

7.3 Aquatic Ecology and Water Quality

7.3.1 Introduction

This section of the EIS is concerned with the aquatic ecology and water quality of the watercourses impacted by the scheme.

The proposed N9 Kilcullen to Powerstown Scheme passes through the catchments of the River Liffey and the River Barrow. While the scheme does not include the River Barrow itself, the proposed route crosses three important tributaries of the River Barrow, and therefore the River Barrow is the ultimate receiving water. As road drainage from the proposed scheme would discharge to watercourses that are tributaries of these major rivers, the impact of these discharges on the water quality and the aquatic ecology requires consideration.

This study provides an assessment of the likely impacts of the proposed N9 Kilcullen to Powerstown Scheme on the aquatic ecology and water quality of existing watercourses between Kilcullen and Powerstown. It is carried out in compliance with the European Communities (Environmental Impact Assessment) Regulations, 1989-2000 and follows the Environmental Protection Agency's *Guidelines on the information to be contained in Environmental Impact Statements* (EPA, 2002).

7.3.2 Methodology

Field Survey

Field surveys were carried out in August / September 2002 to identify, describe, map and evaluate habitats, and to verify the information gathered at the desk study stage. The field survey included an assessment of the aquatic and riparian habitats at the crossing points of watercourses. In February and April 2003, a walkover survey was carried out on any areas of the alignment that had not been surveyed during the earlier field survey.

Consultations

The fisheries value of the main watercourses along the route was determined through consultation with the Eastern and Southern Regional Fisheries Boards (ERFB / SRFB). Dúchas, The Heritage Service and the ERFB / SRFB were consulted to seek their views on various aspects of the scheme including the impacts on fisheries and the proposed mitigation measures.

Water Quality Sampling

The quality of water in rivers and streams is one of the main indicators of whether the watercourse is a potentially suitable habitat for aquatic species. A number of water samples were collected from the above rivers and from some of their feeder streams in August / September 2002. The sampling locations are marked on Figures 7.10 to 7.18 (Volume 2). Sampling took place during a dry period when water depths and flow velocities were low.

Assessment of Existing Water Quality

Biological and physiochemical analysis was undertaken for all of the main watercourses crossed by the route. The biological analysis of water quality of the main watercourses crossed by the scheme was assessed using the EPA's standard biological assessment technique (McGarrigle *et al.*, 2002). Sampling was

carried out in suitable locations in the vicinity of the proposed crossing points in October 2002. Macro-invertebrates were collected in a 2 millimetre mesh hand-net by kick sampling in a suitable gravel-stone substrate for 2 minutes.

The identification of invertebrates and evaluation of water quality were undertaken using the five-point 'Q value' system, summarised in Table 7.3.1.

Table 7.3.1 The Biological River Quality Classification System (Q value) (after Lucey et al., 1999)

Q Value	Community Diversity	Water Quality	Condition	Quality Status
Q5	High	Good	Satisfactory	Unpolluted
Q4	Reduced	Fair	Satisfactory	Unpolluted
Q3	Much reduced	Doubtful	Unsatisfactory	Moderately polluted
Q2	Low	Poor	Unsatisfactory	Seriously polluted
Q1	Very low	Bad	Unsatisfactory	Seriously polluted

Evaluation and Impact Assessment Criteria

Aquatic sites were evaluated and given an overall significance rating on the basis of the criteria outlined in 7.3 Appendix I. The impact levels of aquatic sites were rated as outlined in 7.3 Appendix II.

7.3.3 The Receiving Environment

General

The watercourses crossed by the proposed route in the northern 4 kilometres of the scheme, including the Kilcullen Stream lie within the catchment of the River Liffey. Thereafter, the proposed route intersects three tributaries of the Barrow, namely the River Greese, the River Lerr and the Burren River, as well as their tributaries. Most of the land has been heavily modified by human activity and the predominant land use is agriculture.

The principal watercourses are described below, and summarised in Tables 7.3.3, 7.3.4, 7.3.5 and 7.3.6.

Designated Conservation Areas

Designated conservation areas are areas containing habitats or species of national or international conservation importance. Five designated areas occur within 3 kilometres of the proposed route. These sites, identified and designated by Dúchas, are considered to be of national and / or international importance for nature conservation. Table 7.2.1 in Section 7.2 lists the designated conservation areas that fall within 3 kilometres of the scheme.

The River Lerr and an associated area of land on each side of the river, which has been designated a proposed candidate Special Area of Conservation (pcSAC) in 2003, is crossed by the scheme. While the River Barrow, which has also been designated a proposed candidate Special Area of Conservation (pcSAC), is outside the study area for this scheme, the proximity of the end of the scheme at Junction 5 to the River Barrow and the potential impacts of the scheme on the first order tributaries to the River Barrow warrant that the river is included in the assessment. The River Barrow would also be crossed by any extension of the proposed road.

Aquatic Environment

The main watercourses that are impacted by the route are described and evaluated on the basis of aquatic and riparian habitats, fisheries value and water quality. The presence of Annex II freshwater species is also considered. The proposed route will cross 15 main watercourses and numerous smaller streams and drainage ditches. While the smaller streams and ditches were not surveyed in detail, observations were made during the field survey of all crossings. There is very little documentary evidence for these tributaries and no specific surveys were undertaken due to seasonal constraints.

Although this section of the scheme does not include the River Barrow itself, the proposed route crosses 3 important tributaries of the River Barrow, within Hydrometric Area 15, and therefore the River Barrow is the ultimate receiving water. The Kilcullen Stream, a first order tributary of the Liffey (Hydrometric Area 9), is also impacted by the scheme.

The River Barrow rises in the Slieve Bloom Mountains in Co. Laois and flows north and then east through the Bog of Allen towards Portarlinton. At Monasterevin, it turns south to flow through the counties of Kildare, Carlow and Kilkenny. Most of the catchment is on limestone (O'Reilly 2002). Shallow glides are the predominant feature. The River Barrow is closest to the proposed scheme at Powerstown where it is approximately 750 metres west of the scheme end.

The River Greese is a lowland river, which rises in Dunlavin and joins the River Barrow 2km south of Maganey. It is a fast-flowing limestone river with some deeper, slow stretches. The River Lerr is a small clear stream that rises in the hills to the east of Castledermot and joins the River Barrow approximately 4 kilometres north of Carlow town. The River Burren rises near Myshall in Co. Carlow and flows in a semi-circle to join the River Barrow in Carlow Town (O'Reilly 2002).

Water Quality

The quality of water in rivers and streams is one of the main indicators of whether the watercourse is a potentially suitable habitat for aquatic species. The water quality of all the main watercourses crossed by the proposed route resulted in a Q value of 3 (see Table 7.3.2 for water sample locations). This suggests doubtful water quality, which infers moderate pollution. This was taken into consideration when evaluating the aquatic ecological value of all watercourses.

Table 7.3.2 Water Quality Sampling Locations and Classification

Biological / Chemical Water Sample No.	Chainage / Townland	Name	Catchment	Water Quality
Section A				
AR1	Ch. 76,500-75,000 Yellowbog-common	Kilcullen Stream	River Liffey	Q3
AR2	Ch. 74,000 Baronsland	Third order tributary of the Finnerly River	River Barrow	Q3
AR3	Ch. 67,300 Coolavash	First order tributary of the River Greese	River Barrow	Q3

Table 7.3.2 Water Quality Sampling Locations and Classification (contd.)

Biological / Chemical Water Sample No.	Chainage / Townland	Name	Catchment	Water Quality
Section B				
BR1	Ch. 58,090 Ballynamony	River Greese	River Barrow	Q3
BR2	Ch. 57,700 Ballynamony	First order tributary of the River Greese	River Barrow	Q3
BR3	Ch. 51,625 Woodlands West	River Lerr pcSAC, first order tributary of the River Barrow	River Barrow	Q3
Section C				
CR1	Ch. 47,600 Deerpark	Palatine stream, first order tributary of the River Lerr	River Barrow	Q3
CR2	Ch. 45,600 Russelstown	First order tributary of Palatine stream which is first order tributary of the River Lerr	River Barrow	Not suitable for biological sampling
CR3	Ch. 41,000 Ballycrogue	Burren River first order tributary of the Barrow	River Barrow	Not suitable for biological sampling
CR4	Ch. 38,370 Rathcrogue	First order tributary of the Burren River	River Barrow	Q3
CR5	Ch. 33,500 Powerstown	First order tributary of the Burren River	River Barrow	Q3
Section D				
DR1	Ch. 5,165 Turnerstown	First order tributary of the Athy River	River Barrow	Not suitable for biological sampling
DR2	Ch. 7,485 Burtown Little	Burtown Stream, first order tributary of the Greese River	River Barrow	Not suitable for biological sampling
DR3	Ch. 12,410 Ballinadeen	First order tributary of the Greese River	River Barrow	Q3
DR4	Ch. 13,240 Ballinadeen	Greese River first order tributary of the Barrow	River Barrow	Not suitable for biological sampling

The biological and physiochemical analyses, providing baseline data for all of the main watercourses crossed by the route, are listed in 7.3 Appendices III and IV.

The physiochemical analysis provides baseline data for the fifteen watercourse crossings along the route. The samples taken were tested using twenty-one different parameters of water quality, as listed in 7.3 Appendix IV. The results were compared with the threshold levels of relevant EC directives (as listed in 7.3 Appendix IV) for each substance analysed.

