Chapter 9 Hydrology

9.1 Introduction

This chapter of the EIS assesses the potential hydrological impacts of the proposed M7 Naas to Newbridge By-Pass Upgrade Scheme.

The M7 will be widened from 2 to 3 lanes in each direction. The proposed widening will be completed within the existing footprint of the road with widening generally proposed to be constructed within the existing median. The widened motorway will follow the alignment of the existing road both horizontally and vertically.

As detailed in Chapter 4 of this EIS, the design approach has been to assess the effects of the increased pavement areas on the road run-off and then design the new road drainage system to discharge to the existing outfalls and at the same rates as currently exists. At three of the fourteen existing outfalls there is a history of flooding. New attenuation ponds are proposed at these locations to reduce the existing discharge rate. The existing corrugated steel culvert, approximate span 4m, under the R445 will be extended to accommodate the proposed Newhall Interchange. A new box culvert of 4.5m wide x 2.5m high is also proposed under the interchange eastbound on-slip.

9.2 Methodology

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 principles and guidance of both of these documents was used 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.

National Roads Authority Hydrological Guidance

The National Roads Authority (NRA) Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes outlines a range of best practice guidelines for the assessment of hydrological impacts of road schemes. 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. The hydrological impact assessment methodology is in accordance with the guidance outlined in Section 5.6 of the NRA Guidelines with desktop studies supplemented with the EPA Water Quality monitoring data and Water Framework Directive quality classifications. As all of the drainage outfalls are proposed at the location of existing outfalls it was not considered necessary to supplement the existing information with additional water quality sampling or flow measurements. Impact categories, impact duration and type/nature of impacts have been taken into account in this assessment for the estimation of magnitude of impact and development of a significance rating. The

impact ratings are in accordance with impact assessment criteria provided in the EPA guidance documents. 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 road alignment traverses and quantifying the likely magnitude of any impact on these catchment features and the catchment as a whole. Due cognisance was also paid to the surface water and drainage guidance outlined in the National Roads Authority Design Manual for Roads and Bridges.

Desk Study

The desk based work items involved the following:

- Definition of the study area, in accordance with NRA guidelines as 250m beyond the landtake boundary of the proposed route and taking account of potentially significant impacts which could arise at a greater distance away;
- Compilation of all relevant plan maps relating to the study area and proposed road development;
- Acquisition and compilation of all available regional information on the hydrology of the study area, including:
- Interrogation of the Office of Public Works online Flood Hazard Mapping service, hydrometric records and Preliminary Flood Risk Assessment Integrated Maps;
- Acquisition and examination of the Ordnance Survey of Ireland's (OSI) mapping and aerial photography;
- Acquisition of climatic data from Met Eireann;
- Examination of the Water Framework Directive River Basin Management Plans;
- Examination of the Environmental Protection Agency's (EPA) online hydrological and land use mapping service.

Field Investigations

The field investigations conducted for this study involved the following:

- A drive over survey of the entire road scheme noting in particular any existing drainage problem areas;
- Procurement of a CCTV survey of the existing drainage network.

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).

9.3 Impact Assessment Methodology

The following assessments were undertaken, from the desk and field data acquired, to evaluate the potential impacts of the proposed development on sensitive locations such as areas of known recurring flooding:

- Characterise the sites current hydrological regime based on the topographical and hydrological data acquired;
- Determine and estimate the impact on existing watercourses to which the existing road drainage network outfalls or which cross the carriageway;
- If impacts are identified, consider measures that would mitigate, re-mediate or reduce the identified impact;
- Identify any residual impacts that would remain or arise from the mitigation measures identified;
- Present and report these findings in a clear and logical format that complies with EIS reporting requirements.

The above approach was undertaken following the NRA Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes and general EPA guidance on the preparation of EIS. The likely significant impacts were described using the five-tier system presented in the EPA advice notes, by reference to quality of impact, significance of impact, duration of impact and types of impact and using the criteria for rating site attributes and for rating impact significance as presented in the NRA guidelines.

9.4 Existing Environment

The following sections describe the existing hydrological features along the proposed road widening.

