb (*Epilobium* spp.) and rushes (*Juncus* spp.). Wet woodland also occurs. This area supports populations of typical waterbirds including Mallard, Snipe, Sedge Warbler and Water Rail.

The dunes which fringe the strand at Duncannon are dominated by Marram grass (*Ammophila arenaria*) towards the sea. Other species present include Wild Sage (*Salvia verbenaca*), a rare Red Data Book species. The rocks around Duncannon ford have a rich flora of seaweeds typical of a moderately exposed shore and the cliffs themselves support a number of coastal species on ledges, including Thrift (*Armeria maritima*), Rock Samphire (*Crithmum maritimum*) and Buck's-horn Plantain (*Plantago coronopus*).

Other habitats which occur throughout the site include wet grassland, marsh, reed swamp, improved grassland, arable land, quarries, coniferous plantations, deciduous woodland, scrub and ponds.

Seventeen Red Data Book plant species have been recorded within the site, most in the recent past. These are Killarney Fern (*Trichomanes speciosum*), Divided Sedge (*Carex divisa*), Clustered Clover (*Trifolium glomeratum*), Basil Thyme (*Acinos arvensis*), Hemp nettle (*Galeopsis angustifolia*), Borrer's Saltmarsh Grass (*Puccinellia fasiculata*), Meadow Barley (*Hordeum secalinum*), Opposite-leaved Pondweed (*Groenlandia densa*), Autumn Crocus (*Colchicum autumnale*), Wild Sage (*Salvia verbenaca*), Nettle-leaved Bellflower (*Campanula trachelium*), Saw-wort (*Serratula tinctoria*), Bird Cherry (*Prunus padus*), Blue Fleabane (*Erigeron acer*), Fly Orchid (*Ophrys insectifera*), Broomrape (*Orobanche hederae*) and Greater Broomrape (*Orobanche rapum-genistae*). Of these the first nine are protected under the Flora Protection Order 1999. Divided Sedge (*Carex divisa*) was thought to be extinct but has been found in a few locations in the site since 1990. In addition plants which do not have a very wide distribution in the country are found in the site including Thin-spiked Wood-sedge (*Carex strigosa*), Field Garlic (*Allium oleraceum*) and Summer Snowflake (*Leucojum aestivum*). Six rare lichens, indicators of ancient woodland, are found including *Lobaria laetevirens* and *L. pulmonaria.* The rare moss *Leucodon sciuroides* also occurs.

The site is very important for the presence of a number of EU Habitats Directive Annex II animal species including Freshwater Pearl Mussel (*Margaritifera margaritifera* and *M. m. durrovensis*), Freshwater Crayfish (*Austropotamobius pallipes*), Salmon (*Salmo salar*), Twaite Shad (*Alosa fallax fallax*), three Lamprey species - Sea (*Petromyzon marinus*), Brook (*Lampetra planeri*) and River (*Lampetra fluviatilis*), the marsh snail *Vertigo moulinsiana* and Otter (*Lutra lutra*). This is the only site in the world for the hard water form of the Pearl Mussel *M. m. durrovensis* and one of only a handful of spawning grounds in the country for Twaite Shad. The freshwater stretches of the River Nore main channel is a designated salmonid river. The Barrow/Nore is mainly a grilse fishery though spring salmon fishing is good in the vicinity of Thomastown and Inistioge on the Nore. The upper stretches of the Barrow and Nore, particularly the Owenass River, are very important for spawning.

The site supports many other important animal species. Those which are listed in the Irish Red Data Book include Daubenton's Bat (*Myotis daubentoni*), Badger (*Meles meles*), Irish Hare (*Lepus timidus hibernicus*) and Frog (*Rana temporaria*). The rare Red Data Book fish species Smelt (*Osmerus eperlanus*) occurs in estuarine stretches of the site. In addition to the Freshwater Pearl Mussel, the site also supports two other freshwater Mussel species, *Anodonta anatina* and *A. cygnea*.

The site is of ornithological importance for a number of E.U. Birds Directive Annex I species including Greenland White-fronted Goose, Whooper Swan, Bewick's Swan, Bartailed Godwit, Peregrine and Kingfisher. Nationally important numbers of Golden Plover and Bar-tailed Godwit are found during the winter. Wintering flocks of migratory birds are seen in Shanahoe Marsh and the Curragh and Goul Marsh, both in Co. Laois and also along the Barrow Estuary in Waterford Harbour. There is also an extensive autumnal roosting site in the reedbeds of the Barrow Estuary used by Swallows before they leave the country.

