17 Hydrology

17.1 Introduction

This chapter assesses the hydrological, surface water and drainage aspects associated with both the construction and operational phases of the proposed M7 Osberstown Interchange and R407 Sallins Bypass (i.e. the proposed scheme). The chapter initially sets out the methodology used for assessment (Section 17.2), describes the receiving environment (Section 17.3), examines the predicted impacts of the proposed scheme (Section 17.4), proposes mitigation measures (Section 17.5) and identifies residual impacts (Section 17.6).

The principal potential impacts to surface water quality and character of the receiving waters are associated with the crossing points of the proposed scheme and the potential for sediment loading and associated anthropogenic polluting substances entering surface watercourses as a result of both the construction and operational phases of the proposed scheme.

The assessed potential impacts arising from the proposed scheme include the following:

- Potential impact on surface water quality arising from re-alignment works and discharge of surface water run-off at the crossing points of the scheme.
- Impact on sites of aquatic ecological importance in proximity to surface water crossings.
- Impact on surface water abstraction in proximity to surface water crossings.
- Recognised amenity value of surface waters traversed by the proposed scheme may be impacted.
- Potential alteration (increase or reduction) of current flood risk at proposed crossing points and downstream of discharge locations.

17.2 Methodology

This chapter has been completed in accordance with the requirements of Section (50) Sub-section (2) & (3) of the Roads Act 1993 as amended, and in line with applicable guidelines as detailed in the following sections.

17.2.1 Environmental Protection Agency Guidance

The Environmental Protection Agency (EPA) of Ireland outlines the process of preparation and the content required for an EIS in two guidance documents:

- EPA Guidelines on the Information to be contained in Environmental Impact Statements, March 2002.
- EPA Advice Notes on Current Practice (in the preparation of Environmental Impact Statements), September 2003.

The hydrological impact assessment process utilises the principles and guidance of both of these documents to assess the potential impacts of the proposed road development on the existing hydrological environment and to provide mitigation measures to negate or minimise these potential impacts.

17.2.2 National Roads Authority Hydrological Guidance

In 2008 the National Roads Authority (NRA) published *Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology* for National Road Schemes (hereafter referred to as the "NRA Guidelines"). This document outlines a range of best practice guidelines for the assessment of hydrological impacts of road schemes. The NRA Guidelines reflect the principles and guidance already established by the EPA in their two guideline documents described above. However, the new NRA Guidelines are focused specifically on the hydrological environment and assessing the potential impacts of road schemes on surface water catchments. Consequently the NRA Guidelines provide a greater level of guidance on the methods and compilation of a hydrological impact assessment which has informed the environmental impact assessment process for the proposed road development.

Further guidance from the NRA was also utilised in the development of the methodology from their 2009 *Environmental Impact Assessment of National road Schemes – A Practical Guidance.*

Due cognisance was also paid to the surface water and drainage guidance outlined in the National Roads Authority *Design Manual for Roads and Bridges*.

The hydrological impact assessment methodology is in accordance with the guidance outlined in Section 5.6 of the NRA Guidelines. Impact categories, impact duration and type/nature of impacts have been taken into account in this assessment using Table 17.1 for the estimation of magnitude of impact with examples on hydrological attributes and Table 17.2 for the significance ratings. The impact ratings are in accordance with impact assessment criteria provided in the previously mentioned EPA guidance documents also.

The rating of the potential impact of the proposed road development on the existing hydrological environment has been assessed by classifying the importance of the relevant hydrological features of the specific catchments the proposed scheme traverses and quantifying the likely magnitude of any impact on these catchment features and the catchment as a whole.

Table 17.1: Criteria for Rating Impact Significance at EIA Stage - Estimation of Magnitude of Impact on Hydrology Attributes

Magnitude of Impact	Criteria	Examples
Large Adverse	Results in loss of attribute and/or quality and integrity of attribute	Loss or extensive change to a water body or water dependent habitat. Increase in predicted peak flood level >100mm[1]. Extensive loss of fishery. Calculated risk of serious pollution incident >2% annually[2]. Extensive reduction in amenity value.
Moderate Adverse	Results in impact on integrity of attribute or loss of part of attribute	Increase in predicted peak flood level >50mm[1]. Partial loss of fishery. Calculated risk of serious pollution incident >1% annually[2]. Partial reduction in amenity value.
Small Adverse	Results in minor impact on integrity of attribute or loss of small part of attribute	Increase in predicted peak flood level >10mm[1]. Minor loss of fishery. Calculated risk of serious pollution incident >0.5% annually[2]. Slight reduction in amenity value.
Negligible	Results in an impact on attribute but of insufficient magnitude to affect either use or integrity	Negligible change in predicted peak flood level[1]. Calculated risk of serious pollution incident <0.5% annually[2]
Minor Beneficial	Results in minor improvement of attribute quality	Reduction in predicted peak flood level >10mm[1] Calculated reduction in pollution risk of 50% or more where existing risk is <1% annually[2].
Moderate Beneficial	Results in moderate improvement of attribute quality	Reduction in predicted peak flood level >50mm[1]. Calculated reduction in pollution risk of 50% or more where existing risk is >1% annually[2].
Major Beneficial	Results in major improvement of attribute quality	Reduction in predicted peak flood level >100mm[1].

1 refer to Annex 1, Methods E and F, Annex 1 of HA45/09 (Highways Agency 2009)

2 refer to Appendix B3/Annex 1, Method D, Annex 1 of HA45/09 (Highways Agency 2009)

Table 17.2: Rating of Significant Environmental Impacts at EIA Stage

		Magnitude of Impact			
		Negligible	**Small**	**Moderate**	**Large**
Importance of Attribute	**Extremely High**	Imperceptible	Significant	Profound	Profound
	Very High	Imperceptible	Significant/ Moderate	Profound/ Significant	Profound
	High	Imperceptible	Moderate/ Slight	Significant/ Moderate	Profound/ Significant
	Medium	Imperceptible	Slight	Moderate	Significant
	Low	Imperceptible	Imperceptible	Slight	Slight/ Moderate

17.2.3 Legislation and Guidance

The EU Water Framework Directive 2000/60/EC came into force on 22 December 2000, and was enacted into Irish legislation through SI 722 of 2003 European Communities (Water Policy) Regulations 2003. This legislation and regulation is a significant piece of legislation for water policy, as it provides a co-ordinated approach across Europe for all water policies, establishing a management structure for future water policy. Key objectives of the Directive are to:

- Protect all waters, including rivers, lakes, groundwater, transitional and coastal waters.
- Achieve “good status” in all waters by 2015, and maintaining “high status” where the status already exists.
- Have water management programmes and strategies based on the whole River Basin Districts (RBD).