The results indicate that all the watercourses are marginally alkaline (pH 7.25 to 7.90). Samples BR3, CR1 and DR4 have a BOD of 4mg/l, which is slightly

elevated (Freshwater fish directive 76/659/EEC recommends 3mg/l for Salmonids). All COD levels are within acceptable limits as defined by Surface Water regulations. All samples have elevated levels of Total Oxidised Nitrogen ranging from 3.1-13.8 mg/l. The recommended threshold of the Drinking Water Regulations is 1.0 mg/l. The Nitrite levels of nine of the fifteen watercourses are elevated above the threshold of the Drinking Water regulations while 14 are elevated above the threshold level for Salmonid Waters. Sample CR1 has slightly elevated levels of Nitrate, 6 samples have elevated levels of zinc, 2 samples have elevated levels of iron with AR1 in particular being three times the threshold for drinking water. Four samples have slightly elevated levels of copper, which is higher than the threshold recommended for Salmonid waters.

Riparian and Aquatic Habitats

Many of the rivers and streams have a poor diversity of riparian habitat, due to intensive tillage farming in the area. The substrate of the watercourses is quite variable including sands, gravels and cobbles – suitable for salmonid spawning grounds. Some of the watercourse channels have been modified to facilitate drainage, and this has generally had a damaging effect on the riverbank and substrate habitats.

Fisheries

The entire Barrow River system is a very important salmonid habitat. It has been developed as a navigable waterway from Athy downstream to St. Mullins and the locks and weirs have greatly altered the character of the river, making it more suitable for coarse fish and pike than for trout and salmon. At present it is a fair to good salmon and trout river (O'Reilly 2002).

Protected Aquatic Fauna (Annex II species)

The River Barrow is a designated pcSAC. The designation is based on the presence of salmon (an Annex II species) and applies to the main channel and some of its tributaries. The River Lerr, which is to be crossed by this scheme, is also a pcSAC. Observations of the channel substrate of all watercourses impacted by the route with regard to its suitability for Annex II species was noted as well as any signs of Annex II species listed under the EU Habitats Directive as part of this study. The following species were considered in particular:

The Irish freshwater pearl mussel (*Margaritifera durrovensis*) is an endemic species that is protected under the Convention on the Conservation of European Wildlife and Natural Habitats (Berne Convention) and it is also listed under Annex II and Annex V of the European Union Directive on the Conservation of Natural and Semi natural Habitats and of wild Fauna and Flora (Habitats Directive). It is known to occur in the River Barrow (Moorkens, 1999). There are no documented records of pearl mussel in the tributaries of the River Barrow, which are intersected by this route. No signs of mussel presence were observed during the walk-over survey.

Sea lamprey (*Petromyzon marinus*), **brook lamprey** (*Lampetra planeri*) and **river lamprey** (*L. fluviatilis*) spawn in the main channel of the River Barrow downstream of Borris (Kurz & Costello 1999). The proposed route is not impacting this stretch of the River Barrow. Unspecified lampreys were found in the upper reaches of the Barrow and in the Palatine Stream. Unspecified ammocetes were found in the Barrow, in the upstream reaches of the River Greese and downstream of the Burren River (Lucey, in prep.). No signs of lamprey presence were observed during the walk-over survey.

White-clawed crayfish (*Austropotamobius pallipes*) is generally considered to be widespread in lowland lakes and rivers such as the River Barrow, as it is underlain by Carboniferous limestone, or its derivative - glacial drift (Reynolds, 1998). No signs of crayfish presence were observed during the walk-over survey.

The Atlantic Salmon (*Salmo salar*) is also an Annex II species and occurs throughout the Barrow catchment. The lower reaches of the River Barrow are designated as an SAC and a decision to extend this designation further upstream is awaited. The Lerr also contains important salmonid populations and awaits SAC designation as a consequence.

The otter is a legally protected species under the EU Habitats Directive (listed in Annex II) and is found throughout Ireland (Hayden and Harrington, 2000). Otters tend to occupy linear territories along watercourses and are rarely found far away from water. Although no signs of otter were recorded, all of the main watercourses surveyed have suitable habitat for otters. Many of the minor watercourses will also provide suitable habitat for otters.

Site / Habitat Evaluation

The watercourses along the proposed route are evaluated for each of sections A to D in Tables 7.3.3, 7.3.4, 7.3.5 and 7.3.6. Of the 15 watercourse crossings impacted by the route, one is of internationally important ecological value, 3 are of nationally important ecological value, 2 are of high local ecological value and the other 9 watercourses are of moderate local ecological value.

Section A Kilcullen to Mullamast Ch. 78,500 – Ch. 62,000

There are 3 main crossings of watercourses along this section of the route. The Kilcullen River is of high local ecological value as it has significant populations of breeding salmonids as well as suitable habitat for some Annex II species. The remaining smaller tributary streams are of moderate local ecological value because they contain occasional suitable spawning habitat for salmonids. See Table 7.3.3 for a summary evaluation of the main watercourses in Section A.

Table 7.3.3 Section A – Watercourse Description and Evaluation

Name; Chainage (Ch.); Townland; Sample No.	Aquatic Habitat and Evaluation		Riparian Habitat and Evaluation		Fisheries Value and Evaluation		Presence Of Annex Species		Overall Evaluation*
River Liffey System									
Kilcullen Stream Ch. 76,500 – Ch. 75,000 Halverstown Yellowbogcommon AR1	Channel width =2.5m; Depth = 40-60cm. Uniform slow flowing stream with stony and gravel substrate. Fool's watercress (<i>Apium nodiflorum</i>) dominates periodically.	D	Reed canary-grass (<i>Phalaris arundinacea</i>) and ruderal species grading into improved grassland. Further upstream, a mature hawthorn hedgerow and treeline of alder on eastern bank. Overall low species diversity on both banks.	D	Contains salmonids and brown trout	C	Salmon	C	C
River Barrow System									
3 rd order trib. of Finnerly River Ch. 74,000 Baronsland AR2	Channel width = 1m, Depth = 5-10cm. Slow flow with medium turbidity. Mud/silt substrate in places, some sand and gravel at sampling point. Fool's watercress, duckweed (<i>Lemna</i> sp.) and brooklime (<i>Veronica beccabunga</i>) are the predominant aquatic vegetation.	D	Ruderal species grading into improved grassland. Hedgerow of hawthorn on east bank.	D	Unknown	-	Unknown	-	D
1 st order trib. of the River Greese Ch. 67,300 Narraghmore AR3	Channel width = 2m, Depth = 10-20cm. Moderate flow, with some riffle and glide. Substrate of cobble, gravels, and sand. Fool's watercress and brooklime occur sporadically.	D	Ruderal species grading into improved grassland on east bank with young sycamore saplings on ditch with an abundance of ruderal species between the ditch and the western bank.	E	Suitable habitat for trout.	D	Unknown		D

* See 7.3 Appendix II for evaluation of watercourses

Section B Mullamast to Prumplestown Ch. 62,000 – Ch. 50,000

There are 3 main crossings of watercourses along this section of the route. The River Lerr is of internationally important ecological value as it has significant populations of breeding salmonids as well as suitable habitat for some Annex II species as it is a proposed candidate pcSAC. The River Greese is of national importance due to the presence of Annex II species. A first order tributary of River Greese is of moderate local ecological value because it contains occasional suitable spawning habitat for salmonids. See Table 7.3.4 for a summary evaluation of the main watercourses in Section B.

Table 7.3.4 Section B – Watercourse Description And Evaluation

Name; Chainage (Ch.); Townland; Sample No.	Aquatic Habitat and Evaluation		Riparian Habitat and Evaluation		Fisheries Value and Evaluation		Presence Of Annex Species		Overall Evaluation*
River Barrow System									
River Greese Ch. 58,090 Belan BR1	Channel width = 4m, Depth = 70-90cm. Substrate of predominantly cobble and gravel at sampling point. Slow flow and no aquatic vegetation at crossing point. (Depth = 30cm at sampling point at Belan Bridge, with moderate flow, riffle and glide. Aquatic vegetation confined to a water-crowfoot (<i>Ranunculus</i> sp.).	D	Reed canary-grass and ruderal species grading into improved grassland on both banks.	D	Prime salmonids waters	B	Lamprey (unspecified) in upper reaches. Salmon and crayfish present	B	B
1 st order tributary of River Greese Ch. 57,700 Belan BR2	Channel width = 1.5-2m, Depth = 10-15cm. Slow flow with occasional riffle/glide. Mud/silt substrate in places, some sand and gravel at sampling pt. There is no aquatic vegetation at this crossing point.	D	Hedgerow overhang on north bank with improved grassland and occasional ash on southern bank.	D	There may be salmon / trout present due to proximity of confluence with the River Greese	D	Unknown		D
River Lerr, 1 st order tributary of the River Barrow Ch. 51,540 Woodlands West BR3	Channel width = 6m, Depth = 25-30cm. Slow flow with occasional riffle / glide upstream of crossing point. Some cobble and gravel at sampling location. There is no aquatic vegetation at this crossing point.	A	Hedgerow overhang on north bank with adjacent improved grassland. Treeline of poplars (<i>Populus</i> sp.) on southern bank with adjacent tillage field.	A	High salmon / trout counts	A	Salmon and hence pcSAC designation	B	A

* See 7.3 Appendix II for evaluation of watercourses

Section C Prumplestown to Powerstown Ch. 50,000 – Ch. 32,300

There are 5 main watercourse crossings along this section of the route. The Burren River is of nationally important ecological value as it has significant populations of breeding salmonids as well as suitable habitat for some Annex II species, particularly lamprey. The Palatine Stream is of high local ecological value due to documentary evidence of the presence of some lamprey. The remaining 3 smaller tributary streams are of moderate local ecological value because they contain occasional suitable spawning habitat for salmonids. See Table 7.3.5 for a summary evaluation of the main watercourses in Section C.

