Appendix B

Hydrology

Assessment Report

B

Galway County Council

N6 Galway City Ring Road

NIS - Hydrological Assessment

GCOB-4.04_21.6

Issue 2 | 5 October 2017

Job number 233985

Ove Arup & Partners Ireland Ltd

Arup
Corporate House
City East Business Park
Ballybrit
Galway
H91 K5YD
Ireland
www.arup.com

ARUP

Document Verification

ARUP

Job title	N6 Galway City Ring Road	**Job number**	233985
Document title	NIS - Hydrological Assessment	**File reference**	
Document ref	GCOB-4.04_21.6		

Revision	**Date**	**Filename**	GCOB_4.04_21.6 (NIS Hydrology Assessment).docx		
Issue 1	23 June 2017	**Description**	Issue 1		
			Prepared by	Checked by	Approved by
		Name	Tony Cawley, Hydro Ltd.	Hazel King/Mary Hurley/Fiona Patterson	Eileen McCarthy
		Signature	[signature]	[signature]	[signature]
Issue 2	5 Oct 2017	**Filename**			
		Description			
			Prepared by	Checked by	Approved by
		Name	Tony Cawley Hydro Ltd.	Hazel King / Mary Hurley / Fiona Patterson	Eileen McCarthy
		Signature	[signature]	[signature]	[signature]
		Filename			
		Description			
			Prepared by	Checked by	Approved by
		Name			
		Signature			

Issue Document Verification with Document ✓

Contents

1 Introduction

This report assesses the potential hydrological construction and operational impacts of the proposed N6 Galway City Ring Road, hereafter referred to as the proposed road development, on the receiving waters of the Lough Corrib candidate Special Area of Conservation (cSAC) (000297), Lough Corrib Special Protection Area (SPA) (004042), Galway Bay Complex cSAC (000268) and Inner Galway Bay SPA (004031). An assessment of the hydrological impact on Ballindooley Lough was also carried out as the Lough is supporting habitat for birds within the Lough Corrib SPA and the Inner Galway Bay SPA.

There are no hydrological impacts predicted upstream of the proposed road development, on the upstream sections of Lough Corrib cSAC and the Lough Corrib SPA. The River Corrib and its tributaries flow downstream to the River Corrib Estuary and therefore there is no potential hydraulic pathway for upstream impact from pollutants.

2 Methodology

This report has been prepared having due regard to relevant legislation and the following guidance documents:

- Surface Water and Drainage Guidance in the Transport Infrastructure Ireland, TII Publications road design standards. DN-DNG-03063 June 2015 and DN-DNG-03065, June 2015
- National Road Authority (NRA) Guidelines on Procedures for the Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes
- NRA Environmental Impact Assessment of National Roads Schemes – A Practical Guide, November 2008
- DoEHLG (Nov 2009) Flood Risk Management and the Planning System Guidance document
- Inland Fisheries Ireland (IFI) (2016) Guidelines on protection of fisheries during construction works in and adjacent to waters

The methodology follows the guidance outlined in Section 5.6 of the NRA Guidelines on Procedures for the Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes pertaining to the treatment of Hydrology. The impact category, duration and nature of impact have been considered in this assessment. The range criteria for assessing the importance of hydrological features within the study area and the criteria for quantifying the magnitude of impacts are assessed in accordance with the guidelines.

2.1 Desk Study

The desk study includes an assessment of published literature available from various sources including a web based search for relevant material. Site specific topographical information and aerial photography has been reviewed to locate any potential features of hydrological interest. These features have been investigated on the ground by walkover surveys to assess the significance of any likely environmental impacts on them.

The following list of data sources were reviewed as part of this assessment:

Ordnance Survey Ireland (OSi)

- Discovery Series Mapping (1:50,000)
- Six Inch Raster Maps (1:10,560)
- Six inch and 25inch OS Vector Mapping
- Orthographic Aerial Mapping (2012)

Environmental Protection Agency (EPA)

- Teagasc Subsoil Classification Mapping
- Water Quality Monitoring Database and Reports
- Water Framework Directive Classification
- EPA Hydrometric Data System

Office of Public Works (OPW)

- Arterial Drainage scheme land benefitting Mapping for Ireland
- OPW and Drainage District Arterial Drainage Channels and Maintained Channels
- OPW hydrometric Data website (May 2017)
- OPW Floodmaps.ie website (May 2017)
- OPW FSU (Flood Studies Update) Web Portal Site for Flood Flow Estimation
- OPW Preliminary Flood Risk Assessment Mapping (pFRA)
- OPW Draft CFRAM Flood Risk Mapping, final draft hydrology, hydraulics and flood risk management reports (2016)

Galway County/City Council

- Galway County Development Plan 2015– 2021
- Galway City Development Plan (2017 – 2023)
- Galway Transport Strategy (2016)
- Planning Register
- Water Services – Abstractions, Discharges & Supply Schemes

- National Parks and Wildlife Service (NPWS)
    - Designated Areas Mapping
    - Site Synopsis Reports
    - Conservation Objectives documents

Other sources

- Western River Basin Management Plan (2009 – 2015)
- Aerial survey photography
- Geological Survey of Ireland (GSI) Web Mapping
- Specially commissioned bathymetric Survey
- Topographical Survey

Consultation took place with all relevant regulatory bodies including various departments of Galway County Council, Galway City Council, the Office of Public Works (OPW), GSI, National Parks and Wildlife Service (NPWS) and Inland Fisheries Ireland (IFI).

Available topographical and hydrometric information (field and desk based) in combination with numerical techniques and mathematical modelling has been used to assist in performing the necessary hydrological impact assessments of watercourses and water bodies within or potentially discharging to European sites in Galway Bay and to Lough Corrib cSAC and Lough Corrib Special Protection Area (SPA) and also of Ballindooley Lough that provides supporting habitat for birds within the Lough Corrib and Inner Galway Bay SPAs.

Other neighbouring European sites such as Connemara Bog Complex cSAC; East Burren Complex cSAC; and Lough Fingall Complex cSAC are not hydrologically linked to the study area of the proposed road development. Other European sites such as, Black-Head-Pouallagh Complex cSAC and Inishmore cSAC, Inishmaan cSAC and Inis Oirr Islands cSAC which share the West of Ireland coastal waters are considered sufficiently remote that even a worst-case pollution event would have no perceptible impact given the travel time involved and the extensive dilution available.

2.2 Field Surveys

Field surveys and walkover assessments were carried out to assess the hydrological impacts of the proposed road development. Detailed stream surveys (including topographical surveys where required) were undertaken at areas where hydrological impacts were likely to occur without appropriate mitigation. Specifically, all culvert and bridge crossing locations, proposed road drainage outfall locations and ecologically sensitive areas were visited and field measurements carried out along with reconnaissance of potential flood risk areas, including site visits during the December 2015/January 2016 winter flood event.

Surface water quality monitoring was carried out on all main watercourses and potential outfall receptors. Flow estimation in selected outfall streams were also conducted as were targeted bathymetric surveys of Coolagh Lakes, Ballindooley Lough and the River Corrib.

3 Existing Hydrological Environment

3.1 General

The proposed road development, commences west of Bearna in An Baile Nua, passes to the north of Galway City and connects with the existing N6 at Coolagh on the east side of the city and lies within hydrometric areas 29, 30 and 31. The only physical discharge to the Lough Corrib SPA is via a proposed road drainage outfall for the proposed N59 Link Road which discharges to a small drainage ditch that eventually discharges to the Lough Corrib cSAC and Lough Corrib SPA.

The proposed road development crosses the River Corrib approximately 160m southwest of Menlo Castle and to the north of Coolagh Lakes on the eastern bank and through NUIG Sporting Campus on the western bank. Both the River Corrib and Coolagh Lakes are part of the Lough Corrib cSAC.

The proposed road development does not encroach into the Galway Bay Complex cSAC or Inner Galway Bay SPA as it is located typically 1 to 2km upstream, and completely outside of the coastal and transitional waters of the Galway Bay.

3.2 Surface Drainage Features

There are 5 principal surface water drainage catchments and their sub-catchments intercepted/potentially impacted by the proposed road development which are labelled from west to east as follows (refer to Figures 12.1 and 12.2):

- Sruthán Na Libeirtí Stream
- Trusky Stream
- Bearna Stream
- Knocknacarra Stream
- Corrib Catchment
  1. River Corrib
  2. Coolagh Lakes
  3. Terryland River
  4. Ballindooley Lough System

There are 6 downstream sub-catchments that also discharge to the Galway Bay Complex cSAC and Inner Galway Bay SPA, namely Lough Atalia, Doughiska, Curragreen, Galway City Coastal, Roscam and Glenascaul drainage areas. These small drainage catchments are located on the eastern side of the River Corrib within the karst limestone bedrock formation and do not have surface drainage features. Effective rainfall from these catchments drains to groundwater or is intercepted by the existing urban storm drainage systems. Within these catchments the proposed road drainage is primarily discharging to groundwater and in a number of minor outfalls to the existing urban drainage system. The impact on groundwater and the potential groundwater pathway to the Galway Bay Complex cSAC and Inner Galway Bay SPA is dealt with in the Appendix A (Hydrogeology) of the NIS.