The strategies and objectives of the Water Framework Directive in Ireland have been influenced by a range of legislation and regulation including:

- SI 293 of 1988 European Communities (Quality of Salmonid Waters) Regulations 1988.
- Local Government (Water Pollution) Acts 1977 – 1990.
- SI 258 of 1998 Water Quality Standards for Phosphorus Regulations 1998.

The implementation of the Water Framework Directive and its associated policies has necessitated the introduction of new regulations in Ireland including:

- SI 272 of 2009 European Communities Environmental Objectives (Surface Waters) Regulations 2009.

Under the Water Framework Directive, and SI 722 of 2003 European Communities (Water Policy) Regulations 2003, the water quality of River Basin Districts is assessed biologically, physically and chemically. Assessment using surveys is predominately conducted by the EPA and local authorities, and complemented by other government bodies including the Central Fisheries Board and the Marine Institute. Table 17.3 summarises the quality classes used to establish and monitor the condition of rivers and streams in Ireland.

Table 17.3: River and Stream Water Quality Classes (Clabby et al., 2004; Clabby et al., 2005)

Biotic Indices	Community Diversity	Quality Status	Condition
Q5	High	Good	Satisfactory
Q4	Reduced	Fair	Satisfactory
Q3	Low	Doubtful	Unsatisfactory
Q2	Very Low	Poor	Unsatisfactory
Q1	Little/None	Bad	Unsatisfactory

Where 'Condition' refers to the likelihood of interference with beneficial or potential beneficial uses. The intermediate values (Q1-2, 2-3, 3-4 etc.) below denote transitional conditions.

Biotic Indices	Quality Status	Quality Class
Q5, Q4-5, Q4	Unpolluted	Class A
Q3-4	Slightly polluted	Class B
Q3, Q2-3	Moderately polluted	Class C
Q2, Q1-2, Q1	Seriously polluted	Class D

Where biotic indices or Quality (Q) value indicates specified groups of macro-invertebrates sensitivity to pollution, with:

Q5 =	Mostly pollution sensitive, a few to numerous less pollution sensitive, a few pollution tolerant, and no very pollution tolerant or most pollution tolerant macro-invertebrate species
Q4 =	At least one pollution sensitive, few to numerous less pollution sensitive, numerous pollution tolerant, and a few or no very pollution tolerant or mostly tolerant macro-invertebrate species
Q3 =	No pollution sensitive, few or no less pollution sensitive, dominant in pollution tolerant, a few to common in very pollution tolerant, and few or no most pollution tolerant macro-invertebrate species
Q2 =	No pollution sensitive or less sensitive, few or no pollution tolerant, dominant in very pollution tolerant, and few to common in most pollution tolerant macro-invertebrate species
Q1 =	No pollution sensitive, less sensitive, and pollution tolerant, a few to no very pollution tolerant, and dominant in most pollution tolerant macro-invertebrate species

Where a toxic effect is apparent or suspected, the suffix 0 is added to the biotic indices, for example Q2/0.

Quality classes relate to the potential beneficial use of a water body, with:

A =	Highest water quality, suitable for abstraction, game fisheries, very high amenity value, orthophosphate ~ 0.015 mg P/L, dissolved oxygen close to 100%, maximum BOD is < 3mg/L
B =	Variable water quality, potential problems for abstraction, game fish at risk, considerable amenity value, orthophosphate ~ 0.045 mg P/L, dissolved oxygen <80% to >120%, maximum biochemical oxygen demand (BOD) is occasionally elevated
C =	Doubtful water quality, advanced treatment of abstracted water, coarse fisheries, reduced amenity value, orthophosphate ~ 0.070 mg P/L, dissolved oxygen is very unstable with potential fish kills, maximum BOD is high at times
D =	Poor to bad water quality, low grade to limited abstraction, fish usually absent, low or no amenity, orthophosphate >0.1 mg P/L, dissolved oxygen is low to zero, maximum BOD is usually high to very high

17.2.4 Supplementary Guidance and Information

A range of supplementary best practice hydrological principles and guidance from a range of sources was also utilised for the hydrological impact assessment of the proposed road development including:

- Rural and Urban Hydrology (Mansell, 2003).
- Construction, Replacement or Alteration of Bridges and Culverts (Office of Public Works).
- The Greater Dublin Strategic Drainage Study (Dublin City Council et al., 2005).
- Guidelines for the Crossing of Watercourses during the construction of national roads schemes (NRA, 2008).
- Methods of Flood Estimation, A guide to the Flood Studies Report, March 1978.
- The Planning System and Flood Risk Management - Guidelines for Planning Authorities (OPW, 2009)

17.2.5 Consultation

Consultation for the hydrological impact assessment was undertaken with the following organisations and interested parties:

- Office of Public Works (OPW).
- Kildare County Council (KCC).
- Electricity Supply Board (ESB).
- Environmental Protection Agency (EPA).
- Inland Fisheries Ireland (IFI).

17.2.6 Hydrological Assessment

The assessment of water quality for the proposed road development comprises a desktop study examining water quality data supplied by the EPA from their Water Quality Monitoring Points (WQMPs) compared to relevant water quality standards and guidance.

As part of the hydrological assessment, a detailed flood study was undertaken for the River Liffey crossing points, to identify potential alteration (increase or reduction) of current flood risk.

17.3 Existing Environment

This section provides an overview of the principal river basin catchments and tributary network which forms the existing hydrological environment. It also describes the specific areas of the river basins and the sub-catchments which the proposed road development traverses.

17.3.1 River Liffey

The River Liffey catchment covers an area of approximately 1,122 km^2, with the main channel being 120 km in length, from its source on Kippure Mountain in Co Wicklow to the tidal divide at Islandbridge in Dublin City. The catchment above Islandbridge Weir includes large areas of Counties Wicklow and Kildare with smaller areas of County Meath and also of South Dublin County Council, Fingal County Council and Dublin City Council. Poulaphouca reservoir is located on the upper Liffey which is used for hydroelectric generation by the ESB and as one of the major sources of Dublin's water supply.