The key water features for consideration in the vicinity of the project include:-

Table 9.1 Existing Culverts

Chainage	Culvert Size
Ch 3+300	750mm diameter pipe
Ch 3+350	750mm diameter pipe
Ch 4+040	450mm diameter pipe
Ch 4+720	750mm diameter pipe
Ch 6+750	2350mm corrugated steel culvert
Ch 7+000	600mm diameter pipe
Ch 7+760	900mm diameter pipe
Ch 7+890	750mm diameter pipe
Ch 9+750	750mm diameter pipe
Ch 10+200	750mm diameter pipe
Ch 10+350	900mm diameter pipe
Ch 10+525	900mm diameter pipe
Ch 11+140	2750mm corrugated steel culvert
Ch 11+175	2750mm corrugated steel culvert
Ch 13+040	2 x 1200mm diameter pipes

Chainage	Culvert Size
Ch 13+100	750mm diameter pipe

In addition there is a 74m long corrugated steel culvert (approx span of 4m) under the R445 at the location of the proposed eastern roundabout of the new J10 interchange. The watercourse passing through this culvert merges with that passing beneath the M7 at Ch 6+750, and the combined flow then enters another existing culvert beneath what used to be the original line of the R445 prior to construction of the motorway - an area that is currently landscaped.

The assessment of water quality for the proposed road development comprises a desk-top 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 extension to the Ladytown Stream at Newhall Interchange.

Table 9.2 Summary of Major Surface Water Features

Water feature	Description
Grand Canal	Proposed Natural Heritage Area (pNHA). The Grand Canal runs in close proximity to the existing M7 northwards to Naas from Herbertstown/Corbally Harbour east of the M7/M9 split. The Rathcore Spring feeds the canal from the harbour location and is considered a significant spring site worthy of County Geological Site status by the GSI. From Naas it travels westwards passing beneath the existing M7 south of the existing Maudlins Interchange.
River Liffey & Various Minor Tributaries	The River Liffey runs beneath the existing M9 and M7 immediately south of where the motorways split in an east to west direction. It then loops north and flows northwards in close proximity to the M7 in the area south of the Maudlins Interchange. There are no direct discharges to the River Liffey and the proposed road widening scheme does not cross the river. However many of the minor watercourses crossed by the M7 are tributaries of the River Liffey. The River Liffey has an EPA classification of Q4 Good Status in the vicinity of the M7/M9 split, which decreases to Q3/4 Moderate status north of the Osberstown WWTP. It is categorised as 'at risk' under the Water Framework Directive.
Morell River	The Morell River runs beneath the existing N7 just north of the Maudlins Interchange. It has an EPA classification of Q3/4.

The carriageway drainage currently discharges to local watercourses at 14 locations, identified as **Outfalls A* - N** on **Figures 4.2 – 4.10 in EIS Volume 3**. The new drainage system will continue to discharge at these existing outfalls. The runoff from the section between J9 Maudlins and J8 Johnstown will continue to be discharged attenuation ponds that were constructed as part of the Naas Road Widening Scheme in 2006.

Table 9.3 Summary of Existing Road Drainage Outfalls

Outfall Reference	Outfall Location (chainage)	Chainage Drained
B	3+300	2+100 – 3+300
C	4+000	3+300 – 4+250
D	4+720	4+250 – 4+900

Outfall Reference	Outfall Location (chainage)	Chainage Drained
E	6+750	4+900 – 7+100
F	7+760	7+100 – 8+000
G	8+575	8+000 – 8+575
H	8+875	8+575 – 9+200
I	9+750	9+200 – 9+800
J	10+200	9+800 – 10+350
K	10+525	10+350 – 11+000
L	11+500	11+000 – 12+250
M	13+100	12+250 – 13+600
N	13+600	13+600 – 14+750

*Outfall A Drains the existing M7 beyond the extents of the proposed development

Table 9.4 Treatment Proposed at Drainage Outfalls

Outfall Reference	Proposed	Volume (m3)
B	Online attenuation	1253
C	Online attenuation	990
D	Attenuation Ponds	1550
E	Attenuation Pond	5000
F	Attenuation Pond	1914
G	Online attenuation	529
H	Online attenuation	573
I	Online Attenuation	551
J	Online Attenuation	504
K	Online Attenuation	594
L	Attenuation Pond	2607
M	Online Attenuation	1236
N	Attenuation Pond	Existing

9.5 Predicted Impacts

"Do Nothing" Scenario

The traffic levels on the existing road are high by Irish standards and will continue to rise in all scenarios. The likely impact on the local watercourse network under the do nothing scenario is that there would likely be greater risk of major pollution incident and a greater potential for increased background levels of pollution resulting from the continued operation of the existing road as traffic levels increase without the inclusion of either hydrocarbon interception or spillage control measures as part of the drainage network. It is noted that only Outfall E, at the proposed Newhall Interchange, has a risk of spillage of 1% or greater when assessed under HD45/09 of the UK DMRB and would therefore require spillage preventive measures in accordance with this standard.