Table 7.3.5 Section C – Watercourse Description and Evaluation

Name; Chainage (Ch.); Townland; Sample No.	Aquatic Habitat and Evaluation		Riparian Habitat and Evaluation		Fisheries Value and Evaluation		Presence Of Annex Species		Overall Evaluation*
Palatine Stream, 1st order tributary of the River Lerr Ch. 47,700 Deerpark CR1	Channel width = 1-1.5m, Depth = 5-10cm. Slow flow with occasional glide. Mud/silt substrate in places, some sand and gravel at sampling point. Abundant fool's water-cress throughout the channel.	D	Occasional hawthorn bushes on both banks.	E	Suitable habitat conditions for trout in the lower reaches	D	Lamprey (unspecified)	C	C
1st order tributary of Palatine Stream Ch. 45,760 Russelstown CR2	Channel width = 1.5-2m, Depth = 30-40cm. Slow flow with high turbidity. Mud / silt substrate. Abundant fool's water-cress throughout the channel. The stream is not suitable for biological sampling.	E	Hawthorn and willow on northern bank with ruderal species on both banks.	E	Unknown Poor habitat conditions for fisheries	D	Unknown	-	D
Burren River 1st order tributary of the Barrow Ch. 41,000 Busherstown Moyle Big CR3	Channel width = 9m, Depth = >1m deep with slow flow. Medium turbidity with silty banks. There is no aquatic vegetation at this crossing point. The stream is not suitable for biological sampling.	D	Tillage ground on southern bank, with set-aside on northern bank. Reed canary-grass occurs occasionally on both banks.	E	Good trout river with some salmon	C	Lamprey (unspecified) in the lower reaches Salmon present	B	B
1 st order tributary of the Burren River Ch. 38,370 Tinryland CR4	Channel width = 1.5-2m, Depth = 10cm. Medium turbidity, slow flow with occasional riffle and glide. Silt substrate in places, with some sand and gravel. Fool's water-cress at edges of both banks.	D	Hedgerow on both banks	D	Some suitable conditions for trout	D	Unknown	-	D
1 st order tributary of River Barrow Ch. 33, 500 Clonmelsh CR5	Channel width = 30-70cm, Depth = 5-15cm. Mud/silt substrate in places, some sand and gravel at sampling point. There is no aquatic vegetation at this crossing point.		Hedgerow on north bank with ruderal species on southern bank.	D	Trout present in the lower reaches	D	Unknown	-	D

* See 7.3 Appendix II for evaluation of watercourses

Section D Athy to R747 Link Road

There are 4 main crossings of watercourses along this section of the route. The Greese River is of nationally important ecological value as it has significant populations of breeding salmonids as well as suitable habitat for some Annex II species, particularly, lamprey. The remaining 3 smaller tributary streams are of moderate local ecological value because they contain occasional suitable spawning habitat for salmonids. See Table 7.3.6 for a summary evaluation of the main watercourses in Section D.

Table 7.3.6 Section D – Watercourse Description and Evaluation

Name, Chainage (Ch.), Townland, Sample No.	Aquatic habitat and evaluation	Riparian habitat and evaluation	Fisheries value and evaluation	Presence of Annex species	Overall Evaluation*
River Barrow System					
1 st order tributary of the Athy River Ch. 5,080 Turnerstown DR1	Channel width = 2-2.5m, Depth = 40cm. Slow flow with silty substrate. The aquatic vegetation is comprised of water-cress (<i>Nasturtium officinale</i>), duckweed and fool's water-cress. The stream is not suitable for biological sampling.	D Occasional hawthorn and willow, with some great willow herb on both banks.	E Unknown Poor habitat conditions for fisheries	E Unknown	D
Burtown Stream, 1 st order tributary of the Greese River Ch. 7,485 Butown Big / Little DR2	Channel width = 1.5m, Depth = 25-30cm. Slow flow with silty substrate. There is no aquatic vegetation at this crossing point. The stream is not suitable for biological sampling.	D Hedgerow on west bank with ruderal species on east bank.	D Unknown Poor habitat conditions for fisheries	E Unknown	D
1 st order tributary of the Greese River Ch. 12,410 Ballitore DR3	Channel width = 60-80cm, Depth = 5-15cm. Slow flowing with riffle at one location. Substrate is predominantly stone and gravel with abundant fool's water-cress in the channel.	D Hedgerow on west bank with ruderal species on east bank.	D Some suitable conditions for trout	D Unknown	D
Greese River 1 st order tributary of the Barrow Ch. 13,240 Ballitore DR4	Channel width = 3-4m, Depth = >1m. Very slow moving stream with aquatic vegetation comprised of duckweed and fool's water-cress. The stream is not suitable for biological sampling.	D Improved grassland on west bank with wet grassland with ruderal species on east bank	D Prime salmonids waters	B Lamprey (unspecified) in upper reaches. Salmon present	B

* See 7.3 Appendix II for evaluation of watercourses

7.3.4 Proposed Development – Drainage

Drainage Systems

Efficient drainage of storm water from the carriageways and junctions is an important aspect of road design. Three basic types of drainage system would be employed, as described in Section 3.5. For those parts of the route that are constructed on low embankments, the run-off from the carriageway would be directed across the verge and down the embankment slope to a toe drain at the foot of the embankment. Where the route is in a cut the run-off would generally be collected in a filter drain located in the verge. On high embankments and at junctions and bridges, where kerbs would be provided, the run-off would be through gulleys incorporating silt traps and discharging to drainage pipes located in the verge.

Drainage Locations

Approximately 4 kilometres of main carriageway length would discharge to the Kilcullen Stream catchment, approximately 19 kilometres to the River Greese catchment, approximately 12 kilometres to the River Lerr catchment, approximately 5 kilometres to the River Burren catchment, and the balance, approximately 6 kilometres, to a stream leading to the River Barrow. In addition some 5.5 kilometres of the Athy to R747 Link Road would drain to the Redbawn River and then to the River Barrow, and the remaining 5.7 kilometres would drain to the River Greese catchment. To facilitate this, some 33 drainage discharge points are proposed to the various watercourses along the route, and 7 outfalls are proposed along the Athy to R747 Link Road.

The proposed discharge points are indicated on Figures 3.2 to 3.64 (Volume 2).

Chemical Characteristics of Storm Water Run-off

Storm water run-off from roads is composed of rainwater and whatever contaminants the rain removes from the surface. The main contaminants are:

1. Particulate matter (grit and dust) generated by
 - wear and tear of the road surface,
 - vehicle tyres, brakes and underbodies,
 - combustion engine exhausts,
2. Organic matter resulting from
 - maintenance of road side verges (grass and hedge trimming),
 - falling leaves from nearby deciduous trees,
 - animal faeces (birds, dogs, cats and rodents).
3. Hydrocarbon residues
Contamination of run-off by hydrocarbons, mainly lubricating oils, is largely dependent on the average age of the national vehicle fleet (private and commercial) and the standard of vehicle maintenance. This type of contamination results from drips of oil from faulty seals, loose sump plugs and engine gaskets onto the road surface and subsequent washing off when it rains.

4. Salt

The spreading of common salt, sodium chloride, on roads in freezing weather conditions is common practice, and subsequent run-off contains high concentrations of sodium and chloride.

Section 3 of the Local Government (Water Pollution) Acts, 1977 and 1990, contains a general prohibition on the entry of polluting matter to waters. Section 16(7) prohibits the discharge of polluting matter to any drain or sewer provided solely for the reception or disposal of storm water. Storm water run-off from roads is not subject to licensing under the above Acts because normally it is not considered to be significantly polluting under the prevailing Irish weather conditions.

7.3.5 Predicted Impacts

General Impacts

Impacts from the route, when operational, would mainly be concerned with disposal of storm water from the road surface. There is also a possibility of accidental spillages onto the road and surrounding ground that may subsequently enter watercourses and groundwater.

Various activities during the course of the construction of the scheme could also impact on water quality. Potential impacts can arise from the civil works necessary to bridge the watercourses, the installation of culverts for the smaller streams and ditches beneath the route, the diversion of existing watercourses, the construction of the earthworks embankments and cuttings, and from site facilities.

Designated Conservation Areas

The River Lerr was designated a pcSAC in 2003, and included land adjacent to the river, which is currently under improved grassland and tillage with some hedgerow and a treeline of poplar. This watercourse and the adjacent lands will be impacted by the road scheme. The habitats in the adjacent lands are of low ecological value, and while they are designated pcSAC, this designation relates to the watercourse, hence the evaluation of impacts relates to the watercourse (see Table 7.3.3 for details). Mitigation should focus on minimising the impacts on the watercourse.

Impacts on Aquatic Fauna

Otters are sensitive to disturbance and deterioration of water quality. Any negative impacts on watercourses and fisheries as a result of the proposed development would have knock-on effects for otters.

Annex II species were not recorded during the walk-over survey, however any negative impacts on watercourses as a result of the proposed development would have knock-on effects for these species.

Impacts on Watercourses

The impacts on each of the rivers / streams of ecological value along the proposed route are outlined in Tables 7.3.7, 7.3.8, 7.3.9 and 7.3.10. Of the 15 watercourses, 1 is subject to a severe negative impact, 4 watercourses are subject to major negative impacts, 4 watercourses to moderate negative impacts and 6 watercourses to minor negative impacts.

The general impacts of the N9 Kilcullen to Powerstown Scheme, in terms of its construction and operational phases, on the water quality and aquatic ecology

value of the local watercourses are discussed below. Although the existing quality of each of the main watercourses is described as moderately polluted, it is important that the drainage from the proposed route does not cause any further deterioration in quality.

Construction Phase

There will be temporary negative impacts at all crossing points of watercourses at the construction stage, as culverts are put in place, as new channels are created and as watercourses are directed into realigned channels. Impacts include risk of pollution, risk of siltation, loss and / or disturbance of riparian and in-stream habitat. The risk is greater where spawning areas fall within 1 kilometre downstream of crossings. Any impacts would have knock-on effects for local fish and lamprey populations and their spawning habitat, and for aquatic invertebrates and plants. The impacts could also extend downstream of all crossing points.