The proposed road development is located in the catchment of the River Liffey and crosses this watercourse twice. The catchment area of the River Liffey up to the first crossing of the proposed road development is calculated at approximately 631 km^2 with an urban landcover of approximately 4%. Refer to **Figure 17.2 V3** for the location of the River Liffey in the vicinity of the proposed scheme.

17.3.1.1 Water Quality

The EPA conducts water quality assessment for both physical-chemical and biological water quality at various locations along the River Liffey. The monitoring stations in the vicinity of the proposed scheme are as follows and as shown on **Figure 17.1 V3**:

- (1100) Caragh Br
- (1200) Castlekeely Ford (RHS)
- (1400) Millicent Br
- (1500) Alexandra Br. Clane (d/s side)

The most recent EPA survey of the Liffey took place in 2010 and indicated that water quality in the area nearest Osberstown was considered moderate. The previous seven years of survey Q (Quality) ratings are indicated in Table 17.4.

Table 17.4: River Liffey Biological Quality Ratings (EPA, 2013)

Biological Quality Rating (Q Value)							
Station	Year						
	1991	1995	1998	2002	2005	2007	2010
1100	4-5	-	-	-	-	-	-
1200	3-4	3-4	2	4	4	3-4	3-4
1400	3-4	3-4	3	-	-	-	-
1500	3-4	3	3-4	4	3-4	3-4	4

17.3.1.2 Surface Water Flow

The River Liffey has a history of flood risk to land along its banks at various locations. At the location of the proposed road development watercourse crossing points there are no historical records of flooding on the National Flood Hazard Mapping website (www.floodmaps.ie); however a flood model was created for the River Liffey which shows there is a flood risk for storms with a return period of 1 in 100 years in the existing situation.

There are three hydrometric gauges on the River Liffey in the vicinity of the proposed road development operated by the Environmental Protection Agency (EPA) and Electricity Supply Board International (ESBI); Leinster Aquaduct (EPA Station Number 09033), Millicent Bridge (EPA Station Number 09043) and Osberstown (EPA Station Number 09008). However, there are inadequate records for these gauges to calculate flow ratings for the River Liffey in this area. Annual maximum flows recorded at Straffan (EPA Station Number 09013), downstream of the proposed road development watercourse crossing, were obtained by ESBI from 1982 to 1999, recording a maximum flow in June 1993 of 113.21m^3/s. Refer to **Figure 17.1 V3** for the location of the hydrometric gauges.

A flow of 308.0 m^3/s was calculated for the River Liffey at the proposed road development crossing for a storm with a 1 in 100 year return period using catchment characteristics.

17.3.2 Grand Canal

The Grand Canal will be crossed by the R407 Sallins Bypass near the existing railway line, west of Sallins. The canal is a proposed Natural Heritage Area (pNHA). Refer to **Figure 17.2 V3** for the location of the Grand Canal and pNHA in the vicinity of the proposed scheme.

17.3.2.1 Water Quality

The Grand Canal is designated as an Artificial Water Body (AWB) by the Water Framework Directive and therefore is not subject to the same Biotic or Q Rating classification as rivers. Canals are required to achieve good ecological potential rather than ecological status. Ecological potential means that the water body is managed to achieve the biology that can be attained given its artificial nature.

The ecological potential classification system is set out by the EPA and is summarised in Table 17.5. For classification purposes the ecological potential can be maximum, good, moderate, poor or bad.

Table 17.5: Grand Canal Ecological Potential Classification (EPA, 2009 & 2010)

Ecological Potential						
	Status					
Artificial Water Body (AWB)	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Grand Canal Main Line East of Lowtown (GCEEa)[1]	Good	Good	Good	Good	Good	Good
Grand Canal Main Line East of Lowtown (GCESe)	Good	Good	Good	Good	Good	Good
Grand Canal Main Line West of Lowtown (GCWSe)	Good	Good	Good	Good	Good	Good

[1] Section of the Grand Canal AWB that the proposed R407 Sallins Bypass will cross.

17.3.3 Naas Stream

The Naas Stream is a tributary of the River Liffey in the vicinity of the proposed road development. It carries surface water flow from a small sub-catchment of the River Liffey, outfalling to the River Liffey upstream of the proposed road development crossing. The Naas Stream is culverted under the existing M7 Motorway via a 750mm diameter pipe.

The proposed M7 Osberstown Interchange western auxiliary lanes require widening of the existing M7 Motorway carriageway where the Naas Stream is currently crossed. Refer to **Figure 17.2 V3** for the location of the Naas Stream in the vicinity of the proposed scheme.

There is an existing hydrometric gauge on the Naas Stream north of the M7 Motorway operated by the Environmental Protection Agency (EPA Station Number 09042, refer to **Figure 17.1 V3**). This gauge records stream level and flow. Daily maximum flow records were obtained from the EPA. The gauge record starts in May 2009 and the maximum flow rate over the recording period was recorded on November 2009 at 2.31m³/s.

17.3.4 Existing Carriageway Drainage and Outfalls

The existing M7 in the vicinity of the M7 Osberstown Interchange shows a constant fall longitudinally towards the location of the existing M7 accommodation overbridge. The road surface water drainage on the M7 is currently provided by a system of filter drains. In the vicinity of the M7 Osberstown Interchange the M7 storm water runoff outfalls at four locations, into the Naas Stream and three adjacent land drains to the east which converge into the Osberstown Stream, which then converges into the Naas Stream further downstream, refer to **Figure 17.2 V3**. Two of the three adjacent land drains carry the outflow from the Osberstown Attenuation Pond as detailed in Section 17.3.5 below.

The Naas Stream and the three adjacent land drains flow in a northerly direction crossing under the M7 via piped culverts. The existing M7 Motorway drainage and culverts shall be extended, diverted, maintained and protected from the works as required.

The road surface drainage of the existing R407 Clane Road is collected via a kerb and gully network into a sewer which flows towards the treatment plant in Sallins town. The existing R407 Clane Road drainage shall be diverted, maintained and protected from the works as required.

17.3.5 Osberstown Attenuation Pond and Osberstown Stream

The existing attenuation pond is an artificial waterbody to the south of the M7, fed by two small inflowing streams from the south. The pond is approximately 1 hectare in area. It was constructed in the mid-2000's to attenuate the surface water flows from the planned development in Millennium Park. The assumed catchment area is 127 hectares.