The Sruthán Na Libeirtí Stream and the Trusky Stream discharge to Galway Bay coastal waters outside (to the west) of the Galway Bay Complex cSAC and Inner Galway Bay SPA, whereas the Bearna Stream, Knocknacarra Stream and River Corrib outfall directly to the Galway Bay Complex cSAC and Inner Galway Bay SPA. Coolagh Lakes outfall to the River Corrib, both of which are within the Lough Corrib cSAC. Coolagh Lakes are located within the dinantian pure bedded limestone bedrock formation which is highly karstified and may potentially have subterranean groundwater connection with the Galway Bay Complex cSAC and Inner Galway Bay SPA. The Terryland River and Ballindooley Lough both drain to groundwater within the karstified limestone bedrock region and consequently may have a groundwater connection with the Galway Bay Complex cSAC and Inner Galway Bay SPA, particularly Terryland River which displays a strong tidal signal in its water level, particularly at spring tide periods. Appendix A (Hydrogeology) of the NIS details potential groundwater pathways between the proposed road development and European sites.

The study area for the proposed road development falls within the Western River Basin District (WRBD). The WRBD has classified the transitional coastal waters as good status, the coastal waters as moderate status and Lough Corrib as moderate lake quality (previously classified as poor). The majority of the watercourses and lakes within the study area (including Coolagh Lakes, Ballindooley Lough and many of the water courses in the west) do not have an assigned status. The only watercourses that have been classified are the Terryland River (Poor), the River Corrib (Good) and the lower reach of Bearna Stream which was previously given a pass classification and is currently unassigned. The groundwater quality classification for the entire study area and wider region is good.

3.3 Sruthán na Libeirtí Stream

This is a small stream which rises in a peatland area 2km north of the R336 Coast Road and flows southwards to the coast outfalling to Galway Bay 2km west of Bearna Village at Cora na Libeirtí in An Baile Nua. This stream is unmaintained, narrow (typically 0.5m wide) and shallow < 0.5m. The Sruthán na Libeirtí Stream has a catchment area of 1.5 km^2 and high percentage runoff due to its generally impermeable overburden cover and shallow bedrock.

3.4 Trusky Stream

The Trusky Stream which flows through Bearna is a relatively small stream having a catchment area of 3.3km^2 and outfalls to the Galway Bay at Bearna Harbour. This stream has two main branches one to the east of the harbour road and one to the west. The stream channel has been culverted and modified through Bearna Village and crosses under the R336 Coast Road in two culverts, an original arch culvert near the Twelve Pins Hotel and a concrete piped culvert approximately 170m to the east. This stream represents a flood risk to Bearna Village and the R336 Coast Road at these culvert crossings. This stream rises in peatland to the south of Lough Inch and flows typically southwards 2.5km to the harbour. The channel is not maintained, vegetated and varies in width (0.5 to 1m channel widths) in its middle and upper reaches. The channel through the lower reach has been significantly modified with sections of culverting and new channels to facilitate urban development. Unlike the Sruthán na Libeirtí Stream, the percentage runoff is moderate to low.

3.5 Bearna Stream

The Bearna Stream is the largest of the small watercourses encountered by the proposed road development entering Galway Bay Complex cSAC and Inner Galway Bay SPA near Rusheen Bay. Its catchment measures 9.1km^2 at its sea outfall and its main tributaries are the An Sruthán Dubh and the Tonabrocky Streams. This water system rises in the townlands of Pollnaclogha, Drum and Tonabrocky 4km to the north. It is an unmaintained watercourse which in sections is very overgrown particularly in its middle and upper reaches. Flooding is not a significant issue for this stream. The percentage runoff based on overburden and land slope is moderate to low in magnitude.

This stream is within the Galway Bay Complex cSAC in its lower downstream fluvial reach at Cappagh Park immediately downstream of the Tonabrocky Stream confluence and within the Galway Bay Complex cSAC in its estuarine reach south of the R336 Coast Road. There is a section between Cappagh Park and the R336 Coast Road that is not designated as part of the Galway Bay Complex cSAC.

3.6 Knocknacarra Stream

The Knocknacarra stream is a small and highly urbanised stream that discharges to Galway Bay Complex cSAC and Inner Galway Bay SPA near Blakes Hill in Salthill. The total catchment area of this stream is 4.4km^2. A large portion of its lower reach is culverted almost to its sea outfall. It rises to the north of Rahoon at Letteragh and flows southwards over a distance of 3km to the sea. It would be considered a highly urbanised watercourse with an urban fraction of almost 50%.

3.7 Corrib Catchment

3.7.1 River Corrib

The River Corrib is essentially a short outflow channel from Lough Corrib to Galway Bay at the Claddagh, Galway. The Corrib Drainage and Navigation Works Scheme (1848-1858) excavated a new wide outlet channel from Lough Corrib known as the Friar's Cut which provides a more direct and deeper channel to service the lake than the meandering old channel (almost 1.5km shorter). Significant excavation of the River Corrib channel has taken place both during the original Corrib Drainage and Navigation Works Scheme and during the OPW Corrib-Clare Arterial Drainage Scheme (in the early 1960's).

The area of the River Corrib catchment is approximately 3111km^2 to Wolfe Tone Bridge, which is quite large by Irish Standards and is the biggest river system in the

Western River Basin District. This includes a total lake surface area of approximately 314km^2 mainly due to Lough Corrib and Lough Mask but also includes Lough Carra, Finny Lakes and the Maam Lakes which attenuate winter flood flows and sustain summer low flows.

The River Corrib channel is a navigation channel and is reasonably wide varying typically from 80 to 130m between the river banks and typically 3 to 4m deep. It is an impounded channel with levels maintained generally close to 6m OD throughout the year by the gated weir at the Salmon Weir.

Table 1 presents the river water levels and exceedance percentiles derived at the River Corrib Dangan hydrometric recorder. For example, 99-percentile water level represents the water level which is exceeded 99 percent of the time

Table 1: River Corrib Water Level Statistics at Dangan Gauge

Exceedance Percentile at Dangan Gauge				
1%	5%	50%	95%	99%
6.75mOD	6.32mOD	5.91mOD	5.75mOD	5.70mOD

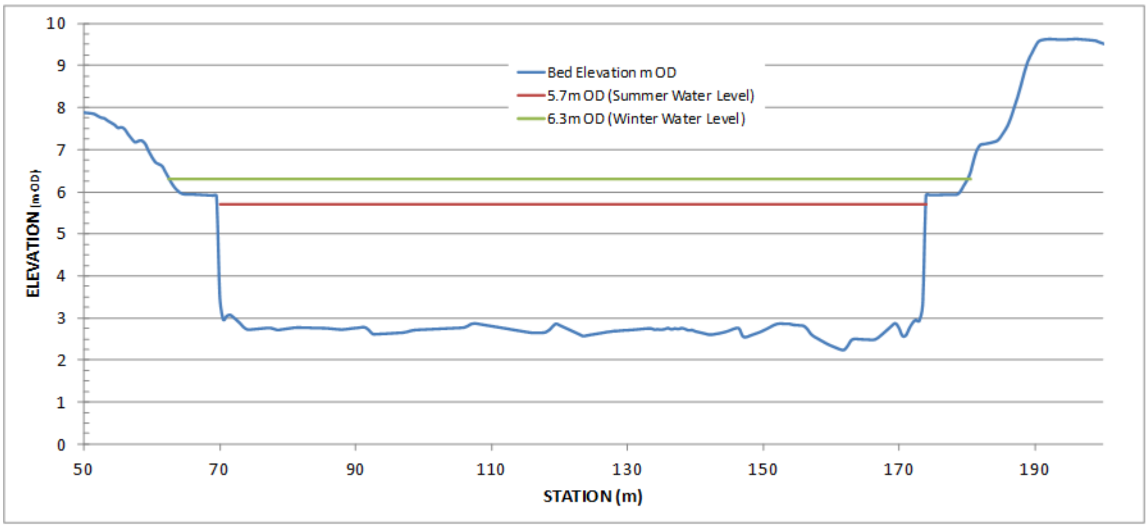
Much of the channel has been excavated with bed levels at the proposed crossing point at 2.75m OD providing a flow area at summer 99-percentile low flow of 300m^2 and a channel velocity of 0.04m/s.

The River Corrib for flow estimation is gauged at Wolfe Tone Bridge which is a strategic location as it captures the total flow from the Corrib system before entering the bay. This site is tidally backwatered and the flow rating is considered only fair. Flow estimates from this gauge are currently not available due to difficulties and inconsistencies with the rating relationship identified in the gauged record dating back as far back as 2002. As part of the flood risk assessment for the proposed road development a reasonably consistent flood rating relationship was derived for the Dangan Gauge using the OPW flood rating measurements and recorded flood level flooding stage when all gates on the Salmon Weir are opened, which generally applies to winter maximum floods. This rating provided a QMED (2year return period) flow at Dangan of 264.4cumec (gauged period 1986 to 2015). The OPW CFRAM study produced a QMED estimate of 248cumec and the FSU estimate is 243cumec (both based on the Wolfe Tone Bridge gauge data for the record period pre 2002). The statistical analysis of a derived annual maximum flood flow series for the Dangan of 264.4cumec is considered more reliable than the FSU and CFRAM estimates as it includes the more recent and wetter period post 2002 and avoids using the Wolfe Tone gauge whose rating is inconsistent.