As there is currently no attenuation provided at the existing drainage outfalls, increases in rainfall intensity as a result of climate change may lead to increased discharge rates and associated downstream flood risk.

Impacts on Hydrology

Water Quality

The likely impacts of the proposed by-pass upgrade on the watercourse quality are as detailed in the following sections.

Construction Phase

The reduction in water quality for those watercourses receiving runoff from the proposed road is a possible indirect impact of the road development on the hydrology during the construction phase. The main potential contaminants during the construction phase will be increased quantities of Suspended Solids, including Silt from excavation activities, and possible contamination from cement based products. 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 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. Other sources of potential pollutants at construction stage include hydrocarbons due to accidental spillages from construction plant and storage depots and faecal coliform contamination from inadequate on-site toilet & washing facilities. The rivers Morell and Liffey are rated as at risk under the Water Framework Directive; the magnitude of this impact is rated as moderate adverse, resulting in a localised impact on the watercourse quality; therefore the significance of this impact is rated moderate.

Operational Phase

The reduced risk to local watercourses as a result of a serious accidental spillage is a possible indirect impact of the road upgrade on the hydrology during the operational phase as a result of the installation of spillage controls and vegetated treatment or hydrocarbon interceptors at each existing outfall from the motorway drainage network. The reduction in risk of accidental spillage to the local watercourse is rated as minor beneficial impact. The rivers Morell and Liffey are rated as at risk under the Water Framework Directive and therefore the significance of this impact is rated minor beneficial.

- 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.

Table 9.5 Annual Probability of a Serious Pollution Incident

Outfall Reference	P_{INC}
B	0.56
C	0.45
D	0.33
E	1.32
F	0.45
G	0.29
H	0.31
I	0.30
J	0.28
K	0.33
L	0.63
M	0.68
N	0.69

Flooding

The likely impacts of the proposed road realignment on the risk of flooding are as follows:

Construction Phase

The potential increased risk of flooding of carriageway and downstream of drainage outfalls is a possible indirect impact of the road development during the construction phase. The proposed construction activity includes the replacement of elements of the existing drainage network which may leave sections of the carriageway un-drained for short periods of time during construction. There may also be an increased risk of blockage of outfalls due to construction activity. This increase in flood risk will be short term and therefore the significance of the impact is rated minor.

Operational Phase

The potential increased risk of flooding upstream of the existing culvert under the R445 is a possible direct impact of the extension of the existing culvert. The construction of the Newhall Interchange requires the extension of an existing corrugated steel type culvert. The existing culvert is approximately 74m long with an approximate span of 4m. The proposed extension will be 86m long resulting in a total culvert length of 160m. The proposed culvert extension will result in an increased afflux associated with the longer culvert which may increase the risk of flooding upstream. The channel upstream of the culvert inlet is currently heavily silted and overgrown. The existing channel will be locally improved to minimise the risk of flooding due to the increase in afflux associated with the culvert extension. Provision for access will be provided at the location where the proposed culvert ties into the existing steel arch to ensure that the risk of blockage of at the culvert is not increased.

The proposed M7 eastbound on slip road follows a similar alignment to the original R445 and will pass over the existing culvert, but would require an extension to the north end while remaining longer than required on the south end. Rather than extending this culvert further it is proposed to take the opportunity to replace it with a culvert of greater cross section and the minimum required length. The proposed

replacement will be a 4.5m x 2.5m concrete box culvert, with the reduction in length creating space for a stilling pond between the outlet of the existing culvert under the R445, the culvert under the M7 at ch 6+750 and the proposed culvert under the eastbound on-slip. The proposed box culvert will remove an existing restriction from the channel reducing the risk of flooding for the proposed slip road.

A reduced risk of flooding downstream of drainage outfalls is a possible indirect impact of the road development during the operational phase. Although the proposed carriageway widening will increase the impervious area in the surface catchments and therefore increase the runoff rate by 20% over these areas, the design of the new road drainage system will attenuate the flows to current discharge rates. Furthermore the attenuation capacity of the new road drainage system will be designed to take account of an additional 20% increase in rainfall intensity due to the potential effects of climate change. This additional attenuation provision will be applied to the existing carriageways as well as added lanes, such that the new drainage system will provide enhanced flooding protection when compared with the do-minimum scenario.