There are two outlets from the pond flowing in a northerly direction. The outlet flows are culverted under the M7 via two 900 mm diameter pipes (as detailed in section 17.3.4 above) where they then enter drainage ditchsand converge into the Osberstown Stream which discharges to the Naas Stream and ultimately to the River Liffey.

The proposed M7 Osberstown Interchange crosses the northwest corner of the Osberstown Attenuation Pond, along with the outlet pipes and drainage ditch.

17.4 Predicted Impacts on Hydrology

17.4.1 Construction Phase

17.4.1.1 General Construction Impacts

Chapter 4 *Description of the Proposed Scheme* outlines the construction activities in detail. Section 17.5 outlines the extensive mitigation measures that will be required to minimise any potential risk to the hydrological environment and consequently aquatic ecology and flood risk during the construction phase of the proposed road development. Construction activities pose a significant risk to watercourses. The main contaminants arising from construction activities include:

- Silt: elevated silt loading in surface water discharge may result from construction activities. Elevated silt loading leads to long term damage to aquatic ecosystems by clogging the gills of fish and smothering spawning grounds. Chemical contaminants bind to the organic particles attached to silt which can lead to increased bioavailability of these contaminants. Silt also stunts aquatic plant growth, limiting dissolved oxygen supplies and reducing the aquatic ecosystems quality. Silt can also contribute to flooding when it deposits, reducing the carrying capacity of the system and potentially causing blockages.
- Concrete, bentonite, grout and other cement-based products are highly alkaline and corrosive and can have significant negative effects on surface water quality. Cement-based products generate very fine, highly alkaline silt (pH 11.5) that can physically damage fish by burning their skin and blocking their gills. The alkaline silt can also smother vegetation and the bed of watercourses and can mobilise pollutants such as heavy metals by altering the water's pH. Concrete and grout pollution is often highly visible.

- Hydrocarbons: accidental spillage from construction plant and storage depots.
- Faecal coliform: contamination from inadequate containment and treatment of on-site toilet and washing facilities.

The extent of the risk of these impacts is determined by the proximity of the construction activity to the watercourse, and the sensitivity of the watercourse.

Construction activities within and alongside surface waters for the construction of bridges or culverts or re-alignment can also contribute to a deterioration of water quality. In-stream and bank-side construction works can alter the bed and bank morphology of a river which can lead to downstream modification of erosion and deposition rates. The re-suspension of bottom sediment can also lead to a deterioration of water clarity, increase turbidity and potentially release contaminants that were locked in the sedimentary matrices. As a consequence, in-stream construction work is considered to be a severe disruption to aquatic ecology.

In-stream and bank side construction works, which may be required where watercourse realignment, new outfalls and culverting takes place along the proposed road development, can cause a loss of conveyance, causing localised increased flood risk upstream. Equally, upsizing/altering the size of an existing culvert can cause an increase to downstream flood risk. Construction traffic can also alter the soil structure, leading to a temporary increase in rainfall runoff rates.

Table 17.6 provides details on the watercourse crossings and outfalls of the proposed scheme.

Table 17.6: Watercourse Crossings and Outfalls of the Proposed Scheme

Road Chainage	Crossing	OutFall	Watercourse	Location	
				E	**N**
Sallins Bypass Ch.1+970	Yes	Yes	River Liffey	288119	222996
Sallins Bypass Ch.3+050	Yes	Yes	River Liffey	288312	224012
Sallins Link Road Ch.0+550	-	Yes	River Liffey (via existing drainage ditch)	288286	223262
Sallins Bypass Ch.1+570	Yes	-	Grand Canal	228140	222601
M7 Osberstown Interchange Eastbound Diverge Slip & Westbound Merge Slip	Yes	Yes	Naas Stream	287546	220879
Sallins Bypass Ch.0+080	Yes	-	Osberstown Stream	287951	221439

General Construction Impact Assessment

The general construction risks outlined above are considered as significant adverse temporary impacts to surface water systems as a consequence of the potential ecological effects caused by a potential spillage or in-stream work during construction of the proposed road development which would impact aquatic ecosystems. However, these adverse impacts can be negated and re-evaluated as imperceptible and temporary impacts on the basis that the construction mitigation measures outlined in Section 17.5.1 are implemented. The extent of the risk of these impacts is determined by the proximity of the construction activity to the watercourse, and the sensitivity of the watercourse, and as both of these criteria vary at each location, the specific impacts are reviewed below.

17.4.1.2 Specific Construction Impacts

River Liffey

The proposed road development traverses the River Liffey at two locations. The River Liffey bridge crossings, while traversing the floodplain, will not directly impact the river channel as the bridges do not require in-stream piers. The potential impact to the river channel morphology itself during the bridge construction can therefore be described as negligible and temporary.

However, there will be significant construction work on the floodplain of the River Liffey to facilitate the construction of the River Liffey bridge crossings.

The surface water drainage and carriageway drainage will require the construction of new outfall connections to the River Liffey channel. The construction of these outfalls can potentially lead to direct impacts to water quality and river morphology during in-stream works and indirect impacts to the downstream catchment.

The potential construction impact to the River Liffey and the catchment as a whole can therefore be described as significant adverse impact. However, these impacts can be negated and re-evaluated as imperceptible and temporary on the basis that the construction mitigation measures outlined in Section 17.5.1 are implemented.

Grand Canal

The proposed road development traverses the Grand Canal. The Grand Canal bridge crossing will not impact on the Grand Canal channel as the design for the bridge does not require in-stream piers or any works to the canal embankment. The potential impact to the Canal channel morphology itself during the bridge construction can therefore be described as negligible and temporary.

All proposed surface water drainage and carriageway drainage will be diverted towards the River Liffey therefore requiring piped drain crossings under the canal. The construction of these features can potentially lead to direct impacts to water quality and canal morphology during in-stream works and indirect impacts to the downstream channel.

The potential construction impact to the Grand Canal can therefore be described as a moderate adverse impact. However, these impacts can be negated and re-evaluated as imperceptible and temporary on the basis that the construction mitigation measures outlined in Section 17.5.1 are implemented.

Naas Stream

The proposed road development traverses the Naas Stream at the existing M7 crossing of the Naas Stream, where widening will be required due to the auxiliary lanes required for the M7 Osberstown Interchange.