Landuse at the site consists mainly of agricultural activities – many intensive, principally grazing and silage production. Slurry is spread over much of this area. Arable crops are also grown. The spreading of slurry and fertiliser poses a threat to the water quality of the salmonid river and to the populations of Habitats Directive Annex II animal species within the site. Many of the woodlands along the rivers belong to old estates and support many non-native species. Little active woodland management occurs.
Fishing is a main tourist attraction along stretches of the main rivers and their tributaries and there are a number of Angler Associations, some with a number of beats. Fishing stands and styles have been erected in places. Both commercial and leisure fishing takes place on the rivers. There is net fishing in the estuary and a mussel bed also. Other recreational activities such as boating, golfing and walking, particularly along the Barrow towpath are also popular. There is a golf course on the banks of the Nore at Mount Juliet and GAA pitches on the banks at Inistioge and Thomastown. There are active and disused sand and gravel pits throughout

the site. Several industrial developments, which discharge into the river, border the site. New Ross is an important shipping port. Shipping to and from Waterford and Belview ports also passes through the estuary.

The main threats to the site and current damaging activities include high inputs of nutrients into the river system from agricultural run-off and several sewage plants, overgrazing within the woodland areas, and invasion by non-native species, for example Cherry Laurel and Rhododendron (*Rhododendron ponticum*). The water quality of the site remains vulnerable. Good quality water is necessary to maintain the populations of the Annex II animal species listed above. Good quality is dependent on controlling fertilisation of the grasslands, particularly along the Nore. It also requires that sewage be properly treated before discharge. Drainage activities in the catchment can lead to flash floods which can damage the many Annex II species present. Capital and maintenance dredging within the lower reaches of the system pose a threat to migrating fish species such as lamprey and shad. Land reclamation also poses a threat to the salt meadows and the populations of legally protected species therein.

Overall, the site is of considerable conservation significance for the occurrence of good examples of habitats and of populations of plant and animal species that are listed on Annexes I and II of the E.U. Habitats Directive respectively. Furthermore it is of high conservation value for the populations of bird species that use it. The occurrence of several Red Data Book plant species including three rare plants in the salt meadows and the population of the hard water form of the Pearl Mussel which is limited to a 10 km stretch of the Nore, add further interest to this site.

APPENDIX 2 Quality of WwTP effluent streams

Table A2.1 Summary water quality results for the two treated effluent streams from the Abbeyleix WwTP during the period February 2007 to March 2008. Derived from data supplied by Laois County Council.

Ammonia

	N	Mean	Minimum	Maximum	St. Dev.	Variance	95% C.I.
New Outlet	13	19.04	4.90	32.25	7.82	61.21	4.25
Old outlet	19	2.99	0.02	12.20	3.62	13.14	1.63

BOD

	N	Mean	Minimum	Maximum	St. Dev.	Variance	95% C.I.
New Outlet	11	**36.18**	10.00	**105.00**	29.80	887.76	17.61
Old outlet	17	22.18	5.00	**74.00**	18.95	359.03	9.01

COD

	N	Mean	Minimum	Maximum	St. Dev.	Variance	95% C.I.
New Outlet	13	**147.08**	68.00	**402.00**	111.57	12447.91	60.65
Old outlet	19	118.68	26.00	**420.00**	107.04	11458.56	48.13

Conductivity

	N	Mean	Minimum	Maximum	St. Dev.	Variance	95% C.I.
New Outlet	13	1396.00	776.00	1817.00	272.81	74424.67	148.30
Old outlet	19	1352.00	728.00	1760.00	273.29	74689.11	122.89

Hardness

	N	Mean	Minimum	Maximum	St. Dev.	Variance	95% C.I.
New Outlet	0						
Old outlet	2	371.69	341.90	401.48			

Nitrates

	N	Mean	Minimum	Maximum	St. Dev.	Variance	95% C.I.
New Outlet	13	1.72	0.02	7.02	2.18	4.76	1.19
Old outlet	19	13.71	0.54	35.02	8.99	80.88	4.04