Assuming good practice will be employed for watercourse crossings, as outlined below in Section 7.3.6, the risk of construction impacts will be significantly reduced.

The main potential contaminant during the construction phase would be suspended solids. With proper planning and project management it would be possible to prevent significant releases of suspended solids to watercourses and therefore the impact on water quality would be negligible.

A number of construction materials and speciality chemical substances are likely to be used in the works, and these would have various polluting potentials if spilled adjacent to or into a watercourse. For this reason secure storage and bunding should be provided to minimise accidental spillages and therefore minimise any adverse impact.

It is most unlikely that groundwater would be affected during the construction phase. However, the ground upstream of the well that supplies the Narragmore Group Water Scheme at Coolavash is susceptible to contamination, and special environmental procedures will need to be put in place prior to and during the construction of road within the susceptible zone. These issues are discussed in Section 7.6 Soils and Geology.

Operational Phase

The main impact would be an increase in the volume of water discharged to the local water courses because of the existence of new impermeable surfaces connected to drains discharging to the water courses. The rate of discharge would increase and this would be proportional to the intensity of rainfall.

In temperate climates such as Ireland, the run-off from roads in non-urban areas does not cause significant pollution of receiving watercourses due to the frequency of rainfall, which has the effect of frequent cleansing of road surfaces. It would be expected following a prolonged dry period that the first significant rain fall discharging from the surface could contain elevated levels of contaminants, especially particulate matter. This is recognised by the Department of the Marine and Natural Resources in their booklet (1998) entitled *Fishery Guidelines for Local Authority Works*. In such a case, in the absence of mitigation, local contamination of the receiving watercourse could result. Without adequate mitigation, because of the delay time between actual discharge and the increase in flow of the receiving water, water quality in these circumstances may deteriorate until the flow increases.

The use of grit and salt on roads during icy weather conditions is a long established practice. The grit is of such a high density that it readily settles in grit traps and the particle size is large enough for it to be effectively removed by filter drains. Salt being soluble would not be significantly reduced by filters or traps on the drainage systems. However, the time of year when salt is used generally coincides with good watercourse flows, and consequently the concentrations of sodium and chloride would be substantially diluted.

Section A Kilcullen to Mullamast Ch. 78,500 – Ch. 62,000

Aquatic Impacts

The impacts on each of the watercourses along the proposed route within Section A are outlined in Table 7.3.7. Of the 3 watercourses, the Kilcullen Stream is subject to a major negative impact. The tributary of the Finnelly River is subject to a moderate negative impact and the tributary of the River Greese is subject to a minor negative impact.

Table 7.3.7 Section A – Watercourse Evaluation And Impacts

Watercourse, Name & Chainage	Overall Evaluation	Length Of River Impacted	Impacts*
Kilcullen Stream Ch. 76,500 – Ch. 75,000 AR1	C	800m of realignment 60m of culvert	Major negative
3 rd order trib. of Finnelly River Ch. 74,000 Baronsland AR2	D	700m of realignment (300m + 400m), 40m culvert	Moderate negative
1 st order trib. of the River Greese Ch. 67,300 AR3	D	160m culvert	Minor negative

* See 7.3 Appendix II for impact criteria.

Section B Mullamast to Prumplestown Ch. 62,000 – Ch. 50,000

Aquatic Impacts

The River Lerr is designated a proposed candidate Special Area of Conservation (pcSAC). It will be impacted by the proposed N9 Kilcullen to Waterford Scheme crossing at Woodlands West (Ch. 51,540). The pcSAC designation relates primarily to the river channel with its riparian habitat and the protection of its aquatic Annex II species. The adjacent land included is primarily as a buffer zone for the protection of the river itself within the pcSAC boundary of the river at the proposed crossing points. It is comprised of improved agricultural grassland (GA1) to the north and tillage land (BC1) with a treeline of poplars on the south bank contributing to a neutral impact.

The impacts on each of the watercourses along the proposed route within Section B are outlined in Table 7.3.8. Of the 3 watercourses, the River Lerr is subject to a severe negative impact; the River Greese is subject to a major negative impact and the tributary of the River Greese is subject to a moderate negative impact. A clear span bridge will cross each of the 2 rivers and hence there will be no direct impact on the river channels and riverbank habitats.

Table 7.3.8 Section B – Watercourse Evaluation And Impacts

Watercourse, Name & Chainage	Overall Evaluation	Length of River Impacted	Impacts*
River Greese Ch. 58,090 BR1	B	26m	Major negative
1 st order tributary of River Greese Ch. 57,700 BR2	D	240m (3 x 80m culverts)	Moderate negative
River Lerr, 1 st order tributary of the River Barrow Ch. 51,540 BR3	A	53m	Severe negative

* See 7.3 Appendix II for impact criteria.

Section C Prumplestown to Powerstown Ch. 50,000 – Ch. 32,300

Aquatic Impacts

The impacts of each of the watercourses along the proposed route within Section C are outlined in Table 7.3.9. Of the 5 watercourses impacted, the Burren River is subject to a major negative impact; the Palatine Stream and a tributary of the Barrow are subject to moderate negative impacts and the tributaries of the Palatine Stream and the River Burren are subject to minor negative impacts. A clear span bridge is proposed for the River Burren crossing and hence there will be no direct impact on the river channel and river bank habitats.

Table 7.3.9 Section C – Watercourse Evaluation And Impacts

Watercourse, Name & Chainage	Overall Evaluation	Length of river impacted	Impacts*
Palatine Stream, 1 st order tributary of the River Lerr Ch. 47,700 CR1	C	100m	Moderate negative
1 st order tributary of Palatine Stream which is 1 st order tributary of the River Lerr Ch. 44,760 CR2	D	120m	Minor negative
Burren River 1 st order tributary of the Barrow Ch. 41,000 CR3	B	28m	Major negative
1 st order tributary of the Burren River Ch. 38,370 CR4	D	200m (120m + 80m culverts)	Minor negative
1 st order tributary of the River Barrow Ch. 33,500 CR5	D	400m Realignment of 240m 90m + 70m culverts	Moderate negative

* See 7.3 Appendix II for impact criteria.

Section D Athy to R747 Link Road

Aquatic Impacts

The impacts on each of the watercourses along the proposed route within Section D are outlined in Table 7.3.10. Of the 4 watercourses, the River Greese is subject to a major negative impact, while the others have a minor negative impact. A clear span bridge is proposed for the River Greese crossing and hence there will be no direct impact on the river channel and river bank habitats.

Table 7.3.10 Section D – Watercourse Evaluation And Impacts

Watercourse, Name & Chainage	Overall Evaluation	Length Of River Impacted	Impacts*
1 st order tributary of the Athy River Ch. 5,080 DR1	D	40m culvert	Minor negative
Burtown Stream, 1 st order tributary of the Greese River Ch. 7,485 DR2	D	40m culvert	Minor negative
1 st order tributary of the Greese River Ch. 12,410 DR3	D	60m culvert	Minor negative
1 st order tributary of the Greese River Ch. 13,030	D	50m culvert	Minor negative
Greese River 1 st order tributary of the Barrow Ch. 13,250 DR4	B	20m	Major negative

* See 7.3 Appendix II for impact criteria.

7.3.6 Remedial or Reductive Measures

General Remedial or Reductive Measures

The impact of road works on natural watercourses can be minimised by applying sound design principles and by following good work practices. The most common and serious impacts arise from:

- Interference with fish migration.
- Interference with mammal movement.
- Loss of aquatic and riparian habitat.
- Harmful discharges during construction and operation.

Outlined below are the general remedial or reductive measures that are recommended to avoid or reduce the predicted impacts of the proposed N9 Kilcullen to Powerstown Scheme on aquatic ecology and water quality. These measures compliment the measures recommended in Section 7.2 of this report for the protection of terrestrial ecology.

The following seasonal constraints and remedial measures are aimed at reducing the impact of the road development and construction works on the general ecology

of affected watercourses. All works should be conducted in consultation with the Southern / Eastern Regional Fisheries Board and Dúchas, the Heritage Service.

- For watercourses that contain salmonids, no works will be permitted during the peak spawning period between the months of October to March inclusive.
- If suitable habitat for breeding birds occurs in the riparian or bankside vegetation, where feasible, no works should be conducted during the months of March to August if breeding birds are present.

All relevant works in the vicinity of rivers and streams should be undertaken in consultation with the Southern and Eastern Regional Fisheries Boards and Dúchas, the Heritage Service.

Designated Areas

The proposed crossing of the River Lerr has been selected to avoid direct impacts on the river habitats of the River Lerr pcSAC. The river bridge is proposed to be a clear span bridge, which will avoid direct impact on the river channel or riparian habitats. Other mitigation measures, as outlined below would also be put in place to avoid increases in siltation or polluting discharges entering the River Lerr system, even in a spillage / accident situation. It is recommended that the bridge abutments will be a minimum distance of 2 metres from the edge of the riverbanks.

Design Issues

Bridge and Culvert Design

All bridges and culverts will be designed in consultation with the ERFB / SRFB and should permit the passage of fish under all but extreme flow conditions.

Clear span bridges will be constructed over the Greese (2 crossings), Lerr and Burren rivers. The bridge abutments will be set back a minimum distance of 2 metres from the riverbank for passage of mammals and protection of riverbanks. Erosion protection at these crossings is required and will be subject to approval of the SRFB at detailed design stage.

If pitching of the bed is essential, it should be laid at the natural grade and level. Raised aprons should be avoided if possible, and if not possible, fish-passes should be incorporated where necessary. If “hard abutments” are used, they should be of minimum length and should be designed to cater for passage of mammals.