The construction of this widening can potentially lead to direct impacts to water quality and stream morphology.

The three land drains crossing the existing M7 Motorway east of the Naas Stream through pipe culverts converge further downstream into the Osberstown Stream which then converges into the Naas Stream as shown in **Figure 17.2 V3**. Two of these land drains are outlets of the Osberstown Attenuation pond. These pipe culverts and land drains will be extended and diverted as required to accommodate the proposed M7 Osberstown Interchange slip roads. The surface water drainage and carriageway drainage in the vicinity of the M7 Osberstown Interchange will outfall to these land drains also. The construction of the outfalls, culvert extensions and diversions can potentially lead to in-direct impacts to the Naas Stream water quality and channel morphology downstream.

The potential construction impact to the Naas Stream can therefore be described as a moderate to significant adverse impact. However, these impacts can be negated and re-evaluated as imperceptible and temporary on the basis that the construction mitigation measures outlined in Section 17.5.1 are implemented.

Osberstown Attenuation Pond and Osberstown Stream

The proposed road development traverses the north western corner of the Osberstown Attenuation Pond. The attenuation pond will have to be reshaped to ensure adequate flood storage is maintained.

The attenuation pond outlet flows cross the M7 through pipe culverts before converging further downstream into the Osberstown Stream and then the Naas Stream as detailed above. These pipe culverts and land drains will be extended and diverted as required to accommodate the proposed M7 Osberstown Interchange slip roads. The construction of the culvert extensions and diversions can potentially lead to in-direct impacts to the Osberstown Attenuation Pond upstream and Osberstown Stream downstream.

The potential construction impact to the Osberstown Attenuation Pond and Osberstown Stream can therefore be described as a moderate to significant adverse impact. However, this impact can be negated and re-evaluated as imperceptible and temporary on the basis that the construction mitigation measures outlined in Section 17.5.1 are implemented.

17.4.2 Operational Phase

17.4.2.1 General Operational Impacts

The operational effects associated with proposed road development can be categorised as either affecting water quality and subsequently aquatic ecology or the alteration of flooding patterns within the catchments the proposed scheme traverses.

Water Quality

Surface water run-off from hardstanding is likely to contain mild non-point contamination. Consequently the quality of the surface water downstream and in close proximity of the proposed scheme could potentially be impacted by a number of sources in the absence of appropriate mitigation measures, these potential sources include:

- Road Runoff: road runoff can contain a variety of contaminants. These arise from the degradation of road surfaces and vehicles, vehicle exhaust combustion by-products, soil erosion and aerial deposition. The primary contaminants known to occur in routine road runoff include hydrocarbons, particulate matter and heavy metals.
- Winter Maintenance: application of salt and grit during icy conditions on the road.
- Accidental Spillage: spillages from accidents involving goods transportation are potentially the most serious source of contaminants to a watercourse from a road.

These potential sources are discussed in greater detail below.

Road Runoff

Contaminants arising from road runoff regarded as having the greatest potential to adversely affect aquatic ecosystems include suspended solids, hydrocarbons and heavy metals. The primary hydrocarbons of concern are the petrochemical derived group which includes petrol, fuel oils, lubricating oils and hydraulic fluids. These are generally liquid and water insoluble.

A wide range of heavy metals are known to occur in road runoff, but the primary metals of concern are cadmium (Cd), lead (Pb), copper (Cu) and zinc (Zn). All of these metals are included in the *EU Dangerous Substances Directive (76/464/EEC) and the proposed EU Priority Contaminating Substances Directive* which forms an addition to the *Water Framework Directive.* Cd is included on the EU blacklist of dangerous substances, and as such its uses are now restricted. This has led to a considerable decrease in concentrations of Cd in road runoff. The concentration of Pb is also reducing in road runoff due to the substantial reduction of Pb as a fuel additive since the mid 1980's. Pb has limited solubility (between 1 – 10%), so that the majority of Pb in road runoff is bound to particulate matter. Cu and Zn are used widely in the automotive industry, and are moderately soluble in water (Buggy & Tobin, 2006).

Sediments are the dominant mass of pollutants from road runoff. While most of the sediment load is chemically inert, the increase in turbidity of a watercourse has detrimental impacts on the aquatic system's quality. The sediment load also acts as the primary transport mechanism for contaminants in the water column, contaminants bind to sulphides and organic matter particles that form suspended colloidal particles. Bound together in this fashion contaminants have the potential to become bioavailable (Buggy & Tobin, 2006).

The main sources of pollution in routine road runoff are vehicular in origin. However, studies have shown no clear correlation between traffic volumes and runoff quality (Buggy & Tobin, 2006). The magnitude of the impact also depends largely on the value and the sensitivity of the receiving watercourse. There will be an increase in hard surface areas and an increased volume of traffic using the proposed scheme. This will lead to an increased risk of pollution to the local watercourse.

Winter Maintenance

Salt applications to road surfaces to mitigate against icy conditions, will result in an increased salinity, pH, conductivity and total dissolved solids concentrations to the receiving aquatic system following application.

Increasing the salinity of the watercourse can adversely affect the ecological balance of the aquatic system and increase the bioavailability of chemical contaminants.

Accidental Spillage

Potentially the most serious source of contamination to a watercourse associated with roads is an accidental spillage resulting from individual accidents involving transported goods. The proposed scheme incorporates the provision of an online emergency containment system at the R407 Sallins Bypass, the M7 Osberstown Interchange and the Link Roads, which can be initiated by the emergency services. The pollutant will be prevented from entering the outfall by a valve mechanism operated by the emergency services and stored in this facility until the emergency services can safely remove it.

Flood Risk

The construction of new paved/hardstand areas could result in rapid runoff of surface water, with increased risk of flooding downstream. Any work modifying the floodplain and the river channel itself can result in morphological change as well as alteration of flooding patterns. The following subsections outline the operational impact a road development can have on the hydrological and morphological regime.

Re-alignment

Stream or river re-alignment may be required in order to accommodate culverting. The re-alignment effectively removes a section of the stream/river including its morphology, bank-side and in-stream ecology. In addition, re-alignment can potentially lead to an exacerbation of flood risk and deterioration of the hydraulic capacity of the surface water feature.