The flow duration curve for Wolfe Tone Bridge gauge (OPW hydrometric section) for the period 1970 to 1997 gave a median (50%) flow of 82cumec, a 95% low flow of 24.6cumec and a 99% low flow of 9.1cumec. The EPA hydrological data publication (1995) for the record period 1970 to 1991 gave an average flow of 95.3cumec and a 95% low flow of 16.9cumec. A Department of Hydrology, NUIG (formerly UCG) (1985) study, as part of their investigation into the hydropower potential of the waterways of Galway City, developed a flow duration curve for the River Corrib at Wolfe Tone Bridge gauge (using OPW flow data from 1950 to 1980). This study gave a mean flow rate of 82.5cumec and the lowest recorded flow of 8.9cumec (occurring in 1962). This flow duration curve gave median flow of 74.4cumec, 95-percentile low flow of 14.1cumec and a 99-percentile low flow of 12.13cumec. It should be noted that the period 1950 to 1980 in terms of rainfall would have represented a drier period than 1980 to present day and therefore the flow estimates are lower, particularly for the 1970's and 1950's which were the driest decades. For the purpose of the study for this NIS, the lower estimates of low flow using a 99-percentile of 12cumec and a 95-percentile of 14cumec will be used and are considered to underestimate such quantiles and thus conservative in respect to critical dilution rates.

The typical winter-summer water level range is 0.6m (typically 5.7m to 6.3m OD). The River Corrib channel at Dangan is approximately 110m wide and the channel bed invert near the crossing is typically 2.6 to 2.8m OD giving a flow depth of 3m and a total flow area of 312m^2 at 5.7m OD and 403m^2 at 6.3m OD. At a low flow (95-percentile) of 14cumec the average channel flow velocity is small at 0.044m/s and in typical winter flows the average velocity is 0.675m/s.

Figure 1: Cross-Section of River Corrib in the vicinity of the river crossing at Dangan



3.7.2 Coolagh Lakes

The Coolagh Lakes are part of the Corrib system and are located within the Lough Corrib cSAC. Whilst, Upper Coolagh Lake is entirely groundwater fed, Lower Coolagh Lake is in continuity with the River Corrib and the lake level within the lakes is influenced by the River Corrib water levels and the control imposed by the OPW at the Galway City Salmon Weirs Barrage (regulation 5.82 to 6.43m O.D. which is achieved approximately 85% of the time). This regulation range is not always achievable particularly during extreme flood events with lake levels exceeding the regulation levels. The periodic closure and opening of gates by the OPW creates inflow and outflow to the lakes in particular to the lower lake which provides additional flushing to the natural local catchment inflows. The water level in the Coolagh Lakes increases until it has positive head to outflow to the River Corrib channel upstream of Jordan's Island via its small narrow outflow channel.

A bathymetric survey of the River Corrib and the Coolagh Lakes reveals very deep bed levels within the middle of the two lakes with the deepest part of the lakes at c. -10 and -12m OD for the upper and lower lakes respectively. This represents maximum water depths of 16.5 and 18.5m respectively. Flow velocities within these lakes are very small with mixing principally by thermal differences and surface wind dynamics. These lakes are likely to represent a permanent sink for sediment from its contributing catchment entering the lakes. The estimated winter 1-percentile water level for Coolagh Lakes is 6.75m OD producing an inundation area of 36ha, whereas the 99% exceedance summer low flow level is 5.73m OD with a combined lake area of 6.8ha.

The local catchment area draining to these lakes based on topographical mapping is estimated to be c. 2.5km^2. Other deeper groundwater connections to karst areas to the northeast and to east cannot be ruled out and are assessed in Appendix B Hydrogeology. Spring flow is evident to the Coolagh Lakes at two spring locations to the east and to the north of the lakes. The mean annual inflow rate to the lakes is estimated to be approximately 30l/s based on water balance calculations and the low flow (95%-percentile) contribution is potentially as low as 2 to 3l/s. The bathymetric survey data for the lake is used to estimate the lake storage-stage relationship which for a summer low water level of 5.7m OD is c. 630,000m^3 with a combined lake surface area (upper and lower lakes) of c. 6.8ha (i.e. the permanent lake volume). The lake storage at median (50-percentile) water level is 649,000m^3 and this volume is used to determine the hydraulic residence time within the lake at various inflow rates. Further storage volume and surface area statistics are presented below in **Table 2**.

Table 2: Percentile Lake levels, surface areas and storage volumes in the Coolagh Lake system

Percentiles	1%	5%	50%	95%	99%
Lake level	6.64mOD	6.24mOD	5.86mOD	5.73mOD	5.70mOD
Area	36.0ha	30.4ha	10.9ha	7.2ha	6.8ha
Volume	801,000m^3	694,500m^3	649,000m^3	639,000m^3	637,000m^3

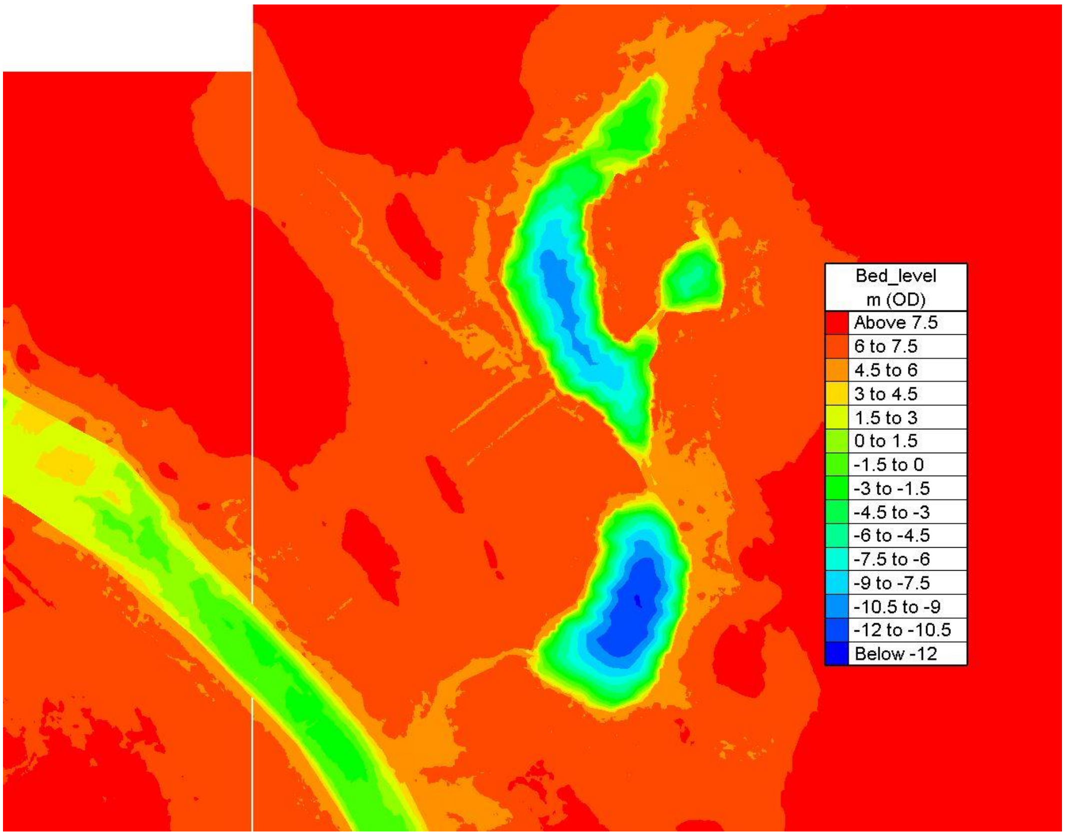
The annual winter-summer difference in storage volume (represented by the difference between the 1 and 99-percentile water levels) is 164,000m^3, therefore the average flushing ratio of this lake system by the River Corrib summer-winter water level variation is approximately 4 years at 5l/s. The natural flushing effect of recharge from the local drainage catchment is significantly higher at 0.7years (250days) at a mean annual inflow of 30l/s and the combined effect of the local recharge and the River Corrib is of the order of 35l/s producing an average hydraulic retention period of 215 days. These hydraulic retention times suggest moderate flushing time/exchange rate for a lake system.

The fringes of Coolagh Lakes dry out and only get inundated by the River Corrib water levels in winter. Alkaline Fen (Annex I habitat), which are fed by groundwater flow and seepages, has been identified surrounding the lakes. The waters within the lakes are alkaline with hardness values recorded in excess of 200 mg/l CaCO3 and the typical pH at 7.8 to 8.2.

Figure 2 shows the permanent water extent of the Coolagh Lakes and linkage to the River Corrib. A contour map of Coolagh Lakes and adjacent River Corrib channel generated using Lidar and bathymetric survey is presented in **Figure 3**.

Figure 2: Aerial View of Coolagh Lakes and the River Corrib

Figure 3: Bathymetry of Coolagh Lakes and the adjoining ~ River Corrib Channel.