Orthophosphate - 2007 and 2008 available data

	N	Mean	Minimum	Maximum	St. Dev.	Variance	95% C.I.
New Outlet	13	2.07	0.32	3.43	0.90	0.82	0.49
Old outlet	18	2.58	1.30	4.74	1.04	1.08	0.48

pH

	N	Mean	Minimum	Maximum	St. Dev.	Variance	95% C.I.
New Outlet	13	8.06	7.52	8.53	0.23	0.06	0.13
Old outlet	19	7.95	7.66	8.32	0.19	0.04	0.09

Suspended solids

	N	Mean	Minimum	Maximum	St. Dev.	Variance	95% C.I.
New Outlet	12	**87.42**	19.00	**288.00**	84.86	7201.36	48.01
Old outlet	19	**92.53**	13.00	**384.00**	94.12	8859.37	42.32

Nitrites

	N	Mean	Minimum	Maximum	St. Dev.	Variance	95% C.I.
New Outlet	0						
downstream of plant	2	0.0515	0.043	0.06			

APPENDIX 3 Laois County Council river water quality monitoring results

Table A3.1 Summary water quality results for the Gloreen Stream upstream and downstream of the outfall of the Abbeyleix WwTP during the period February 2007 to March 2008. Derived from data supplied by Laois County Council. Parameters considered to be elevated are shown in bold (based on criteria given in EPA, 2001).

Ammonia* (mg/l)

	N	Mean	Minimum	Maximum	St. Dev.	Variance	95% C.I.
Upstream of plant	17	0.17	0.02	**1.53**	0.36	0.13	0.17
Downstream of plant	17	**0.37**	0.09	**0.94**	0.27	0.07	0.13

BOD (mg/l)

	N	Mean	Minimum	Maximum	St. Dev.	Variance	95% C.I.
Upstream of plant	16	1.44	1.00	2.00	0.51	0.26	0.25
Downstream of plant	16	2.44	1.00	4.00	1.03	1.06	0.51

Conductivity (µs cm-1)

	N	Mean	Minimum	Maximum	St. Dev.	Variance	95% C.I.
Upstream of plant	17	658.82	413.00	728.00	83.29	6937.90	39.59
Downstream of plant	17	683.18	429.00	766.00	88.06	7754.03	41.86

Dissolved oxygen (mg/l)

	N	Mean	Minimum	Maximum	St. Dev.	Variance	95% C.I.
Upstream of plant	17	9.29	**5.63**	12.44	1.70	2.90	0.81
Downstream of plant	17	8.93	**4.47**	11.71	1.91	3.66	0.91

Nitrates (mg/l)

	N	Mean	Minimum	Maximum	St. Dev.	Variance	95% C.I.
Upstream of plant	17	**4.30**	**1.11**	**6.57**	1.46	2.14	0.70
Downstream of plant	17	**4.39**	**1.16**	**6.17**	1.35	1.82	0.64

Orthophosphate (mg/l)

	N	Mean	Minimum	Maximum	St. Dev.	Variance	95% C.I.
Upstream of plant	17	**0.06**	0.02	**0.22**	0.05	0.00	0.03
Downstream of plant	17	**0.13**	**0.05**	**0.35**	0.08	0.01	0.04

pH (pH units)

	N	Mean	Minimum	Maximum	St. Dev.	Variance	95% C.I.
Upstream of plant	17	8.07	7.70	8.35	0.19	0.04	0.09
Downstream of plant	17	8.02	7.74	8.20	0.12	0.01	0.06

Suspended solids (mg/l)

	N	Mean	Minimum	Maximum	St. Dev.	Variance	95% C.I.
Upstream of plant	2	8.00	3.00	13.00			
Downstream of plant	2	16.50	7.00	**26.00**			

Total Phosphorous (mg/l)

	N	Mean	Minimum	Maximum	St. Dev.	Variance	95% C.I.
Upstream of plant	2	**0.09**	**0.08**	**0.10**			
Downstream of plant	2	**0.21**	**0.12**	**0.30**			

Total Nitrogen (mg/l)

	N	Mean	Minimum	Maximum	St. Dev.	Variance	95% C.I.
Upstream of plant	2	5.80	5.50	6.10			
Downstream of plant	2	6.50	5.40	7.60			

COD (mg/l)