Where bridging is not an economic option and culverts are required, their length should be kept to a minimum by running them square-on to the line of the road. This may result in some stream realignment.

Use should be made wherever possible of arch-type culverts, leaving the stream-bed undisturbed and maintaining some natural bankway at both sides to allow for the passage of mammals.

Where bottomless culverts are not being used, they should be designed to facilitate the maintenance of a minimum depth of water and to provide a suitable ledge for the passage of mammals. The following criteria should be applied:

- a) Culverts should be set below bed-level.
- b) Culvert widths should approximate to that of the natural channels, the use of multiple units of lesser width is not recommended.

- c) Box culverts should include a stepped bottom profile to facilitate the maintenance of a minimum depth of water and to provide a suitable ledge for the passage of mammals.
- d) Where possible, the culvert should be laid at a level and grade which allow the upstream invert to remain drowned (by back-watering) under low-flow conditions (e.g. 100 millimetres for trout, 150 millimetres for salmon).
- e) If the gradient is too steep, the drowning effect should ideally be met by way of a fish pass at the downstream end of the culvert.
- f) If a culvert has to be laid at a steep gradient, special provision must be made to allow fish to swim upstream without undue effort.
- g) Pools should be formed at each end of the culvert to provide for transition from the shape of the slope to the shape of the bed. They should be built in masonry or concrete, and designed to provide take-off conditions for upstream migrants entering and leaving the culvert. The downstream pool should be designed to act as a stilling-chamber which will prevent erosion of the banks below and provide quiescent take-off conditions for fish.
- h) If the culvert length exceeds 100 metres, it is desirable to provide light-opes, but this is also dependent on the diameter of the culvert.

Notes: 1. Pre-cast culverts are unlikely to be amenable to the provision of mammal passage, and accordingly, separate facilities must be provided for the species in question.

Notes: 2. If a stream runs parallel to the line of the road and inside the toe-line of the embankment, it may be preferable to divert it laterally than to culvert it.

The use of concrete for preventing erosion of stream beds and banks should be avoided if possible. Use should be made of natural bank protection techniques such as willow-fagotting, stone armour, or composite protection using products such as coir-matting or geoweb with appropriate planting (reeds, willow, etc).

Pollution Prevention

Storm run-off from the proposed road to watercourses of fisheries value will be fed through pollution control measures that will be designed with adequate storage capacity and in a manner to facilitate maintenance and cleaning. Sediment traps should also be provided.

Watercourse Diversions and In-stream Works

Diversions of watercourses should be designed to replicate a natural watercourse system, incorporating meanders, riparian vegetation and other features of a natural watercourse.

New channels will be sinuous and meandering rather than uniformly straight. The constant erosion and deposition within a sinuous channel results in the formation of riffle, glide and pool conditions. The degree of sinuosity within the channel depends on the space available and should be designed according to the prevailing conditions. Incorporating stone deflectors, v-notch weirs and other appropriate features can develop riffle, glide and pool conditions, within straight channel cuttings.

Temporary stream diversions should be made on geotextile surfaces with a surface layer of coarse aggregate to hold it in place. Both Dúchas and the ERFB / SRFB will approve the outline approach for permanent watercourse diversions, the detailed design and construction methodology.

Construction Phase

General

Bunds, siltation ponds, hydrocarbon and grit interceptors will be put in place, as appropriate, to control pollution and run-off.

Pollution Prevention

A wide variety of speciality chemical substances are used in modern construction. Generally these are used in small quantities and the materials are normally stored in secured site huts or sheds. It is also normal to store diesel fuel for construction equipment on-site. The storage tanks would be located within a bunded area to a capacity at least 50% greater than the storage tank so that secondary containment can be provided. Provision of secondary containment for fuel tanks and secured storage areas for construction chemicals would also serve to protect groundwater resources.

Adequate protection measures will be put in place to ensure that all hydrocarbons and other chemicals used during the construction phase are appropriately handled, stored (no storage of hydrocarbons or any toxic chemicals should occur within 50 metres of a watercourse) and disposed of in accordance with recognised standards. Re-fuelling of plant should not occur within 50 metres of any watercourse.

Concrete (including waste and wash-down water) will be contained and managed appropriately to prevent pollution of all watercourses. Pouring of concrete for aprons, sills, and other works should be carried out in the dry and allowed cure for 48 hours before re-flooding. Pumped or tremied concrete should be monitored carefully to ensure no accidental discharge. Mixer washings and excess concrete should not be discharged to water.

The contractors' site compounds will be equipped with temporary toilet facilities, and the contractor would be responsible for their servicing and maintenance. Foul drainage from the offices and from other construction facilities will be contained and disposed of in an appropriate manner to prevent pollution of all watercourses. There would be no discharge from these facilities to the local environment.

During the construction phase periodic monitoring of water quality in the vicinity of works would be carried out to ensure that there are no unauthorised discharges and to ensure the effectiveness of procedures designed to prevent pollution.

Finally, notwithstanding the fact that this project is being undertaken by a state authority and local authorities, the Local Government (Water Pollution) Acts (1977, 1990) contain provisions which permit any person to take appropriate legal action in the event of pollution taking place.

Siltation and Suspended Solids

Techniques for the control of suspended solids are well established (e.g., interceptors and traps) and the management of this forms part of the overall project management for the development. The contract documents will specify the necessity for the contractor to take all reasonable precautions to prevent silt laden water from discharging directly to watercourses.

Siltation of water bodies will be minimised by the appropriate use of settlement ponds, silt traps and bunds and by avoiding operating within water bodies where

feasible. Where pumping of water is to be carried out, filters will be used at intake points and discharge will be through a sediment trap.

All watercourses that occur in areas of land that will be used for accommodation works or storage depots will be fenced off at a distance of at least 10m to avoid any direct impacts.

Bankside vegetation should be left intact where feasible by erecting fencing prior to the commencement of any site works. Where possible the fence will be set at a minimum distance of 5 metres from the bank of the watercourse or at the edge of the woody canopy (whichever is greater).

If temporary or permanent diversion of the watercourse is required, this should be carried out prior to the removal of bankside vegetation.

Watercourse Diversions and In-stream Works

It is not envisaged that excavations for structures or construction of structural foundations, except culverts, in any watercourse would be needed. Typical measures for control at river bank-sides include installation of cofferdams so that the river flows around the outside leaving the interior, that is, the work area, dry. As an alternative, the channel could be diverted around the work area leaving the latter dry. Such works would preferentially be done during the dry period of the year when flows are low and the risk of suspended solids release is minimal.

A number of the smaller streams may be slightly realigned to pass under the road through culverts. In most cases the culvert would be made in pre-cast sections that can be lowered into the existing channel with minimal disturbance. However, in some cases it may be necessary to construct the culvert beside the existing channel and then connect the upstream end to the channel, while in other cases it might be more appropriate to divert the existing channel slightly 'off-line' and construct the culvert in the dry channel bed.

In-stream works may not be carried out in watercourses frequented by salmon or trout during the Annual Close Season, which typically extends from the end of September to the end of February. Further seasonal restrictions may apply in salmon and trout spawning and nursery areas and where late spawning would result in juveniles being at risk beyond the close season. Restrictions may also apply in the case of watercourses containing significant populations of other species including lamprey, coarse fish, freshwater pearl mussel, freshwater crayfish, etc.

Instream containment and dewatering operations may facilitate operation outside of closed periods. All dewatering flow should be passed through settlement ponds or tanks to remove sediments and should be preceded by a fish salvage operation carried out by, or on behalf of, ERFB / SRFB.

Where suitable spawning gravels occur within a watercourse at the site of a proposed crossing point, these gravels should be removed and stored for reinstatement on completion of the works, in accordance with the requirements of the ERFB / SRFB.

Watercourse diversions should be carried out in the dry and in isolation from the existing watercourse. The compensatory diversion channel should be designed in detail and to the satisfaction of the statutory bodies. This will involve the grading of

the riverbanks to an acceptable slope, the construction of a sinuous channel and the incorporation of suitable substrates.

Where natural bankside vegetation is to be removed, machinery should operate from the bank and pull the vegetation back from the edge of the watercourse. If temporary or permanent diversion of the watercourse is required, this should be carried out prior to the removal of bankside vegetation. Where permanent diversion is taking place, existing vegetation should be removed in sods for replanting on the new river banks.

Replanting or rehabilitation of banksides will be undertaken following sensitive grading of the banks to replicate a natural topography (slopes should not be greater than 1:2). Planting will be conducted using native species and will follow a natural zonation that is appropriate to the river profile. Temporary deer proof fencing would be erected to protect newly planted areas if required.

Transplanting of bankside vegetation will be conducted in the dormant season, but where restrictions are in place due to the presence of salmonids, transplanting should be carried out during the period August to November.

Once the construction is completed and re-vegetation has been established, the connection to the existing watercourse can be made. This should only occur within the approved operational window for instream works. The salvage of fish from the section of watercourse to be abandoned will be undertaken by or on behalf of the relevant Fisheries Board.

Operation of machinery instream should be kept to an absolute minimum. All construction machinery operating instream should be mechanically sound to avoid leaks of oils, hydraulic fluid, etc. Machinery should be steam-cleaned and checked prior to commencement of instream works.

Fording of watercourses to gain access to the opposite bank should only be considered where no alternative option exists and under approval of the ERFB / SRFB. Where required, access should be restricted to one crossing point and traffic limited. Instream and bankside preparation and rehabilitation will be required.

Operational Phase

The main consequence of the proposed route on the watercourses would be additional volumes of water from the storm water drainage. The road drainage design has assessed the discharge flows from the road drainage against the flows in the natural streams. At drainage outfalls where it has been identified there is a risk of flooding in the receiving water, attenuation measures have been included in the design to reduce the discharge to approximate to that of the natural catchment.