3.7.3 Terryland River

The Terryland River, also known as the Sandy River, is a small drainage system that essentially drains the Terryland basin with a total catchment area of 6.75km^2. The river's outlet is to groundwater via two swallow-holes located at Poulavourleen, west of Castlegar Village. Old historic maps of Galway (Grand Jury Map, 1819) show that this river was a spur off the River Corrib channel and the valley floor was almost a lake bed during winter flooding. Arterial drainage works as part of a Public Works Corrib Drainage and Navigation Works Scheme were carried out in the 1850's and as part of these works constructed the Dyke Road embankment to prevent flooding from the River Corrib and allow the reclamation of the Terryland Valley for farm land. Today this embankment and the Salmon Weirs control, protect important commercial, industrial and retail developments that include the Galway Retail Park, Galway Shopping Centre, Terryland Shopping Centre, Terryland Retail Park and Liosbán Industrial Estate.

A water intake from the River Corrib near Jordan's Island provides controlled inflow to feed the Galway City water supply at the Terryland Water Treatment Works, with the excess discharging to the Terryland River. This inflow from the River Corrib to the Terryland River in terms of river flow is relatively small and not significant in respect to flood flow contribution. The watercourse is partially tidal with the tidal signal (0.7 to 0.8m range on spring tides and 0.3 to 0.4m range on neap tides upstream of the swallow-holes) evident and particularly so on spring tides which produces an almost reversal in flow direction coinciding with the flooding and ebbing spring tides (Terryland River Valley Drainage Scheme Report, 1998). These swallow holes are believed to discharge to Galway Bay but the location of the outlet in Galway Bay is of yet unknown. The integrity of these swallow holes is unknown. Ballindooley Lough is considered to be part of the Terryland catchment but the connection is via groundwater flow which has not been proved.

The inflow from the River Corrib to the Terryland River is via a manmade channel referred to as the Galway Bore which is also the abstraction/intake channel to the Terryland Water Treatment Plant. The excess flow from the bore overspills down into the Terryland River Basin. Historical maps (1819) showed the entire Terryland River Valley as inundated and part of the River Corrib system.

3.7.4 Ballindooley Lough System

Ballindooley Lough is an enclosed lough located on the N84 Headford Road at Ballindooley, on the outskirts of Galway City. The lough forms at the floor of a large enclosed depression having a surrounding topographical catchment area of 2.25km^2. The December 2015 event, which peaked on the 2 January 2016, produced possibly the highest flood levels in at least 50 years both within this system and within the Corrib System, with the maximum flood level recorded at 10.29m OD. The typical summer lake low water level is approximately 1.5m lower at c. 8.8m OD and in more severe drought conditions it is likely that lake levels fall below 8.5m OD. This suggests that the more extreme annual range in lake level is of the order of 2m but for a typical year it is likely to be between 1 and 1.5m.

During the December 2015 flood event maximum winter flood levels both in the River Corrib and Lough Corrib reached 6.93m OD and 7.27m OD respectively and water levels in the Terryland basin near Castlegar were below 4m OD.

A bathymetric survey of the Ballindooley Lough carried out as part of this study showed that the deepest part of the lake has a bed level of -2.5m OD (i.e. 2.5m below mean sea level) whereas the overbank floodplain area is typically at an elevation of 9.3 to 9.5m OD. This bed level suggests a water depth of some 12m at its deepest location.

At the maximum recorded flood level of 10.29m OD the surface area of the lake expands to 29.7ha and at the summer low water level of 8.5m OD it reduces to c. 4.5ha (4.2ha main lake and 0.3ha smaller pond to the southwest, both connected via a 3m wide and 250m long drain). There is over 2.4km of drainage channel draining the floodplain area of this lough, which feed into the permanent lake. This drainage channel is reasonably maintained and typically the cross-section dimensions are 1.5 to 2m deep and 3m top width. The live storage volume between the winter high of 10.3m OD and the summer low level of 8.5 is 271,500m^3. Approximately 500mm of rainfall (recorded at Met Éireann gauge in Athenry) fell in November and December 2015 and resulted in Ballindooley Lough rising by 1.3m from c. 9m OD to 10.3m OD. This represents a change in lake storage volume of almost 250,000m^3, which is 22% of the recorded rainfall depth over the 2.25km^2 catchment area.

The recession characteristics of the recorded lake levels indicate that the water level empties slowly (falls) by typically 0.8 to 1cm per day with almost similar recession characteristics at both high and low lake levels. In the summer period this fall is likely to represent evaporation losses from the lake surface. This slow almost constant like fall in levels suggests an emptying process influenced by the slower more continuous regional groundwater flow with the lake rising and falling with the groundwater table as opposed to a concentrated point (conduit flow via a swallow hole) outflows. The hydrological monitoring indicates that the lake is perched above the surrounding groundwater table in summer dry periods and influenced by the groundwater table in the wetter winter period. The proposed road development in terms of the groundwater table and groundwater flow is located down gradient of Ballindooley Lough. This feature is explained further in the Appendix A (Hydrogeology) of the NIS.

3.8 Baseline Water Quality Sampling of Receiving Waters

Bi-monthly to quarterly sampling of surface water quality was carried out over a winter summer period from winter 2015 to summer 2016. This was carried out to establish baseline water quality conditions in the receiving waters. The sampling locations are as follows:

1. Sruthán na Libeirtí at the R336 Coast Road culvert upstream
2. Trusky Stream at the R336 Coast Road culvert upstream
3. Bearna Stream at Cappagh North
4. Bearna Stream at Cappagh South
5. River Corrib at Dangan Slip
6. River Corrib at Terryland Intake Channel, Jordan's Island
7. Upper Coolagh Lake
8. Lower Coolagh Lake
9. Ballindooley Lough

The water quality sampling results are presented in Annex 1of this report and showed consistently good quality water at all of the sites with nutrient, Biochemical Oxygen Demand (BOD), sediments and heavy metal concentrations well within acceptable limits based on the surface water regulations. Bacterial faecal contamination was identified at all locations, possibly associated with the presence of agricultural activities and point septic tank and slurry pit sources within the respective catchments.

As was expected the western watercourses (Bearna, Trusky and Sruthán na Libeirtí Streams) associated with the granite bedrock and peatland areas showed slightly lower pH, lower alkalinity and hardness, and elevated iron concentrations over the eastern limestone watercourses. The most alkaline and highest hardness waters were found within Ballindooley Lough followed by the Coolagh Lakes.

3.8.1 EPA Monitoring River Programme

The EPA carries out water quality assessments of rivers as part of a nationwide monitoring programme. Data is collected from physio-chemical and biological surveys, sampling both river water and the benthic substrate (sediment) in contact with the water.

Water sampling is carried out throughout the year and the main parameters analysed include: conductivity, pH, colour, alkalinity, hardness, dissolved oxygen, biochemical oxygen demand (BOD), ammonia, chloride, ortho-phosphate, oxidised nitrogen and temperature.

Biological surveys are normally carried out between the months of June and October. These examine the relationship between water quality and the relative abundance and composition of the macro-invertebrate communities in the sediment of rivers and streams. The macro-invertebrates include the aquatic stages of insects, shrimps, snails and bivalves, worms and leeches. It is generally found that the greater the diversity of species recorded, the better the water quality is.

The collated information relating the water quality and macro-invertebrate community composition is condensed to a numerical scale of Q-values or Biotic Index. The indices are grouped into four classes based on a river's suitability for beneficial uses such as water abstraction, fishery potential, amenity value, etc. (refer to **Table 3** below).

Table 3: Biological River Water Quality Classification System

Biotic Index (Q value)	Quality Status	Quality Class	Condition
Q5, Q4-5, Q4	Unpolluted	Class A	Satisfactory
Q3-4	Slightly Polluted / Eutrophic	Class B	Transitional
Q3, Q2-3	Moderately Polluted	Class C	Unsatisfactory
Q2, Q1-2, Q1	Seriously Polluted	Class D	Unsatisfactory

The River Corrib is monitored at Wolfe Tone Bridge and is currently categorised as having good status (Q4) for the period (2004 - 2015). The Terryland River is categorised as having poor Status (Q2 - Q3). No Other watercourses within the study area are currently monitored by the EPA as part of the EPA Monitoring River Programme

One of the major aims of the Water Framework Directive is that all European waters should achieve a good water quality status by 2027 at the latest.

3.9 Ecological Attribute Status of Surface Waters

Given the European designation and salmonid status of the River Corrib (Lough Corrib cSAC) it is considered to have an extremely high attribute value and includes the Coolagh Lakes near Menlo Castle.

The remaining watercourses encountered within the study area are all minor watercourses, with all such streams having catchment areas of less than 10km^2. The following watercourses generally have a fisheries value of local high or local low value and the overall ecological valuation of local high:

1. Sruthán Na Libeirtí (1.5 km^2)
2. Trusky Stream (3.3 km^2)

3. Bearna Stream (9.14 km^2)
4. Knocknacarra Stream (4.4 km^2)
5. Terryland Stream (6.7 km^2)

The Galway Bay Complex cSAC is the coastal/transitional waters east of White Strand Beach. The Bearna Village coastal area is outside of the Galway Bay Complex cSAC and Inner Galway Bay SPA but given the easterly flooding and westerly ebbing tidal flows these water mix with the cSAC/SPA waters within a single tidal excursion.