The provision of attenuation ponds at three existing outfalls which discharge to watercourses with a history of flooding will reduce the rate of discharge from the motorway drainage at these locations.

9.6 Mitigation Measures

Mitigation by avoidance

The design process is considered the best possible mitigation, in terms of avoiding impact to the hydrological environment. Mitigation by avoidance has been actively applied to the design as the Impact Assessment progressed. This includes avoiding the construction of new watercourse crossings, and with the exception of the new interchange, avoiding the lengthening of existing crossings, limiting the footprint of the upgraded road to within the existing landtake, and utilising the existing drainage outfalls to discharge road runoff from the proposed newly paved surfaces.

Watercourse quality

The principles of SuDS (Sustainable Drainage Systems) have been used throughout the scheme in order to improve the quality of runoff prior to discharge. In the verges where filter drains are used for road drainage, these will prevent the discharge of sediment and suspended solids from the road to the watercourse. In the median where linear drainage channels are used, the inspection chambers will contain silt traps to collect the sediment. A suitable maintenance programme will be developed at detailed design stage to ensure that satisfactory operation of the drainage is maintained.

Water quality improvement will be provided through the provision of oil and petrol interceptors; these interceptors will be Class 1 bypass oil and petrol separators designed to cater for 10% of the peak flow from a five year storm. A suitable maintenance programme will be developed at detailed design stage to ensure the satisfactory ongoing operation of the oil and petrol interceptors.

Each outfall is to be fitted with a shut off valve/penstock in order to facilitate the interception & isolation of any spillage before discharge to the downstream watercourse. Spillage containment will be occur in either the lined attenuation ponds or the sealed oversized pipes provided in advance of each outfall.

In addition to minimise the potential impacts on watercourse quality during construction measures for the containment of suspended solids on site will be required to be included in all method statements for construction.

An Environmental Operating Plan will be prepared by the contractor prior to construction. As a minimum this plan will include for the following:-

- The proposed works at the Newhall Interchange will incorporate the use of settlement ponds, silt traps and bunds to prevent silt laden runoff draining to the Ladytown Stream. 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 5m. 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.
- Surface water flowing onto the construction area will be minimised through the provision of berms and diversion channels.
- 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 upstream & downstream of the proposed works at the Ladytown Stream. Parameters to be monitored will include pH, Total Suspended Solids (TSS), BOD and COD. Monitoring of water quality in the stream downstream of the existing culvert will be undertaken for 1 month prior to construction commencing and acceptable water quality levels agreed with Inland Fisheries Ireland.
- 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.
- 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.
- 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.

Watercourse flow

In addition to the SuDS measures outlined above, as described in Chapter 4, flow restricting devices such as a 'Hydrobrake' will be provided upstream of the point of discharge to a receiving waterbody in order to restrict the outlet flows to existing runoff rates together with the provision of temporary storage of the surface water runoff. This storage or attenuation will be provided upstream of the flow restriction by oversizing the upstream pipe networks and utilising the storage capacity of the proposed filter drains.

The runoff from the section between J9 Maudlins and J8 Johnstown will continue to be discharged through the petrol interceptors and attenuation ponds that were constructed as part of the Naas Road Widening Scheme in 2006.

Flood Risk

The existing channel upstream of the culvert to be extended will be locally improved to ensure that the likely increase in afflux associated with the culvert extension is accommodated within the channel. In addition a stilling pond will be provided between the existing culvert outlet and the new culvert to be constructed under to the eastbound on-slip.

9.7 Residual Impacts

The final or designed residual impacts of the proposed road realignment on the hydrological aspects of the environment are described in the following sections. These impacts occur as a result of the mitigation measures inherent in the design of the new road drainage system. The following sections describe these residual impacts.

Water Quality

The increase in the level of treatment to runoff prior to discharge and the associated protection afforded to watercourses is a possible indirect impact of the road development on hydrology. This impact is considered to remain residual, minor beneficial and permanent in nature.

Flood risk

The proposed extension to the existing culvert under the R445 to facilitate the Newhall Interchange will result in a permanent increase in afflux associated with the culvert and an associated increase in flood risk. This impact will be mitigated by localised improvement works to the channel upstream and the provision of a secondary flow path through the fish pass culvert. This impact is considered to remain residual, slight adverse and permanent in nature.

The increase in the level of protection afforded to watercourses is a possible indirect impact of the road development on hydrology. The mitigation measures included in

the design will provide a greater level of protection against flooding than is currently available. This impact is considered to remain residual, minor beneficial and permanent in nature.