Diversion of runoff from one catchment to another

At some locations, the creation of the proposed road development perpendicular to the natural line of drainage may lead to the interception of overland flow into a drainage system that will convey it into the nearest watercourse. This may lead in some cases to permanent diversion of flow that would have flowed into one area of a catchment into another.

Conveyance

Conveyance is a channel's ability to pass flow. The construction of an inappropriately sized structure in the floodplain can lead to reduced conveyance, which would result in increases in water level upstream of that structure.

Floodplain storage

The construction of a structure within the floodplain results in the loss of an area that could have been used to store water (floodplain storage). This will result in increased flows downstream, with an increased risk of flooding.

General Operational Impact Assessment

The general operational risks outlined above are considered as moderate to significant adverse impacts to surface water systems as a consequence of the potential ecological affects caused by a potential accidental spillage during operation of the proposed road development which would impact aquatic ecosystems. However, these impacts can be negated and re-evaluated as imperceptible permanent impacts on the basis that the operation mitigation measures outlined in Section 17.5.2 are implemented.

As was the case with the construction impacts, the extent of the risk of the operational impacts is determined by the proximity of the proposed road development to the surface watercourse and the sensitivity of the surface watercourse. As both of these criteria vary at each location, the specific impacts are reviewed below.

17.4.2.2 Specific Operational Impacts

River Liffey

There is a potential impact on water levels upstream of the crossing points as the existing floodplain is extensive and there is potential for adverse impacts in terms of flooding to land and properties upstream. However findings from the hydraulic modelling showed that the proposed two span and three span structural crossings in combination with ground levelling in the vicinity of the structure had no significant effect on existing flood levels or the extent of flooding in the area.

Operation impacts associated with outfalling road runoff and surface water discharge to the River Liffey from the proposed road development have the potential to affect water quality and flow within the catchment and possibly as a consequence, aquatic ecology.

The potential operation impact to the River Liffey can be described as significant adverse impact. However, all of these impacts can be negated and re-evaluated as imperceptible permanent impacts on the basis that the operation mitigation measures outlined in Section 17.5.2 are implemented.

Grand Canal

The proposed road development traverses the Grand Canal and all proposed surface water drainage and carriageway drainage shall be diverted towards the River Liffey crossing under the canal. Therefore there is no operational impact on the Grand Canal.

Naas Stream

Alteration of the Naas Stream channel through potential extensions to the Naas Stream culvert and tributary watercourse culverts, and realignment as a measure to ensure suitable fisheries passage and habitats, reduce flood risk and maintain conveyance can potentially lead to direct impact to stream morphology.

Operation impacts associated with outfalling road runoff and surface water discharge to the Naas Stream from the proposed road development have the potential to affect water quality and flow within the catchment and possibly as a consequence, aquatic ecology.

The potential operation impact to the Naas Stream can be described as a moderate to significant adverse impact. However, all of these impacts can be negated and re-evaluated as imperceptible permanent impacts on the basis that the operation mitigation measures outlined in Section 17.5.2 are implemented.

Osberstown Attenuation Pond and Osberstown Stream

There is potential impact to the Osberstown Attenuation Pond and Osberstown Stream flow and possibly as a consequence aquatic ecology, associated with outfalling road runoff and surface water discharge to the inlet and outlet landdrains to the pond.

Alteration to the Osberstown Stream channel through culverting and extensions to tributary land drain culverts as a measure to maintain conveyance can potentially lead to direct impact to stream morphology.

The potential operation impact to the Osberstown Attenuation Pond and Osberstown Stream can be described as moderate to significant adverse impact. However, all of these impacts can be negated and re-evaluated as imperceptible permanent impacts on the basis that the operation mitigation measures outlined in Section 17.5.2 are implemented.

17.5 Mitigation Measures

17.5.1 Construction Phase

Prior to construction an Environmental Operating Plan (EOP) will need to be prepared by the Contractor. The following will be implemented as part of the EOP:

- Prepare an Emergency Response Plan detailing the procedures to be undertaken in the event of a spill of chemical, fuel or other hazardous wastes, a fire, or non-compliance incident with any permit of license issues. The Plan should also address flood risks.
- Ensure staff are trained in the implementation of the Emergency Response Plan and the use of any spill control equipment as necessary.

- Prepare a Water Quality Management Plan (please see below for further details) to ensure compliance with current environmental quality standards (EQSs) specified by legislation
- Prepare method statements for the control, treatment and disposal of potentially contaminated surface water.
- Inform the relevant fisheries board of all in-stream construction work scheduled to take place.
- Obtain all necessary permits and licences for in-stream construction work and culverting from Kildare County Council, the OPW and the NPWS.
- Prepare a site plan showing the location of all surface water drainage lines and proposed discharge points to surface water. This will also include the location of all existing and proposed surface water protection measures, including monitoring points, sediment traps, settling basins, interceptors etc.

Dewatering and surface water runoff discharges on the site, during construction and prior to completion will be controlled and discharged to the existing surface water network at agreed rates of flow in consultation with Kildare County Council. All necessary facilities will be incorporated (settlement tanks/ponds/oil/grit interceptors) to ensure that only clean surface water is discharged (to meet the relevant standards) to the surface watercourses.

In addition, pollution of aquatic systems during the construction phase will be reduced by the implementation of the following best practice mitigation measures. Due cognisance is paid to the following guidance documents for construction work on, over or near water:

- Eastern Regional Fisheries Board for use by all Regional Fisheries Boards - Requirements for the Protection of Fisheries Habitat during Construction and Development Works at River Sites.
- Central Fisheries Board – Channels and Challenges, The Enhancement of Salmonid Rivers.
- CIRIA – Guideline Document C532 Control of Water Pollution from Construction Sites. Guidance for consultants and contactors.
- CIRIA – Guideline Document C648 Control of Water Pollution from Linear Construction Projects.
- CIRIA – Guideline Document C697 The SUDS Manual.
- CIRIA – Guideline Document C624 Development and flood risk - guidance for the construction industry.
- UK Environment Agency – PPG5 Pollution Prevention Guidelines Works and Maintenance in or near Water.

Based on these guidance documents the following mitigation measures are prescribed for the construction phase to protect all the catchments, watercourses and ecologically protected areas with which the proposed scheme interacts (traversing catchments, watercourse crossings and discharging to) as outlined in Section 17.4.1 and Tables 17.4:

- Use of settlement ponds, silt traps and bunds and minimising construction within watercourses.