Sections of the proposed road development will eventually drain into the Galway Bay Complex cSAC and Inner Galway Bay SPA via surface water streams, existing urban storm drainage systems and groundwater flows. The Sruthán Na Libeirtí Stream and the Trusky Streams do not directly discharge to the Galway Bay Complex cSAC and Inner Galway Bay SPA, outfalling to the sea near Bearna. The remaining streams all outfall into the Galway Bay Complex cSAC and Inner Galway Bay SPA. The Terryland River which has a water intake from the River Corrib at Jordan's Island drains the Terryland basin and disappears underground via karst swallow-holes near Castlegar. The outflow from the Castlegar swallow holes is unknown but is likely to discharge to the Galway Bay Complex cSAC and Inner Galway Bay SPA via submarine springs or even further out to sea west of the cSAC/SPA.

The majority of the above streams have either partially or extensively been urbanised. The fishery resource of these streams is presented in Appendix J of the NIS and is also assessed (as appropriate) in the main report of this NIS and is briefly summarised below:

- The Sruthán na Libeirtí is categorised as of local importance (lower value) for European eel and with no Salmonids present. The lower reaches have some moderate quality salmonid and European eel habitat
- The Trusky Stream is categorised to be of local importance (higher value) for salmonids, European eel and as a nursery for flounder in its lower reaches at Bearna. Some spawning habitat for trout exists in the lower reaches but this is limited
- The Bearna Stream is salmonid and is categorised to be of local importance (higher value) for Brown trout. Upper reaches seasonal but moving downstream the habitat becomes an important salmonid river.
- An Sruthán Dubh is a tributary of the Bearna Stream and is considered to be an excellent salmonid habitat throughout its upper reaches and is considered an excellent nursery salmonid stream with good numbers of juvenile brown trout and small numbers of European eel. This is classified to be of local importance higher value for brown trout and European eel
- The Knocknacarra Stream is categorised to be of local importance (higher value) for European eel and as a nursery for estuarine fish. Upper reaches are seasonal and of no fishery value but lower fluvial and estuarine reaches are of importance as a transitional habitat to estuarine fish and eel

- The River Corrib is an important salmonid river system and is considered to have an extremely high attribute value due to its European designation
- The Terryland River continues to be impacted by urban pollution and is considered to be of limited fisheries value and categorised to be of local importance (lower value) for European eel
- The Coolagh Lakes are categorised to be of local importance (lower value) for coarse fish species and European eel and despite its connection to the River Corrib is of limited or no value to salmonids. The Coolagh Lakes are within the Lough Corrib cSAC and therefore classified as of high importance
- Ballindooley Lough is considered an excellent coarse fishery, but not of importance as a salmonid fishery and is categorised to be of local importance (higher value) for coarse fish species

3.10 Climatological Data in the area of the proposed road development

The mean long term annual rainfall (SAAR) in the area of the proposed road development varies slightly with a tendency for increased rainfall from east to west. The SAAR value for the Bearna area is typically 1275mm, whereas the proposed River Corrib crossing point it is 1250mm and further to the east in the Coolagh/Doughiska area it is 1140mm.

The Annual Potential Evapotranspiration Rate based on the Athenry Meteorological Station is 508mm and for the Mace Head Station (located along Connemara west coast) is 562mm. The Athenry Station is considerably more suitably located to the proposed road development than the Mace Head Station and therefore considered more applicable. Combining this with the annual rainfall the typical effective rainfall rate for recharge and runoff is calculated as 714mm.

Table 4: Monthly Climatological Data Recorded at Mellows College Athenry Station (2013 to 2016)

(a) Total Rainfall (mm) for Athenry Station (Mellows College)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
2016	145.2	129.8	79.4	49.2	56.7	98.5	85.1	96.3	138.0	58.4	59.1	n/a	1005.6
2015	191.1	68.7	129.9	74.8	138.0	44.9	138.2	114.6	93.3	66.6	216.3	299.4	1575.8
2014	182.5	177.7	103.1	47.6	103.1	38.6	92.4	104.9	10.4	140.9	139.0	124.1	1264.3
2013	132.2	46.5	36.9	102.4	97.2	61.4	101.5	72.8	47.9	120.0	100.0	220.3	1139.1
mean	116.7	87.8	94.7	72.0	75.3	79.6	86.5	107.8	100.3	128.9	120.3	123.2	1192.9

(b) Potential Evapotranspiration (mm) for Athenry (Mellows College)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2016	13.1	17.3	34.5	53.4	80.3	84.2	72.2	61.2	39.9	26.5	9.8	3.4	495.8
2015	13.2	14.6	33.8	60.7	65.2	78.9	71.3	63.4	43.6	23.9	17.6	16.0	502.2
2014	10.8	19.3	32.6	58.5	65.7	87.4	81.8	66.5	47.9	26.3	9.9	10.6	517.3
2013	6.5	14.6	28.7	52.9	68.4	82.4	98.6	65.0	44.1	27.0	12.4	14.8	515.4
mean	10.9	16.5	32.4	56.4	69.9	83.2	81.0	64.0	43.9	25.9	12.4	11.2	507.7

4 Potential Hydrological Impacts

4.1 General

Types of hydrological impact fall into two broad categories of quantitative and qualitative impacts.

4.1.1 Quantitative Impacts

Quantitative hydrological impacts represent changes to the natural flow regime in the aquatic system in terms of changes to the water balance, flow depth, velocities, temperature and density leading to changes in the hydrodynamics of the aquatic system. These changes can be brought about by direct encroachment of the waterbody or by altering the recharge to a waterbody generally by the presence of a road and its associated road drainage system within the catchment area.

Hydraulic structures such as bridges, culverts, channel diversions and outfalls can, if not appropriately designed impact negatively on upstream and downstream water levels and on flow velocities. If a bridge or culvert opening is too narrow or a diversion channel undersized it may impede flow during times of floods thus causing water levels upstream of the structure to be raised above what would occur in the absence of the structure. If in-stream culvert structures and associated channel diversions and transitions are too wide or steep this can significantly affect the mean and low flow regime of the stream in terms of velocity and water depth changes resulting in low velocities and low water depths which can alter the local sedimentology and flow regime resulting in benthic impacts and potential fishery impacts.

Hard paved areas and local changes in the topography created by the road formation can alter the groundwater and surface water recharge regime. The footprint of the proposed road development and its associated drainage system can capture surface runoff, unsaturated soil interflow and groundwater flows from up gradient and divert them to point surface and groundwater discharge points. Surface water drainage from the carriageway, grassed margins and embankment slopes can lead to localised increased flows and flooding in the receiving streams. The road formation can act as a large stone drain causing diversion of recharge flows and in deep cuttings into the water table a dewatering effect on the groundwater system which impacts both surface and groundwater systems.

Construction activities such as temporary encroachments of watercourses for construction purposes of a bridge, culvert, outfall, temporary access road and temporary diversion can give rise to changes in the local flow regime which may alter velocities and depths and potentially give rise to changes to the hydrological flow regime and changes to channel morphology (channel deposition and erosion).

4.1.2 Qualitative Hydrological Impacts

Qualitative hydrological impacts represent changes to the chemistry of the receiving water bodies generally arising from road drainage discharges. Water quality impact on receiving watercourses at storm outfalls from routine road runoff (generally sediment associated contaminants, heavy metals, hydrocarbons and suspended solids, de-icing agents (salt and grit) and to a lesser extent nutrients, organics, and coliforms). A wide range of heavy metals are known to occur in road drainage waters, the primary metals of concern are Cadmium (Cd), Lead (Pb), Copper (Cu) and Zinc(Zn). All of these metals are included in the EU substances Directive (76/464/EEC), the EU Directive on Pollution Caused by Certain Dangerous Substances (2006/11/EC), the EU Water Framework Directive (2000/60/EC) and the proposed EU priority Contaminating Substances Directive. In particular, Cadmium is a List 1 substance included in the EU Blacklist of dangerous substances; all other compounds are List 2 substances. Salt and grit applications to road surfaces to mitigate icy conditions, will result in an increased salinity, pH, conductivity and total dissolved solids concentrations to receiving aquatic system. Increased salinity of watercourses can alter the ecological balance of the aquatic system and increase the bioavailability of chemical contaminants.

The road drainage and associated storm outfalls provide a direct pathway for contaminant from accidental spillages associated with HGV's (agricultural, oil/chemical spillages, bulk liquid, cement, etc.) to gain rapid un-attenuated access to receiving watercourses.

Construction activities pose a significant risk to watercourses particularly contaminated surface water runoff from construction activities entering nearby watercourses. Construction activities within and alongside surface waters associated with bridge and culvert construction, outfalls and channel diversions can contribute to the deterioration of water quality and can physically alter the stream/river bed and bank morphology with the potential to alter erosion and deposition rates locally and downstream. Activities within or close to the watercourse channels can lead to increased turbidity through re-suspension of bed sediments and release of new sediments from earthworks. Consequently, in-stream works can potentially represent a severe disruption to aquatic ecology.