Pollution Prevention

All surface water run-off from the new road to watercourses of fisheries value should be directed through pollution control measures. These measures should be designed with adequate storage capacity and in a manner to facilitate maintenance and cleaning.

The proposed drainage systems would ensure that the release of particulate matter (mainly grit, dust and grass clippings where grass is planted) to watercourses would be minimal and consequently there would be no significant adverse impact

on surface and groundwater chemical quality. This is particularly important in the case of drainage from the route surfaces following a dry spell. As noted above the levels of particulate matter in the run-off are likely to be elevated at such times compared to the normal Irish weather. Consequently a drainage system incorporating a means of reducing the level of particulate matter discharged is essential.

The outfall for each drainage discharge pipe would be specifically designed to ensure that scouring of either the bottom or the banks of the receiving watercourse would be minimal.

Section A Kilcullen to Mullamast – Remedial or Reductive Measures

Aquatic Ecology

While the general remedial or reductive measures for watercourses outlined above apply to the watercourses in Section A, the more pertinent remedial or reductive measures are outlined in Table 7.3.11.

The realignment of the Kilcullen Stream is a short-term impact as this stretch of river will be re-established as a watercourse with natural features. The current condition along this stretch is of low ecological value due to the absence of a variety of flow regime. The realignment will improve the flow regime of this stretch of watercourse by incorporating the measures outlined above for stream diversions.

Table 7.3.11 Section A – Remedial or Reductive Measures for Watercourses

Watercourse, Name & Chainage	Overall Evaluation	Impacts	Remedial or Reductive Measures
AR1 - Kilcullen Stream Ch. 76,500 – Ch. 75,000	C	Major negative	Realignment of channel incorporating the ERFB recommendations and incorporating principles detailed above – Watercourse Diversions
AR2 - Third order trib. of Finnerly River Ch. 74,000	D	Moderate negative	Realignment of channel incorporating the SRFB and incorporating principles detailed above – Watercourse Diversions
AR3 First order trib. of the River Greese Ch. 67,300	D	Minor negative	Culvert design to satisfaction of SRFB and incorporating principles detailed above – Bridge and culvert design. Ensure best practice during construction as outlined above – Pollution Prevention

* Refer to detailed remedial or reductive measures for aquatic ecology.

Section B Mullamast to Prumplestown – Remedial or Reductive Measures

Aquatic Ecology

While the general remedial or reductive measures for watercourses (see above) apply to Section B, the more pertinent remedial or reductive measures are outlined in Table 7.3.12.

Table 7.3.12 Section B – Remedial or Reductive Measures for Watercourses

Water-Course Name & Chainage	Overall Evaluation	Impacts	Remedial or Reductive Measures
BR1 _ River Greese Ch. 58,090	B	Major negative	Avoidance of works in the river channel
BR2 - First order tributary of River Greese Ch. 57,700	D	Moderate negative	Culvert design to satisfaction of SRFB and incorporating principles detailed above – Bridge and culvert design. Ensure best practice during construction as outlined above – Pollution Prevention
BR3 - River Lerr, first order tributary of the River Barrow Ch. 51,540	A	Severe negative	Avoidance of works within river channel

* Refer to detailed remedial or reductive measures for aquatic ecology.

Section C Prumplestown To Powerstown – Remedial Or Reductive Measures

Aquatic Ecology

While the general remedial or reductive measures for watercourses (see above) apply to Section C, the more pertinent remedial or reductive measures are outlined in Table 7.3.13.

Table 7.3.13 Section C – Remedial or Reductive Measures for Watercourses

Water-Course Name & Chainage	Overall Evaluation	Impacts	Remedial or Reductive Measures*
CR1 - Palatine Stream, first order tributary of the River Lerr Ch. 47,700	C	Moderate negative	Culvert design to satisfaction of SRFB and incorporating principles detailed above – Bridge and culvert design. Ensure best practice during construction as outlined above – Pollution Prevention
CR2 - First order tributary of Palatine Stream which is 1st order tributary of the River Lerr Ch. 45,760	D	Minor negative	Culvert design to satisfaction of SRFB and incorporating principles detailed above – Bridge and culvert design. Ensure best practice during construction as outlined above – Pollution Prevention
CR3 - Burren River first order tributary of the Barrow Ch. 41,000	B	Major negative	Avoidance of works within river channel
CR4 - First order tributary of the Burren River Ch. 38,370 CR4	D	Minor negative	Culvert design to satisfaction of SRFB and incorporating principles detailed above – Bridge and culvert design. Ensure best practice during construction as outlined above – Pollution Prevention

Table 7.3.13 Section C – Remedial or Reductive Measures for Watercourses (contd.)

Water-Course Name & Chainage	Overall Evaluation	Impacts	Remedial or Reductive Measures*
CR5 - First order tributary of the River Barrow Ch. 33,500	D	Moderate negative	Culvert design and realignment design to satisfaction of SRFB and incorporating principles detailed above – Bridge and culvert design. Ensure best practice during construction as outlined above – Pollution Prevention and Watercourse diversions

* Refer to detailed remedial or reductive measures for aquatic ecology.

Section D Athy to R747 Link Road – Remedial or Reductive Measures

Aquatic Ecology

While the general remedial or reductive measures for watercourses (see above) apply to Section D, the more pertinent remedial or reductive measures are outlined in Table 7.3.14.

Table 7.3.14 Section D – Remedial or Reductive Measures for Watercourses

Watercourse Name & Chainage	Overall Evaluation	Impacts	Remedial or Reductive Measures
DR1 - First order tributary of the Athy River Ch. 5,080	D	Minor negative	Culvert design to satisfaction of SRFB and incorporating principles detailed above – Bridge and culvert design. Ensure best practice during construction as outlined above – Pollution Prevention
DR2 - Burtown Stream, first order tributary of the Greese River Ch. 7,485	D	Minor negative	Culvert design to satisfaction of SRFB and incorporating principles detailed above – Bridge and culvert design. Ensure best practice during construction as outlined above – Pollution Prevention
DR3 - First order tributary of the Greese River Ch. 12,410	D	Minor negative	Culvert design to satisfaction of SRFB and incorporating principles detailed above – Bridge and culvert design. Ensure best practice during construction as outlined above – Pollution Prevention
DR4 - Greese River first order tributary of the Barrow Ch. 13,240	B	Major negative	Avoidance of works within river channel

* Refer to detailed remedial or reductive measures for aquatic ecology.

7.3.7 Residual Impacts

As part of the construction contract, the contractor will be required to put in place sound environmental protection procedure prior to the commencement of work on site.

Provided good working practices are adopted during the construction of the works, there should be little residual impact on water quality. In this respect, all relevant works in the vicinity of rivers and streams should be undertaken in consultation with the Regional Fisheries Boards and Dúchas, the Heritage Service.

Storm water run-off from the proposed road to watercourses of fisheries value will be fed through pollution control measures interceptors that will be designed with adequate storage capacity and in a manner to facilitate maintenance and cleaning. The installation of these measures will largely mitigate any impacts on water quality.

The proposed drainage system would delay the release of surface drainage water and any associated contaminants from entering the adjacent watercourse following any chemical or related spillages resulting from traffic accidents. This would afford an opportunity for the road maintenance authority and the emergency services to assess the nature of the hazard and to determine the most appropriate response. The standard procedure where possible would be to contain the material and collect it. In the case of solid materials this is usually feasible. The proposed drainage system would give better environmental protection than currently exists on the existing N9 where a spillage of liquid could drain rapidly to the nearest watercourse with little chance of containment. For a liquid chemical spillage that has entered the drainage system it could be decided that the best response would be to remove all material including soil from the affected part of the drain and transport it to a specialist remediation facility for decontamination.

The impacts of each of the rivers / streams of ecological value post remedial or reductive measures are outlined in Tables 7.3.15, 7.3.16, 7.3.17 and 7.3.18. Of the 15 watercourse crossings, 3 watercourses are subject to moderate negative residual impact, 7 watercourses are subject to minor negative residual impact and 5 suffer no significant residual impact.

Designated Conservation Areas

The River Lerr, proposed pcSAC, will not be directly impacted by the road scheme. See Section B 7.3.5 Predicted Impacts for details. The alignment of the road through the southern tip of Cloghrystick wood will remain a severe negative impact, post compensatory planting.

Section A Kilcullen to Mullamast Ch. 78,500 – Ch. 62,000

Aquatic Ecology

The residual impacts on each of the watercourses along the proposed route within Section A are outlined in Table 7.3.15. Of the 3 watercourses, the Kilcullen Stream is subject to a moderate negative residual impact. The tributary of the Finney River is subject to a minor negative residual impact. The residual impact on the tributary of the River Greese is not significant.

Table 7.3.15 Section A – Watercourse Crossings’ Residual Impacts

Water-Course Name & Chainage	Overall Evaluation	Impacts	Residual Impacts
AR1 - Kilcullen Stream Ch. 76,500 – Ch. 75,000	C	Major negative	Moderate negative
AR2 - Third order trib. of Finney River Ch. 74,000	D	Moderate negative	Minor negative

Table 7.3.15 Section A – Watercourse Crossings’ Residual Impacts (contd.)

Water-Course Name & Chainage	Overall Evaluation	Impacts	Residual Impacts
AR3 - First order trib. of the River Greese Ch. 67,300	D	Minor negative	Not significant

Section B Mullamast to Prumplestown Ch. 62,000 – Ch. 50,000

Aquatic Ecology

The residual impacts on each of the watercourses along the proposed route within Section B are outlined in Table 7.3.16. Of the 3 watercourses, the residual impact on the River Lerr and the River Greese is not significant and the tributary of the River Greese is subject a moderate negative residual impact.