	N	Mean	Minimum	Maximum	St. Dev.	Variance	95% C.I.
Upstream of plant	1	10.00	10.00	10.00			
Downstream of plant	2	8.50	5.00	12.00			

Hardness (mg/l)

	N	Mean	Minimum	Maximum	St. Dev.	Variance	95% C.I.
Upstream of plant	2	357.70	347.31	368.08			
Downstream of plant	2	376.94	368.74	385.14			

Nitrites (mg/l)

	N	Mean	Minimum	Maximum	St. Dev.	Variance	95% C.I.
Upstream of plant	2	**0.663**	**0.304**	**1.022**			
Downstream of plant	2	**0.034**	**0.031**	**0.037**			

**Species not specified in data supplied. Assessed as 'Total Ammonia'.*

APPENDIX 4 Biological water quality assessment (2008)

Table A4.1 Macroinvertebrates recorded during the kick sampling survey on the Gloreen Stream at sites located upstream (Tullyroe) and downstream (Gloreen Bridge) of the outfall from the Abbeyleix WwTP. Samples were taken on the 4th August 2008.

Group/organism	Pollution sensitivity group	Functional group	Relative abundance at site	
			Gloreen Bridge (receptor)	Tullyroe (control)
MAYFLIES (Uniramia, Ephemeroptera)				
Spiny crawler mayflies (Ephemerellidae)				
Blue-winged olive *Ephemerella ignita*	C	Gathering collector	7	13
Baetidae				
Large dark olive *Baetis rhodani*	C	Scraper & gathering collector	12	30
Iron blue dun *Baetis muticus*	B	Scraper & gathering collector	2	
STONEFLIES (Plecoptera)				
Needleflies (Leutridae)				
Leutra fusca	B	Shredder		2
CASED CADDIS FLIES (Tricoptera)				
Northern caddisflies (Limnephilidae)				
Potamophylax sp.	B	Shredder	11	1
Family Goeridae				
Indeterminate sp.	B	Scraper		1
CASELESS CADDIS FLIES (Trichoptera)				
Green sedges (Rhyacophilidae)				
The sandfly *Rhyacophila dorsalis*	C	Predator	3	7
TRUE FLIES (Diptera)				
Blackfly (Simulidae)	C	Filtering collector	10	27
Craneflies (Tipulidae)	C	Shredder		
Dicronata sp.	C	Shredder	2	
Family Chironomidae				
Green chironomid	C	Filtering collector		4
BEETLES (Coleoptera)				
Crawling water beetles (Haliplidae)				
Brychius elevatus	C	Predator/grazer		1
Riffle Beetle (Elmidae)				
Helmis sp. (larvae)	C	Predator		4
Elmis aenea (adult)	C	Predator		2
SNAILS (Mollusca, Gastropoda)				
Family Ancylidae				
River limpet *Ancylus fluviatilis*	C	Grazer		5
SEGMENTED WORMS (Annelida, Clitellata)				
Aquatic earthworm (Lumbricidae)	D	Collector		2
LEECHES (Hirudinae)				
Erpobdellidae				
Erpobdella octoculata	D	Predator	8	
CRUSTACEANS (Crustacea)				
Amphipods (Amphipoda, Gammaridae)				
Freshwater shrimp *Gammarus deubeni*	C	Shredder	200	85
Isopods, Asellidae				
Hog louse *Asellus aquaticus*	D	Shredder	2	

Group/organism	Pollution sensitivity group	Functional group	Relative abundance at site	
			Gloreen Bridge (receptor)	Tullyroe (control)
ROUNDWORMS (Nematoda)	D	Collector	2	1
Total number of organisms			259	185
Number of families			10	14
Q value			3	3
Quality class			C	C
BMWP score			48.9	82.3
ASPT			5.43	6.33

Table A4.2 Selected chemical characteristics of the two sites surveyed on the River Gloreen on the 4th August 2008.

	Gloreen Bridge (receptor)	Tullyroe (control)
Temperature (°C)	15.8	15.7
Dissolved Oxygen (%)	90.8	91.7
Dissolved Oxygen (mg O2l-1)	9.00	9.12
Conductivity (µS cm-1)	670	663

Table A4.3 Selected physical characteristics of the two sites surveyed on the River Gloreen on the 4th August 2008.