The main contaminants arising from construction runoff include:

- Elevated silt/sediment loading in construction site runoff. Elevated silt loading can lead to long-term damage to aquatic ecosystems by smothering spawning grounds and gravel beds and clogging the gills of fish. Increased silt load in receiving watercourses stunts aquatic plant growth, limits dissolved oxygen capacity and overall reduces the ecological quality with the most critical period associated with low flow conditions. Chemical contaminants in the watercourse can bind to silt which can lead to increased bioavailability of these contaminants
- Spillage of concrete, grout and other cement based products. These cement based products are highly alkaline (releasing fine highly alkaline silt) and extremely corrosive and can result in significant impact to watercourses altering the pH, smothering the stream bed and physically damaging fish through burning and clogging by the fine silt of gills
- Accidental spillage of hydrocarbons from construction plant and at storage depots/construction compounds
- Faecal contamination arising from inadequate treatment of on-site toilets and washing facilities

4.2 Road drainage Surface Water Outfalls

There are 16 proposed mainline surface water outfalls discharging directly to surface water courses, located primarily in the western section of the study area (over the western 10.15 km of the 17.5km the mainline for the proposed road development). The remaining 7.35km, to the east of the River Corrib will be discharged to groundwater or to existing public storm and foul sewer systems in the absence of surface water drainage features. The realigned N84 Headford Road and slip roads for the N84 Headford Road Junction will discharge to a small ditch that inflows to Ballindooley Lough. The two short sections of tunnel in the eastern section will discharge to the public foul sewer via pumping. A summary of the proposed outfalls are presented in **Table 5** below.

These road drainage outfalls if not appropriately designed have a potential to adversely impact water quality in the receiving watercourse and groundwater from routine contaminants that are contained in road drainage waters.

The water quality and ecological status of the receiving waters are also potentially threatened by contamination arising from large liquid spillages as a result of an accident on the proposed road development.

The surface water storm outfalls also have the potential to impact the general flow and morphological regime of a receiving watercourse by increasing the volume and rate of runoff during storm events. The morphology of the stream is significantly influenced by ambient flow and flooding conditions in the stream. The potential increase in flow volume to the stream arises from increased impervious area by the road pavement area, the provision of road and embankment drainage with a direct pathway via the road drainage system to the receiving watercourse and potential interception of groundwater and diversion of drainage waters that would not otherwise have reached the outfall point. The hard-paved areas and the road drainage system reduces the time of concentration for rainwater to arrive at the outfall and thus increase the rate of runoff over the natural greenfield condition.

It is anticipated that the proposed road development which will take traffic from existing roads will provide some benefit as most of these existing roads do not have sustainable urban drainage systems to protect surface and groundwater alike.

Most of the surface watercourses being outfalled to by the proposed road drainage are only of high local value but do eventually discharge either to the European sites of the Lough Corrib cSAC and the Galway Bay Complex cSAC and Inner Galway Bay SPA. The N59 Link Road North drainage network S15, and the proposed NUIG Playing Pitches S44 outfall via open drains at Dangan, which eventually discharges to Lough Corrib cSAC and Lough Corrib SPA. Such watercourses provide a good buffer for attenuation and provide natural wetland treatment before reaching any of the European sites. Outfalls S18A and S18B (near Dangan Slip and Menlo Castle Ref. Figure 8.2.7 of the NIS) are locally sensitive as they discharge directly to the River Corrib channel, which is of high sensitivity being part of the Lough Corrib cSAC, a salmonid watercourse and major public water supply source. Much of the receiving watercourses have local higher attribute value further downstream in their lower reaches and all the outfalls to the Bearna, Knocknacarra and Corrib Systems eventually discharge into the Galway Bay Complex cSAC and

Inner Galway Bay SPA. Waters in the Sruthán na Libeirtí and the Trusky Stream at Bearna have the potential after mixing with the coastal waters to reach the tidal waters of the Galway Bay Complex cSAC and Inner Galway Bay SPA.

Table 5: Proposed Road Development Drainage Outfalls to Watercourses

Drainage Reference (Refer to Figures 8.2.1 to 8.2.15)	Approx. Ch. Of Outfall	Road Section Ch. Start – Ch. End	Total Impervious Road Area (ha)	Receiving Catchment Area (km2)	Mean Flow (cumec)	95% Low Flow (cumec)	Catchment
S1	0+000	0+000 – 0+700	1.285	1.474	0.033	0.003	Sruthán na Libeirtí
S2	0+625	0+700 – 1+000	0.380	0.792	0.018	0.0016	Sruthán na Libeirtí
S3	0+900	1+000 – 1+475	1.281	0.324	0.007	0.0006	Sruthán na Libeirtí
S4A	1+550	1+475 – 1+900	0.624	0.049	0.001	0.0001	Trusky Tributary
S4B	1+560	L-580 – 680	0.069	0.050	0.001	0.0001	Trusky Tributary
S5A	2+750	1+900 - 2+850	1.532	0.502	0.011	0.0010	Trusky
S5B	2+750	L- 000 – 300	0.137	0.073	0.0012	010001	TruskyDitch
S7A	3+000	2+850 – 3+050	0.244	0.060	0.001	0.0001	Ditch Trusky Tributary
S7B	3+950	3+050 – 3+900	1.070	5.815	0.129	0.0116	Bearna Stream
S8	4+000	3+910 – 4+125	0.256	0.85	0.019	0.0017	Bearna Stream
S9	4+150	4+125 – 4+900	1.192	4.94	0.110	0.0099	Bearna Stream
S10	4+850	4+900 – 5+640	1.219	1.9	0.042	0.0038	Bearna Tributary. Tonabrocky
S11	6+000	5+640 – 6+325	1.572	0.16	0.004	0.0003	Storm sewer to Knocknacarra
S12	6+850	6+325 – 7+300	2.446	1.77	0.039	0.0035	Knocknacarra Tributary
S13	7+350	7+300 – 7+525	0.632	0.316	0.007	0.0006	Knocknacarra Tributary
S14A	8+300	7+525 – 8+250	2.199	0.14	0.003	0.0003	River Corrib Tributary
S14B	8+550	8+250 – 8+525	0.652	0.264	0.006	0.0005	River Corrib Tributary
S15	East of N59 Link	0 – 625 N59 Link	0.727	0.05	0.001	0.0001	Local Ditch to River Corrib

Drainage Reference (Refer to Figures 8.2.1 to 8.2.15)	Approx. Ch. Of Outfall	Road Section Ch. Start – Ch. End	Total Impervious Road Area (ha)	Receiving Catchment Area (km2)	Mean Flow (cumec)	95% Low Flow (cumec)	Catchment
S18A	9+250	8+525 – 9+250	1.580	3136	82.000	14.000	River Corrib West Bank
S18B	9+425	9+250 – 10+150	1.954	3136	82.000	14.000	River Corrib East Bank
S36A	3+380	L – 3+350	0.24	0.10	0.003	0.0003	Bearna Tributary
S36B	3+380	L – 3+350	0.10	0.14	0.003	0.0003	Trusky Stream
S31A	7+230	L – 7+250	0.09	0.32	0.007	0.0006	Knocknacarra Tributary
S31B	7+230	L – 7+250	0.15	0.32	0.007	0.0006	Knocknacarra Tributary
S44	9+150	N/A	0	0.17	0.003	0.0003	River Corrib Tributary

4.2.1 Water Quality Impact – Accidental Spillage Risk Assessment

The risk of pollution to both surface and groundwater resulting from accidental spillage is an issue considered in the development of proposed road infrastructure projects. Trying to predict the occurrence of a spill with any degree of certainty is difficult. One can conclude that the risk is influenced by the type of roadway, length of road, the traffic volume, and proportion and type of heavy goods vehicles (HGV's). A spillage risk assessment of the proposed road development has been carried out in accordance with the TII Publications DN-DNG-03065 (formerly NRA Design Manual for Roads and Bridges HD45/15) – see **Tables 6** and **7**.

The overall combined probability of a serious HGV spillage entering a watercourse from the proposed road development is low at 0.089%. This spillage risk analysis was based on the projected AADT traffic values, which indicate that HGV's figures vary between 2 to 6% of the AADT.

The spillage assessment shows the proposed road development will have very low magnitude of risk of impact for individual outfalls or grouped catchment outfalls and of such a low probability that specific pollution control measures for road drainage are not required under the TII DMRB spillage risk assessment analysis. However, given the sensitivity of the sites the road drainage design incorporates pollution reduction measures in the form of spillage containment area, oil and petrol interceptor and wetland /attenuation pond upstream of its outfalls and in the case of the storm drainage discharging to groundwater an engineered infiltration basin. This approach ensures in the event of a serious spillage the risk to receiving waters will be negligible.