Table 7.3.16 Section B – Watercourse Crossings’ Residual Impacts

Watercourse, Name & Chainage	Overall Evaluation	Impacts	Residual Impacts
BR1 - River Greese Ch. 58,090	B	Major negative	Not significant*
BR2 - First order tributary of River Greese Ch. 57,700	D	Moderate negative	Moderate negative
BR3 - River Lerr, first order tributary of the River Barrow Ch. 51,540	A	Severe negative	Not significant*

* This residual impact evaluation for watercourses with clear-span bridges assumes bioengineering practices are taken on board rather than gabion baskets for regrading of banks.

Section C Prumplestown to Powerstown Ch. 50,000 – Ch. 32,300

Aquatic Ecology

The residual impacts of the 5 watercourses along the proposed route within Section C are outlined in Table 7.3.17. The residual impact on the Burren River is not significant. The Palatine Stream and a tributary of the Barrow are subject to moderate negative residual impacts. The tributaries of the Palatine Stream and the River Burren are subject to minor residual negative impacts.

Table 7.3.17 Section C – Watercourse Crossings’ Residual Impacts

Watercourse, Name & Chainage	Overall Evaluation	Impacts	Residual Impacts
CR1 - Palatine Stream, 1 st order tributary of the River Lerr Ch. 47,700	C	Moderate negative	Moderate negative
CR2 - First order tributary of Palatine Stream which is first order tributary of the River Lerr Ch. 45,760	D	Minor negative	Minor negative
CR3 - Burren River first order tributary of the Barrow Ch. 41,000	B	Major negative	Not significant*
CR4 - First order tributary of the Burren River Ch. 38,370	D	Minor negative	Minor negative

Table 7.3.17 Section C – Watercourse Crossings’ Residual Impacts (contd.)

Water-Course Name & Chainage	Overall Evaluation	Impacts	Residual Impacts
CR5 - First order tributary of the River Barrow Ch. 33,500	D	Moderate negative	Minor negative

* This residual impact evaluation for watercourses with clear-span bridges assumes bioengineering practices are taken on board rather than gabion baskets for regrading of banks.

Section D Athy to R747 Link Road

Aquatic Ecology

The residual impacts on each of the watercourses along the proposed route within Section D are outlined in Table 7.3.18. Of the 4 watercourses, the residual impact on the River Greese is not significant and the other streams are subject to minor negative residual impacts.

Table 7.3.18 Section D – Watercourse Crossings’ Residual Impacts

Water-Course Name & Chainage	Overall Evaluation	Impacts	Residual Impacts
DR1 - First order tributary of the Athy River Ch. 5,080	D	Minor negative	Minor negative
DR2 - Burtown Stream, first order tributary of the Greese River Ch. 7,485	D	Minor negative	Minor negative
DR3 - First order tributary of the Greese River Ch. 12,410	D	Minor negative	Minor negative
DR4 - Greese River first order tributary of the Barrow Ch. 13,240	B	Major negative	Not significant*

* This residual impact evaluation for watercourses with clear-span bridges assumes bioengineering practices are taken on board rather than gabion baskets for regrading of banks.

7.3 Appendix I: NATURA Scheme for the Evaluation of Watercourses

Watercourses are evaluated on the basis of a number of characteristics and features as outlined below. The characteristics are defined as follows:

Riparian habitat on a watercourse refers to the associated vegetation or habitats that are generally particular to rivers, such as fringing wet woodland, floodplain and oxbow lakes.

Aquatic habitat refers to the in-water conditions of any watercourse, including substratum, that are typically associated with un-modified river and stream channels, including riffles, glides and pools.

The fisheries value of a watercourse refers to its suitability for fish, primarily salmonids (salmon, sea-trout and brown trout), and to the associated value for recreational angling purposes.

Annex II species are those that are listed for, or legally protected under the Habitats Directive (92/43/EEC).

Annex I habitats are those that are listed for, or legally protected under the Habitats Directive, including Priority Habitats.

The evaluation of water quality uses a five-point system (Q value) based on the presence and relative abundance of various invertebrates using the Environmental Protection Agency's (EPA) standard technique (Lucey et al., 1999). Q5 equates to pristine conditions while Q1 equates to gross pollution.

Rating	Riparian Habitat	Aquatic Habitat	Fisheries Value	Annex II Species Annex I Habitat	Water Quality
A	Designated SAC/SPA	Designated SAC/SPA	Designated Salmonid Water		
B	Designated NHA. Containing species listed under Flora Order. Annex I habitats.	Designated NHA. Containing species listed under Flora Order. Annex I habitats.	Significant populations of breeding salmonids.	Significant spawning or resident populations. Significant area of Annex I habitat.	
C	Poor examples of Annex I habitats Semi-natural habitats	Poor examples of Annex I habitats Semi-natural habitats	Containing some resident salmonids or good stocks coarse species	Limited spawning or resident populations. Limited area of Annex I habitat.	Q5 or Q4/5
D	Some semi-natural habitat limited in size	Some semi-natural habitat limited in size	Contains some fish species	Headwater or tributary of watercourse with Annex II species.	Q4
E	Artificial or highly modified	Artificial or highly modified	No significant populations any species fish		Q3 or less
F	Sites that have not been adequately assessed but may contain habitat or species of note.				

7.3 Appendix II: Criteria for Assessing Impact Significance

Aquatic Sites

Site Category*

A Sites

	Temporary	Short-term	Medium-term	Long-term
Extensive	Major	Severe	Severe	Severe
Localised	Major	Major	Severe	Severe

B Sites

	Temporary	Short-term	Medium-term	Long-term
Extensive	Major	Major	Severe	Severe
Localised	Moderate	Moderate	Major	Major

C Sites

	Temporary	Short-term	Medium-term	Long-term
Extensive	Moderate	Moderate	Major	Major
Localised	Minor	Moderate	Moderate	Moderate

D Sites

	Temporary	Short-term	Medium-term	Long-term
Extensive	Minor	Minor	Moderate	Moderate
Localised	Not significant	Minor	Minor	Minor

E Sites

	Temporary	Short-term	Medium-term	Long-term
Extensive	Not significant	Not significant	Minor	Minor
Localised	Not significant	Not significant	Not significant	Not significant

* Site categories A to E are defined in 7.2 Appendix II.

In line with the EPA guidelines (EPA 2002), the following terms are defined when quantifying duration:

- Temporary: up to 1 year,
- Short-term: from 1-7 years,
- Medium-term: 7-15 years,
- Long-term: 15-60 years,
- Permanent: over 60 years.

Localised impacts on rivers are loosely defined as impacts measurable no more than 250m from the impact source. Extensive impacts on rivers are defined as impacts measurable more than 250m from the impact source. Any impact on salmonid spawning habitat, or nursery habitat where it is in short supply, would be regarded as an extensive impact as it is likely to have an impact on the salmonid population beyond the immediate vicinity of the impact source.

7.3 Appendix III: Biological water sample results

	Ar 1	Ar 2	Ar3	Br 1	Br 2	Br 3	Cr1	Cr 4	Cr 5	Dr 3	EPA
ANNELIDA											
Hirudinea (Leeches)											
<i>Glossiphonia</i> sp.	-	2	-	-	-	3	3	1	-	-	D
<i>Erpobdella</i> sp.	-	-	-	-	-	-	-	2	-	-	D
Oligochaeta (worms)											
Oligochaeta indet.	2	2	-	3	6	-	4	29	2	-	--
Lumbricidae indet.	-	1	-	-	-	-	-	-	-	-	--
AMPHIPODA											
<i>Gammarus</i> sp.	235	42	154		347	81	116	139	144	7	C
<i>Asellus</i> sp.	-	64	1	2	-	10	-	5	7	22	D
<i>Austropotamobius pallipes</i>	-	-	-	1	-	-	-	-	-	-	C
MOLLUSCA											
Gastropoda (snails)											
<i>Lymnaea</i> sp.	-	-	-	-	-	-	-	3	-	-	D
<i>Ancylus fluviatilis</i>	-	-	-	2	-	-	-	54	-	-	C
<i>Potamopyrgus jenkinsi</i>	-	-	-	192	-	-	70	-	-	-	C
<i>Physa fontinalis</i>	8	8	-	-	-	2	-	-	-	-	D
Bivalvia											
Planorbidae	1	-	-	-	-	-	-	-	-	-	D
ARTHROPODA – INSECTA											
Ephemeroptera (mayflies)											
<i>Ephemera ignita</i>	-	-	-	-	-	24	-	-	-	-	C
<i>Baetis rhodani</i>	18	23	29	8	10	152	71	161	73	72	C
<i>Baetis muticus</i>	-	-	-	-	-	1	7	-	-	-	B
<i>Baetis scambus</i>	-	-	-	-	-	30	-	-	-	-	B
<i>Ecdyonurus</i> sp.	-	-	-	1	-	-	-	-	-	-	A
Trichoptera (caddis flies)											
<i>Goeridae</i> indet.	-	-	-	-	-	6	-	-	-	-	B
<i>Limnephilus flavicornis</i>	-	1	-	-	-	-	-	-	-	-	B
<i>Silo pallipes</i>	3	-	-	-	-	-	-	-	-	-	B
Limnephilidae	1	-	-	-	-	2	10	-	-	3	B
<i>Agapetus fuscipes</i>	2	-	-	-	-	-	1	-	-	-	B