	Gloreen Bridge (receptor)	Tullyroe (control)
Wetted width (m)	5.5	5
Mean depth (cm)	20	15
Maximum depth (cm)	40	30
Rock (%)	5	15
Cobble (%)	10	40
Gravel (%)	35	30
Fine (%)	50	15
Shade (%)	30	35
Instream vegetation (%)	15	10
Bank height (m)	0.6	0.7
Bank slope (°)	75	90
Bank cover (%)	90	80
Evaluation	Riffle habitat surveyed, suitable site for Q rating assessment, moderately silted, filamentous algae present.	Riffle habitat surveyed, ideal site for Q rating assessment.

APPENDIX 5 Dangerous substances

Table A5.1 Dangerous substances results from Laois County Council monitoring data.

	U/s Abbeyleix WwTP		Abbeyleix WwTP combined outlet		D/s Abbeyleix WwTP			Dangerous substances standards (µg/l) for freshwater		Dangerous substances standards (µg/l) for all freshwater	Freshwater Fish Dir. (78/659/EEC) limit	Salmonid Water Reg. (1998) limit	Compliance
Grid ref	243193 185608		242664 185108		242074 185170								
Sample date	24/04/08	08/05/08	24/04/08	08/05/08	24/04/08	08/05/08	11/10/06	$CaCO_3$ mg/l					
								<100	>100				
Arsenic (µg/l)	0.2	0.4	<2	<2	0.2	0.4	1.033	25	25	-	N/A	N/A	✓
Atrazine (µg/l)	<0.01	<0.01	<0.01	<0.025	<0.01	<0.01	-	-	-	1	N/A	N/A	✓
Barium(µg/l)	191.3	202.9	80.8	92.4	188.1	194.6	-	-	-	N/A	N/A	N/A	✓
Boron (µg/l)	0.03	0.03	0.21	<0.2	0.03	0.03	-	-	-	2000	N/A	N/A	✓
Cadium (µg/l)	<0.1	<0.1	<1	<1	<0.1	<0.1	-	-	-	5	N/A	N/A	✓
Chromium (µg/l)	<1	<1.0	<10	<10	<1	<1.0	1.416	5	30	-	N/A	N/A	✓
Copper (µg/l)	3.4	<3.0	<30	<30	<3	<3.0	5	5	30	-	< 0.04 mg/l Cu	water hardness <0.005–0.112 mg/l Cu	✓
Cyanide (µg/l)	<5	<5	<5	<5	<5	<5.0	-	10	10	-	N/A	N/A	✓
Dichloromethane (µg/l)	<5	<5	<5	<5	<5	<5.0	-	-	-	10	N/A	N/A	✓
Fluoride (µg/l)	<0.1	<0.1	0.2	0.2	0.1	<0.1	29	500	500	-	N/A	N/A	✓
Lead (µg/l)	0.4	<0.3	<3	4.3	0.5	0.3	2.125	5	10	-	N/A	N/A	✓
Mercury (µg/l)	0.02	<0.02	<0.2	<0.2	<0.02	<0.02	-	-		N/A	N/A	N/A	✓
Nickel (µg/l)	1.9	1.5	<5	<5	1.3	1.6	3.216	8	50	-	N/A	N/A	✓
Oxylene (µg/l)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	10.0	N/A	N/A	✓
p,m xylene (µg/l)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	10.0	N/A	N/A	✓
Selenium (µg/l)	0.5		<2	4.3	0.3	0.6	-	-	-	N/A	N/A	N/A	✓
Simazine (µg /l)	<0.01		<0.01	<0.025	<0.01	<0.01	-	-	-	1	N/A	N/A	✓
Toluene (µg /l)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	10.0	N/A	N/A	✓
Tributyl Tin (µg/l)	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	-	-	-	0.001 (applies to tidal rivers)	N/A	N/A	✓
Xylenes (µg /l)	-	-	-	-	-	-	-	-	-	10.0	N/A	N/A	✓
Zinc (µg /l)	29.9	0.8	76.3	**113.1**	6.6	7.4	14.73	See note[1]	100	-	N/A	water hardness <0.03-0.5 mg/l Zn	Not compliant at combined outfall.

Note[1] In the case of zinc, the standard is 8µg/l for water hardness less than or equal to 10mg/l $CaCO_3$, or 50µg/l for water hardness >10mg/l & ≤100mg/l $CaCO_3$.