- Where pumping of water is to be carried out, filters will be used at intake points and discharge will be through a sediment trap.
- Management of excess material stockpiles to prevent siltation of watercourse systems through runoff during rainstorms will be undertaken. This may involve allowing the establishment of vegetation on the exposed soil and surrounding stockpiles with cut-off ditches to contain runoff.
- All land drains and streams that occur in areas of land that will be used for site compound/storage facilities will be fenced off at a minimum distance of 5 m. In addition, measures will be implemented to ensure that silt laden or contaminated surface water runoff from the compound does not discharge directly to the watercourse.
- Site compounds and storage facilities will be located at a minimum distance of 50 m from the River Liffey watercourse.
- Surface water flowing onto the construction area will be minimised through the provision of berms and diversion channels.
- Any surface water abstracted from a river for use during construction shall be through a pump fitted with a filter to prevent intake of fish.
- All chemical and fuel fill points and hoses will be contained within bunded areas.
- Foul drainage from all site offices and construction facilities will be contained and disposed of in an appropriate manner to prevent pollution of rivers and local watercourses in accordance with the relevant statutory regulations.
- Protection measures will be put in place to ensure that all hydrocarbons used during the construction phase are appropriately handled, stored and disposed of in accordance with recognised standards as laid out by the EPA.
- Routine monitoring of water quality will be carried out at appropriate locations during construction. Parameters to be monitored will include pH, Total Suspended Solids (TSS), BOD and COD. In addition, biological monitoring (Q value assessment) will be carried out.
- The quality of surface water discharge from the site will meet water quality targets specified to protect riparian ecosystems and protected species. Appropriate current Environmental Quality Standards specified by legislation will be utilised to determine specific water quality targets for each catchment.
- Riparian vegetation will be fenced off to provide a buffer zone for its protection and will be specified in consultation and agreement with the appropriate Fisheries Board and NPWS.

For further detail on mitigation measures required to protect ecology please refer to Chapter 14 - *Ecology*.

Particular risks are posed to water quality when construction is taking place over or near surface waters. As previously mentioned, concrete and cementicious compounds have a deleterious effect on water chemistry and aquatic habitats and species. Due to the sensitivity of all of the receiving surface waters in the study area, alternative construction methods shall be investigated if work in or in close proximity to the water is necessary. For example, use of pre-cast or permanent formwork will reduce the amount of in-situ concreting required. Ready-mix suppliers will be used in preference to on-site batching.

For any construction work within or directly adjacent to the water the following mitigation measures will apply:

- Hydrophilic grout and quick-setting mixes or rapid hardener additives shall be used, to promote the early set of concrete surface exposed to water. When working in or near the surface water and the application in situ cannot be avoided, the use of alternative materials such as biodegradable shutter oils shall be considered.
- Where concrete is to be placed under water it will be designed to provide a cohesive mix to limit segregation and washout of fine material. This will be achieved by having either a higher than normal fines content, a higher cement content or the use of chemical admixtures.
- Underwater concrete will be placed within the confines of a cofferdam or caisson. Normally, the forms of the construction works will be provided by pre-cast sections or sheetpiles. In either case, it is essential to seal joints securely and to engage clutches on sheetpiles properly to prevent fine particles polluting the watercourse.
- Any plant operating close to the water will require special consideration on the transport of concrete from the point of discharge from the mixer to final discharge into the delivery pipe (tremie). Care will be exercised when slewing concrete skips or mobile concrete pumps over or near surface waters.
- Any river re-alignment work will be undertaken in consultation and with the agreement of the appropriate regional fisheries board.

Concrete waste and wash-down water will be contained and managed on site to prevent pollution of all surface watercourses. The following construction mitigation measures will be utilised to control concrete and cementicious material wash down water interaction with surface water:

- All batching and mixing activities will be located in areas well away from watercourses and drains.
- Surface water drainage around the batching plant will be controlled via the provision of perimeter bunding with runoff diverted to appropriate treatment facilities.
- There will be no hosing into surface water drains of spills of concrete, cement, grout or similar materials.
- Washout from mixing plant of concrete lorries will be carried out in a designated, contained impermeable area.

17.5.1.1 Proposed monitoring

Water Quality Monitoring will be required prior to, during and post construction. The monitoring team will report findings to the relevant local authorities. Baseline sampling shall commence a minimum of six months prior to construction and conclude a minimum of three months after full operation has commenced to assess potential residual impact. The road authority will make recommendations regarding all the water quality parameters to assess and the sampling periods.

However as a minimum requirement there will be monthly water quality analysis from a minimum of one upstream and one downstream sampling point at each construction water outfall and surface water crossing point. The following water quality parameters shall be analysed for regularly (monthly) throughout the construction phase:

- Temperature.
- pH.
- Electrical Conductivity.
- Turbidity/Transparency.
- Biological Oxygen Demand.
- Chemical Oxygen Demand.
- Total Hardness.
- Total Suspended Solids.
- Total Dissolved Solids.
- Nitrate.
- Nitrite.
- Ammoniacal Nitrogen.
- Orthophosphate.
- Polycyclic Aromatic Hydrocarbons (ICES 16).
- Petroleum Range Hydrocarbons.
- Diesel Range Hydrocarbons.
- Dissolved Metals (Al, Cd, Cu, Fe, Pb, Zn).
- Chlorophyll.
- Total Coliforms.
- Faecal Coliforms (E.coli).

The monitoring regime shall include visual monitoring of the surface water network for visible signs of construction impact e.g. riparian vegetation loss or river born sediment plumes as well as submitting samples to a certified laboratory for physico-chemical testing. The monitoring team will compare results with current Environmental Quality Standards (EQSs) arising from the water quality standards (Surface Water Regulations 2009) and the monthly meteorological conditions. Monthly monitoring data will be compared with the Maximum Allowable Concentration EQS (MAC-EQS) specified by the 2009 Regulations. Should any water quality parameter MAC-EQS be exceeded, further monitoring will be required to determine efficiency of the construction pollution control mechanisms for that catchment and to determine if an alternative source had an influence on the receiving water quality. The Water Quality Management Plan will outline construction procedures (including alternative water treatment mechanisms) should an EQS be breached as a result of the proposed scheme construction.