Table 6: Serious Spillage Pollution Risk Assessment at proposed outfalls to surface watercourses

Drainage Reference (Refer to Figures 8.2.1 to 8.2.15)	Road Chainage	Watercourse	Outfall Risk (%)	Combined Risk (%)
S1	0+000 – 0+700	Sruthán na Libeirtí	0.0066	
S2	0+700 – 1+000	Sruthán na Libeirtí	0.0005	
S3	1+000 – 1+475	Sruthán na Libeirtí	0.0025	0.0096
S4A	1+475 – 1+900	Trusky Tributary	0.0023	
S4B	Link Rd. 0+580 – 0+680	Trusky Tributary	0.0001	
S5A	1+900 - 2+850	Trusky Stream	0.0068	
S5B	Link Road	Ditch Trusky Trib	0.0001	
S7A	2+850 – 3+050	Ditch – Trusky Trib	0.0004	0.0097
S7B	3+050 – 3+910	Bearna	0.0015	
S8	3+910 – 4+125	Bearna	0.0004	
S9	4+125 – 4+900	Bearna	0.0029	
S10	4+900 – 5+640	Bearna Tributary.	0.0028	0.0080
S12	6+325 – 7+300	Knocknacarra Tributary	0.0031	
S13	7+300 – 7+525	Knocknacarra Tributary	0.0008	0.0073
S14A	7+525 – 8+250	Corrib Tributary	0.0062	
S14B	8+250 – 8+525	Corrib Tributary	0.0029	
S15	0 – 625 N59 link	Existing Ditch to Corrib	0.0062	
S18A	8+525 – 9+250	Corrib River West Bank	0.0054	
S18B	9+250 – 10+150	Corrib River East Bank	0.0067	0.042
S21A	Sliproads and N84 interchange	Ballindooley Lough	0.0138	
S36A	Aille Road North	Bearna Stream Tributary	0.0000	
S36B	Aille Road South	Trusky Stream Tributary	0.0000	
S31A	Letteragh Rd	Knocknacarra Tributary	0.0000	
S31B	Letteragh Rd	Knocknacarra Tributary	0.0000	
S44	9+150	River Corrib	0.0000	

Table 7: Serious Spillage Pollution Risk Assessment at Proposed Outfalls to Groundwater Infiltration

Drainage Reference (Refer to Figures 8.2.1 to 8.2.15)	Approx. Chainage	Outfall Risk (%)
S19A	10+150 to 10+730	0.00286
S19B	10+730 to 11+150	0.00207
S20	11+414 to 12+017	0.00320
S21B	12+017 to 13+700	0.01361
S22A	13+700 to 13+920	0.01557
S22B	13+920 to 14580	0.0038
S22C2	13+650 to 14+160	0.00045
S22E	Sliproads & N17 Loop	0.00006
S40	10+450	0.0000

Research has found that a broad band of potential pollutants are associated with routine runoff from road schemes arising from road traffic and road maintenance. These contaminants are generally associated with the particulate phase and are principally heavy metals, hydrocarbons and suspended solids and de-icing agent's routine runoff from road schemes arising from road traffic and road maintenance. These contaminants are generally

4.2.2 Impact of Routine Road Runoff on receiving waters

Research has found that a broad band of potential pollutants are associated with routine runoff from road schemes arising from road traffic and road maintenance. These contaminants are generally associated with the particulate phase and are principally heavy metals, hydrocarbons and suspended solids and de-icing agents (salt and grit) and to a lesser extent nutrients, organics and faecal coliforms and other chemical pollutants. In terms of potential impact to receiving watercourses the first flush runoff (10 to 15mm rainfall runoff) particularly after extended dry periods produces elevated concentrations locally in the receiving waters due to concentrated load. The impact of contaminants within routine road runoff depends on the loading (associated with traffic numbers) and the available dilution in the receiving watercourse.

The high density of outfall discharge points along the mainline of the proposed road development, disperses and reduces the potential pollutant point load from the proposed road drainage system. The design traffic volume in conjunction with the relatively small contributing road areas will not give rise to any potential significant hydraulic or pollutant loads on the receiving waters. The potential impact of routine runoff in the absence of storm drainage pollutant removal represents a localised impact on water quality of the receiving environment. The overall loading of heavy metals, sediments, hydrocarbons and other waste products on the receiving waters will be significantly reduced through the provision of various drainage design elements such as, petrol and oils interceptors, filter drains, grassed surface water channels wetlands, infiltration areas and storm attenuation ponds upstream of the outfalls designed to capture and treat the first flush rainfall runoff events.

TII Publications DN-DNG-03065 (NRA HD45/15) gives guidance and assessment tools for the impact of road projects on the water environment, including the effects of runoff on surface waters in the absence of pollution reduction measures. The Highways Agency Water Risk Assessment Tool (HAWRAT) is the tool used to assess the effects of road runoff on surface water quality and uses toxicity thresholds based on UK field research programmes which are consistent with the requirements of the Water Framework Directive (WFD) and are appropriate for assessment of National Road Schemes in Ireland. The UK research programme has shown that pollution impacts from routine runoff on receiving waters are broadly correlated with Annual Average Daily Traffic (AADT) numbers.

4.2.2.1 HAWRAT Assessment of Road Drainage Outfalls

A HAWRAT assessment has been carried out for all proposed drainage outfalls directly discharging to surface watercourses along the proposed road development, including realigned and upgraded link roads and junctions, see **Table 6** below. The HAWRAT assessment tool uses the AADT category of 10,000 to 40,000 in the assessment process which is appropriate for the Design Year AADT numbers. Further to the west, as ADDT numbers reduce, this category is likely to be precautionary in terms of its water quality predictions as the ADDT numbers are much closer to 10,000 than 40,000.

It is also important to note that the HAWRAT assessment is based on direct discharges to watercourses in the absence of proposed drainage treatment design measures. These design measures include petrol interceptors, water quality treatment ponds and wetlands and attenuation ponds, therefore the predictions are worst case and do not include treatment performance improvements provided by the design measures. The design measures provided at each outfall will achieve in excess of 60% reduction in suspended sediments and associated heavy metals. The HAWRAT analysis was carried out on all of the proposed outfalls in the absence of proposed water quality and attenuation design measures and the required level of treatment quantified, refer to **Table 8** below.

In cases where the road drainage outfall discharges to a drainage ditch with very limited drainage catchment, resulting in dry conditions during low flows, the local HAWRAT assessment will produce a FAIL result, as there is no dilution available for solutes nor flow velocities to disperse sediment away from the outfall. These failures in the HAWRAT analysis are not considered to represent an impact as such minor ditches are only serving as conduits to the larger stream and river channels. In these cases, the potential impact on watercourses is also assessed further downstream where it joins the larger stream channel, refer to outfall locations on **Figures 8.2.1** to **8.2.15**. Note the HAWRAT assessment is carried out in the absence of pollution control measures such as attenuation and water quality improvement pond systems which are designed to achieve in excess of 60% sediment removal performance which significantly reduces local and downstream impacts on water quality.

In general, HAWRAT is considered to provide a very precautionary means to assess those road outfall discharges that will not adversely affect receiving water quality with respect to soluble and sediment-bound pollutants. The screening parameters are sediment and the dissolved heavy metals of zinc and copper concentrations. These represent the primary waste constituents in the road drainage discharges and used as screening parameters for other pollutant substances such as de-icing agents of salt and grit, hydrocarbons, Cadmium, Pyrene, PAHs, nutrients and organics.

Table 8: Results of the HAWRAT Road Outfall Water Quality Assessment of Receiving Surface Waters

Outfall No. (Refer to Figures 8.2.1 to 8.2.15)	**Water Hardness (mg/l $CaCO_3$)**	**Dissolved Copper (ug/l)**	**Dissolved Zinc (ug/l)**	**Sediment Deposition Index**	**Comment**
S1	Low < 50	0.31	0.93	174	**Pass** Solubles, **Fail** Sediment (Settlement required 43%)
S2	Low < 50	0.20	0.62	84	**Pass** Solubles, **Pass** Sediment accumulates but not extensive
S3	Low < 50	1.07	3.27	248	**Fail** Solubles, **Fail** Sediment (Required Treatment Solubles 30% reduction Settlement 76%
S4A	Low < 50	2.01	6.27	250	**Fail** Solubles, **Fail** Sediment (Required Treatment 61% settlement and 56% soluble reduction)
S5A	Low < 50	0.87	2.65	299	**Fail** Solubles, **Fail** Sediment (Required Treatment 67% settlement and 25% soluble reduction)
S7A	Low < 50	1.39	4.27	122	**Fail** Solubles, **Fail** Sediment (Required Treatment 18% settlement and 44% soluble reduction)
S7B	Low < 50	0.09	0.27	41	**Pass** Solubles, **Pass** Sediment
S8	Low < 50	0.16	0.50	44	**Pass** Solubles, **Pass** Sediment
S9	Low < 50	0.13	0.40	50	**Pass** Solubles, **Pass** Sediment
S10	Low < 50	0.31	0.96	87	**Pass** Solubles, **Pass** Sediment