	Ar 1	Ar 2	Ar3	Br 1	Br 2	Br 3	Cr1	Cr 4	Cr 5	Dr 3	EPA
Trichoptera (caddis flies)											
<i>Agapetus</i> sp.	-	-	2	-	3	-	-	-	-	2	B
<i>Sericostoma personatum</i>	-	-	-	-	-	-	-	1	-	-	B
Leptoceridae	-	-	-	-	2	-	-	-	-	-	B
<i>Rhyacophila dorsalis</i>	2	-	1	-	-	-	-	6	-	-	C
<i>Hydropsyche</i> sp.	-	-	-	9	-	-	-	-	-	-	C
<i>Hydropsyche agustipennis</i>	-	-	-	-	-	-	-	17	1	2	C
<i>Hydropsyche siltali</i>	-	-	-	-	-	-	-	-	-	1	C
Diptera (true flies)											
Chironomidae indet.	5	20	3	-	22	-	5	4	3	57	C
Tipulidae indet.	-	3	3	1	-	14	14	3	-	4	C
<i>Dicronata</i> sp.	9	-	-	1	-	-	-	-	-	-	C
<i>Simulidae</i> indet.	112	-	8	40	-	42	-	15	-	86	C
<i>Diptera</i> indet.	-	-	-	-	-	-	1	1	-	-	C
Coleoptera (beetles)											
<i>Elmis aenea</i> (larvae)	21	22	-	20	1	7	-	42	2	5	C
<i>Elmis aenea</i>	15	60	-	14	-	4	-	47	-	-	C
<i>Limnius volckmari</i> (larvae)	-	1	-	-	-	-	-	7	-	-	C
<i>Limnius volckmari</i>	1	-	-	5	-	-	1	-	-	-	C
<i>Brychius</i>	-	-	-	3	-	-	-	-	-	-	C
<i>Agabus</i> sp.	-	1	-	-	-	-	-	-	-	1	C
<i>Helodidae</i>	-	-	-	-	-	-	2	-	-	1	C
Total no. of individuals	435	227	203	301	391	378	307	538	232	263	
Total no. of species or taxa	15	13	10	15	7	14	15	19	7	13	
Q-index	Q3	Q3	Q3	Q3	Q3	Q3	Q3	Q3	Q3	Q3	

Numbers shown are numbers of individuals per sample. Q indices calculated as follows. 1 or 2 individuals = Present, <1% = Scarce/Few, <5% = Small numbers, 5-10% = Fair numbers, 10-20% = Common, 25-50% = Numerous, 50-75% = Dominant, E >75% = Excessive.

The EPA faunal indicator groups of sensitivity to pollution are A (sensitive), B (less sensitive), C (tolerant), D (very tolerant) and E (most tolerant).

7.3 Appendix IV: Physiochemical Analysis

Detection Method	5 DAY ATU	GC	GC	GC	GC	GC	GC	GC	GC	GC	GC	GCMS	GCMS	GCMS	GCMS	
Method Detection Limit	<2mg/l	<10ug/l	<10ug/l	n/a	<10ug/l	<10ug/l	<10ug/l	<10ug/l	<10ug/l	<10ug/l	<10ug/l	<10ug/l	<10ng/l	<10ng/l	<10ng/l	<10ng/l
UKAS Accredited																
Sample Identity	BOD Unfiltered	Diesel Range Organics	Mineral Oil by GC	DRO Interpretation	Petrol Range Organics C4-C10	Petrol Range Organics C10+	Benzene	Toluene	Ethylbenzene	Total Xylene	MTBE	Naphthalene	Acenaphthylene	Acenaphthene	Fluorene	
Parameters of Water Quality	mg/l	ug/l	ug/l		ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ng/l	ng/l	ng/l	ng/l	
	≤3 (S)* ¹ ≤6 (C)* ¹ ≤5* ⁴	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AR1	3	355	231	See attached	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
AR2	3	<10	<10	See attached	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
AR3	3	<10	<10	See attached	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
BR1	2	<10	<10	See attached	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
BR2	3	<10	<10	See attached	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
BR3	4	<10	<10	See attached	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
CR1	4	<10	<10	See attached	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
CR2	3	<10	<10	See attached	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
CR3	<2	<10	<10	See attached	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
CR4	2	<10	<10	See attached	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
CR5	<2	<10	<10	See attached	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
DR1	2	<10	<10	See attached	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
DR2	<2	<10	<10	See attached	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
DR3	2	<10	<10	See attached	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
DR4	4	<10	<10	See attached	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10

Detection Method	GCMS	GCMS	GCMS	GCMS	GCMS	GCMS	GCMS	GCMS	GCMS	GCMS	GCMS	GCMS	GCMS	ICP	ICP
Method Detection Limit	<10ng/l	<10ng/l	<10ng/l	<10ng/l	<10ng/l	<10ng/l	<10ng/l	<10ng/l	<10ng/l	<10ng/l	<10ng/l	<10ng/l	<10ng/l	<0.4ug/l	<5ug/l
UKAS Accredited															
Sample Identity	Phenanthrene	Anthracene	Fluoranthene	Pyrene	Benzo(a)anthracene	Chrysene	Benzo(b)fluoranthene	Benzo(k)fluoranthene	Benzo(a)pyrene	Indeno(123cd)pyrene	Dibenzo(ah)anthracene	Benzo(ghi)perylene	Total 16 EPA PAHs	Dissolved Cadmium Low Level**	Dissolved Copper Low Level**
	ng/l	ng/l	ng/l	ng/l	ng/l	ng/l	ng/l	ng/l	ng/l	ng/l	ng/l	ng/l	ng/l	ug/l	ug/l
Parameters of Water Quality	-	-	-	-	-	-	-	-	-	-	-	-	0.0002* ₂	0.005* ₂	0.5* ₂ ≤0.005* ₄
AR1	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<0.4	6
AR2	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<0.4	<5
AR3	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<0.4	<5
BR1	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<0.4	<5
BR2	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<0.4	5
BR3	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<0.4	7
CR1	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<0.4	<5
CR2	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<0.4	<5
CR3	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<0.4	<5
CR4	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<0.4	5
CR5	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<0.4	<5
DR1	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<0.4	<5
DR2	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<0.4	<5
DR3	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<0.4	6
DR4	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<0.4	6

Detection Method	ICP	ICP	ICP	KONE	KONE	KONE	KONE	KONE	METER	METER	METER	METER	SPECTRO	SPECTRO	TITRATION
Method Detection Limit	<1ug/l	<5ug/l	<5ug/l	<1mg/l	<0.3mg/l	<0.05mg/l	<0.03mg/l	<0.3mg/l	<0.014mS/cm	<0.1mg/l	napH Units	<10mg/l	<0.2mg/l	<15mg/l	<5mg/l
UKAS Accredited															
Sample Identity	Dissolved Iron Low Level**	Dissolved Lead Low Level**	Dissolved Zinc Low Level**	Chloride	Nitrate as NO3	Nitrite as NO2	ortho Phosphate as PO4	Total Oxidised Nitrogen as N	Conductivity	Dissolved Oxygen	pH	Total Suspended Solids	Ammoniacal Nitrogen as N	COD Settled	Total Hardness
Parameters of Water Quality	ug/l	ug/l	ug/l	mg/l	mg/l	mg/l	mg/l	mg/l	mS/cm	mg/l	pH Units	mg/l	mg/l	mg/l	mg/l
	0.2* ²	0.05* ²	≤0.3 (S)* ¹ ≤1.0 (C)* ¹ ≤0.03* ⁴	250* ²	11.3* ²	0.03* ² ≤0.015* ⁴	2.2* ²	11.3* ²	1,500* ²	≥9 (S)* ¹ ≥7 (C)* ¹ 50%≥9* ⁴ ≥70* ⁵	6.0-9.0 * ¹ 6.0<pH<9.0* ² ≥6 and ≤9* ³ ≥6 ≤9 * ⁴ 7.0-9.0* ⁵	1,500* ²	0.23* ²	A3 waters 40* ⁶	-
AR1	606	<5	163	19	15.5	0.06	0.20	3.6	0.631	5.6	7.25	<10	0.4	<15	225
AR2	12	<5	24	15	26.8	0.09	0.50	6.2	0.653	7.2	7.41	<10	0.2	22	220
AR3	9	<5	33	14	13.1	0.08	0.20	3.0	0.644	7.7	7.76	20	<0.2	17	166
BR1	13	<5	28	19	24.9	0.09	0.10	5.8	0.614	6.7	7.78	<10	<0.2	<15	250
BR2	12	<5	11	18	13.4	0.15	0.10	3.1	0.673	6.9	7.55	<10	<0.2	18	204
BR3	46	<5	29	16	32.5	0.85	1.90	7.8	0.656	6.2	7.49	20	0.7	19	137
CR1	11	<5	55	23	59.5	0.34	<0.03	13.8	0.631	6.7	7.68	<10	<0.2	16	266
CR2	18	<5	64	26	26.3	2.60	0.20	6.8	0.719	6.4	7.53	<10	1.9	21	183
CR3	170	<5	31	13	19.5	0.21	0.40	4.5	0.355	6.8	7.30	<10	0.3	18	71
CR4	28	<5	19	21	23.5	0.47	0.80	5.6	0.654	7.0	7.65	<10	0.2	21	187
CR5	11	<5	27	18	28.2	0.16	<0.03	6.5	0.752	6.6	7.73	12	<0.2	<15	233
DR1	10	<5	9	34	37.7	0.13	0.10	8.7	0.712	5.7	7.48	<10	0.2	15	270
DR2	28	<5	109	18	12.7	0.05	<0.03	3.8	0.568	6.9	7.78	<10	<0.2	<15	154
DR3	22	<5	84	19	18.9	0.06	0.20	4.4	0.571	6.9	7.90	<10	0.4	<15	166
DR4	24	<5	110	25	25.4	0.27	0.20	5.9	0.645	6.1	7.61	<10	0.5	<15	158

*1 Freshwater Fish Directive (78/659/EEC); *2 Drinking Water Regulations (80/778/EEC); *3 Bathing Water Regulations (76/160/EEC); *4 Salmonid Waters Regulations; *5 Shellfish (79/923/EEC); *6 Surface Water Regulations (75/440/EEC)

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