17.5.2 Operation Phase

All rainfall runoff will be prevented from discharging directly to the receiving surface waters by the proposed road sustainable drainage system. Road runoff will only outfall to receiving surface waters at specified outfall locations. Catchment sizes will be conserved as far as practicable by minimising diversion of sub-catchment runoff from one watercourse into another. As outlined in Chapter 4 – *Description of the Proposed Scheme*, the proposed sustainable drainage system incorporates a range of appropriate pollution control mechanisms to prevent pollutants from entering the receiving watercourses. All outfalls are designed to prevent impact to river morphology and surface water flow hydrodynamics. The installation of emergency spill containment facilities will mitigate against any potential adverse impacts to the receiving surface waters arising from an accidental spillage associated with road haulage along the proposed road development.

The proposed drainage attenuation system will be sized to accommodate any potential increase in surface water runoff and accommodate increased rainfall during storm events up to the 30 year return period storm. For ponds designed in flood prone areas this design is increased to cater for storm events up to the 100 year return period storm.

All culverts and bridges are designed to prevent impact to river morphology and to prevent impoundment or alteration of surface water flow hydrodynamics. For further information on the design of the proposed new bridges please refer to Chapter 4 – *Description of the Proposed Scheme* . All culverts and bridges are also designed to allow for both aquatic and mammalian species migration, and to maintain the existing river bed as far as possible, in accordance with “Guidelines for the Crossing of Watercourses During the Construction of National Road Schemes,” NRA, 2008. Chapter 14 – *Ecology* discusses in greater detail the requirements of culverting for the protection of local ecology. Culverts and bridges will be sized in accordance with the requirements of the Arterial Drainage Act, Section 50 consent by the OPW. This will allow conveyance of surface water flow and maintain the hydraulic capacity of surface water features.

The current proposal for flood mitigation measures in the River Liffey area consist of a two span structure at the southern crossing and a three span structure at the northern crossing. These measures will ensure that there will be negligible increase to upstream or downstream water levels and flood risk from the proposed road development.

All watercourse re-alignment work will create new channels that will be designed to achieve maximum ecological benefits and improve on the existing hydrological environment.

There will be no use of persistent herbicides, pesticides or artificial fertilisers in any landscaping or subsequent maintenance within 2 m of a watercourse. Applications of herbicides or pesticides will be in accordance with manufacturer’s recommendations and confined to periods when the vegetation is not wet from rainfall or dew within a zone of 10 m from any watercourse.

17.6 Residual Impacts

As a consequence of compliance with the construction and operational mitigation there will be negligible permanent impacts across the catchments traversed by the proposed road development.

Residual hydrological impacts across the proposed scheme's study area and adjacent catchments can be assessed by overall hydrological parameter rather than catchment specific for the following parameters:

- Water Quality.
- Flood Risk.
- Morphology.
- Aquatic Ecology.

17.6.1 Water Quality

No negative residual impacts to water quality are anticipated, as all mitigation measures as stated in Section 17.5 are implemented for the proposed road development. The classification status of the receiving surface waters are likely to remain as they currently are, or demonstrate gradual improvement over time which will comply with the objectives of the draft river basin management plans.

17.6.2 Flood Risk

17.6.2.1 Runoff

There is a potential to increase peak flows and runoff volume due to the increased impermeable area associated with the proposed road development. However, provided that all mitigation measures as stated in Section 17.5 are implemented, negative impacts on flood risk due to increased runoff are not anticipated for design events of up to the 30 year return period event, with the exception of the River Liffey catchment where negative impacts on flood risk due to increased runoff are not anticipated for design events of up to the 100 year return period event.

17.6.2.2 Diversion of runoff from one catchment area to another

At some locations, the creation of the proposed road development perpendicular to the natural line of drainage has led to the interception of overland flow into a drainage system that will convey it into the nearest watercourse. This may lead in some cases to diversion of flow that would have flowed into one catchment area into another. There will be a corresponding reduction in flow in one area and increase in the other. The relative percentages of the catchment sizes involved, and the length of reaches affected have led to this effect being overall classified as an imperceptible permanent impact.

17.6.2.3 Conveyance

In general, no negative residual impacts on flood risk due to loss of conveyance are anticipated at the River Liffey crossings for flood events with an annual probability of less than 1% in a future climate scenario.

17.6.2.4 Floodplain storage

In general, no negative impacts to floodplain storage are anticipated at river crossing points. The piers of the River Liffey crossing are located within the floodplain, with a negligible impact.

17.6.2.5 Morphology

No negative residual impacts to surface water feature morphology are anticipated, as all practicable mitigation measures for drainage, bridges, culverting and re-alignment as stated in Section 17.5 are implemented in the proposed road development.

17.7 Impact Summary

Table 17.5: Summary of Construction Impacts Prior to Mitigation

Catchment	Impact before Mitigation
River Liffey	Significant adverse and temporary
Grand Canal	Moderate adverse and temporary
Naas Stream	Moderate to significant adverse and temporary
Osberstown Attenuation Pond and Osberstown Stream	Moderate to significant adverse and temporary

Table 17.6: Summary of Operational Impacts Prior to Mitigation

Catchment	Impact before Mitigation
River Liffey	Significant adverse and permanent
Grand Canal	Negligible
Naas Stream	Moderate to significant adverse and permanent
Osberstown Attenuation Pond and Osberstown Stream	Moderate to significant adverse and permanent

Table 17.7: Summary of Cumulative Impacts Prior to Mitigation

Catchment	Construction impacts before mitigation	Operation impacts before mitigation
River Liffey	Significant adverse and temporary	Significant adverse and permanent
Grand Canal	Moderate adverse and temporary	Negligible
Naas Stream	Moderate to significant adverse and temporary	Moderate to significant adverse and permanent
Osberstown Attenuation Pond and Osberstown Stream	Moderate to significant adverse and temporary	Moderate to significant adverse and permanent

Table 17.8: Summary of Residual Impacts

Catchment	Construction impacts	Operation Impacts	Cumulative impacts
River Liffey	Imperceptible and temporary	Imperceptible and permanent	Imperceptible and permanent
Grand Canal	Imperceptible and temporary	Imperceptible and permanent	Imperceptible and permanent
Naas Stream	Imperceptible and temporary	Imperceptible and permanent	Imperceptible and permanent
Osberstown Attenuation Pond Osberstown Stream	Imperceptible and temporary	Imperceptible and permanent	Imperceptible and permanent

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