Outfall No. (Refer to Figures 8.2.1 to 8.2.15)	Water Hardness (mg/l $CaCO_3$)	Dissolved Copper (ug/l)	Dissolved Zinc (ug/l)	Sediment Deposition Index	Comment
S12	Low < 50	0.60	1.87	191	**Pass** Solubles, **Fail** Sediment (Required Treatment 48% settlement)
S13	Low < 50	0.82	2.55	178	**Fail** Solubles, **Fail** Sediment (Required Treatment 44% settlement and 3% soluble reduction)
S14A	Med 50 – 200	2.39	7.38	725	**Fail** Solubles, **Fail** Sediment (Required Treatment 87% settlement and 35% solubles reduction)
S14B	Med 50 – 200	1.11	3.46	365	**Fail** Solubles, **Fail** Sediment (Required Treatment 49% settlement and 10% solubles reduction)
S15	Med 50 – 200	2.42	7.49	175	**Fail** Solubles, **Fail** Sediment (Required Treatment 61% settlement and 25% solubles reduction)
S18a	Med 50 – 200	<0.00	<0.00	1	**Pass** Solubles, **Pass** Sediment
S18b	Med 50 – 200	<0. 00	<0.00	2	**Pass** Solubles, **Pass** Sediment

A cumulated HAWRAT water quality assessment of the proposed road development outfall discharges to the River Corrib, whereby all River Corrib outfall discharges (S14A, S14B, S15, S18A and S18B, ref Figures 8.2.6 and 8.2.7 and 8.2.12 for the NIS) were combined as one loading giving a total contributing paved area of 7.08ha and total drainage area of 12.58ha. Note that the outfall from the proposed NUIG Pitches S44 was not assessed in this combination as this catchment is not a road, therefore routine road runoff water quality characteristics from traffic at this location isn't applicable. This analysis easily passed with no discernible acute or chronic impacts on the water quality of River Corrib from proposed road drainage discharges. The event statistics for the untreated effluent in the drainage runoff give the following event statistics, refer to **Tables 9** and **10**. These loadings are used as the mean concentration in the two-dimensional modelling of the River Corrib receiving waters presented latter in this section.

Table 9: Event Statistics for soluble heavy metal pollutants in untreated Road Drainage Runoff

	Dissolved Copper Cu (µg/l)	**Dissolved Zinc Zn (µg/l)**
Mean	24.00	67.53
90%	45.95	144.85
95%	57.54	191.09
99%	90.93	346.16

Table 10: Event Statistics for soluble heavy metal pollutants in River Corrib at 95% low flow

	Dissolved Copper Cu (µg/l)	**Dissolved Zinc Zn (µg/l)**
Mean	0.00	0.01
90%	0.00	0.01
95%	0.01	0.02
99%	0.03	0.08

The event statistics for this grouped discharge give a mean event concentration in the river of that is negligible (<0.00 (µg/l)) for copper and (<0.01 (µg/l)) for zinc and 99-percentile event statistics of 0.03 (µg/l) dissolved copper and 0.08 (µg/l) dissolved zinc which are considered to represent only trace concentrations and well below the maximum allowable concentrations of 30 and 100 µg/l as set out in the Surface Water Regulations. In the HAWRAT manual the runoff specific thresholds for short term exposure of organisms gives the short-term exposure threshold values for dissolved copper and zinc. Refer to **Table 11** below.

Table 11: Maximum Short-term exposure threshold limits for dissolved copper and zinc (WRc 2007)

<table>
<tr><th rowspan="3">Exposure Duration</th><th rowspan="3">Copper (µg/l)</th><th colspan="3">Zinc (µg/l)</th></tr>
<tr><td colspan="3">Harness</td></tr>
<tr><td>Low
(< 50mg/l CaCO3)</td><td>Medium
(50 to 200 mg/l CaCO3)</td><td>High
(>200mg/l CaCO3)</td></tr>
<tr><td>24hour</td><td>21</td><td>60</td><td>92</td><td>385</td></tr>
<tr><td>6hour</td><td>42</td><td>120</td><td>184</td><td>770</td></tr>
</table>

This assessment clearly shows that the dilution available in the River Corrib even at 95-percentile low flow conditions ensures that the potential toxicity impact from road runoff contaminants on this salmonid river will be negligible and well below allowable levels for dissolved copper and zinc set out in the Salmonid Waters Directive and in the Surface Waters Regulations and also well below the recommended short-term exposure thresholds presented in **Table 11** above.

It should be noted that the above assessment is carried out in the absence of proposed road drainage water quality and attenuation treatment and therefore the potential impact will be considerably lower after the designed treatment, refer to **Table 8**.

The provision of first flush treatment in a wetland system and the storage in the attenuation pond provides residence time for the sediment to settle out before being discharged to the watercourse. This storage also reduces the outfall discharge rate with the contaminated first flush event being stored and released gradually.

This grouped assessment was also carried out on Sruthán na Libeirtí, the Knocknacarra, Bearna and Trusky Streams and were found to satisfy the HAWRAT water quality assessment in the downstream fishery reaches. The impact on water chemistry downstream in the coastal waters will be negligible due to the significant mixing available in the downstream reaches of the watercourses and within the tidally flushed estuarine reaches.

For the various individual outfalls discharging to small drains and streams with limited upstream catchment, it is found that the majority of these outfalls fail the HAWRAT assessment (in absence of pollution control measures), simply because there is negligible flow for dilution during 95-percentile low flow design conditions. At these locations, these failures are not considered significant as further downstream in the receiving streams the flow rate and contributing catchment area increases which lessens any potential impact.

The proposed storm drainage design for all proposed new surface water outfalls discharging to watercourses includes a spillage containment area ($25m^3$), a petrol and oil interceptor, a surface flow (SF) wetland with a permanent pond depth of 0.6m (to take first flush volume 15mm) and an attenuation pond (typically having a storage volume of a further 70mm rainfall over the paved area). Such facilities will achieve a long hydraulic residence time for first flush pollutant events ensuring good settlement performance. Flood attenuation will not be provided at the direct outfalls to the River Corrib S18A and S18B as attenuation of the road storm flow is not warranted give immense scale of the River Corrib catchment and capacity of the channel relative to the proposed road drainage direct discharges at S18A and S18B. The other pollution control elements including spillage containment, wetland first flush treatment and petrol and oil interceptors will be provided to achieve storm water treatment and accidental spillage protection for these outfalls.

The expected performance of the designed pollution control measures are expected to achieve in excess of 60% settlement performance of particulate matter but for soluble substances unlikely to achieve above 30% reduction and lower performances during the non-growing season, refer to **Table 12** below. The design ensures no significant water quality impact on receiving designated waters of the Lough Corrib cSAC and Lough Corrib SPA and the downstream Galway Bay cSAC and Inner Galway Bay SPA.

Table 12: Expected Pollutant Removal Performance of Vegetated systems extracted from TII DN-DNG-03063

Runoff Constituent	**Stormwater treatment system Performance**					
	Swales	Infiltration Basins	SF Wetlands	SSF ** Wetlands	Detention / Retention Ponds	Sedimentation Ponds
Sus Solids & associated heavy metals	Good	Good	Good	Good	Moderate	Good
Heavy Metals in solution *	Moderate-Good	Moderate-Good	Moderate-Good	Good	Poor	Poor-moderate
Oil and grease	Good	Moderate-Good	Good	Good	Moderate	Moderate
Nutrients	Poor	Poor	Moderate-Good	Good	Poor	Poor-moderate

Notes:

Poor represents < 30% removal efficiencies, Moderate represents 30 to 60% removal efficiency and Good represents > 60% removal efficiency

** applicable to Growing Season*

*** very limited operational life of SSF Wetlands due to clogging of substratum*

In general, the most likely impact of untreated road runoff from the proposed road development is the increased total suspended solids loading to receiving waters and associated trace amounts of heavy metals (Cu, Zn) and hydrocarbons. At all proposed surface drainage outfalls, water quality treatment of the sediment load is provided for, which will reduce local impacts from sediment deposition accumulation and potential toxicity levels in the stream/drain channel immediately close to the outfall.

The two tunnel sections of the road do not receive direct surface water runoff, however small volumes of water could potentially be carried into the tunnel on tyres and bodies of wet vehicles. These volumes will be picked up by the internal sealed tunnel drainage and pumped to the foul sewer. This volume for treatment is miniscule (fraction of a percent) in comparison to the overall sewage and combined storm volume treated at the Mutton Island Plant and discharged to the Galway Bay via the Mutton Island marine outfall and therefore will have no perceptible effect of treatment performance of the Mutton Island Treatment Plant and the Galway Bay receiving waters.

The Water Quality Impact Assessment is presented in **Table 13** below:

Table 13: Water Quality Impact Assessment

Network Drainage Ref. No.	Outfall Chainage	Dilution Characteristics	Receiving Water Details	Water Quality Impact
S1	0+000	Low summer dilution available	Sruthán na Libeirtí	Slight Permanent Local Slight downstream
S2	0+625	Low summer dilution available	Sruthán na Libeirtí	Slight Permanent Local Slight downstream
S3	0+900	Low summer dilution available	Sruthán na Libeirtí	Moderate Permanent Local Slight downstream
S4A	1+550	Very Low summer dilution available	Trusky Tributary	Moderate Permanent Local Slight downstream
S5A	2+750	Low summer dilution available	Trusky Tributary	Slight Permanent Local Slight downstream
S7A	3+950	Very Low summer dilution available	Bearna Tributary	Moderate Permanent Local Slight downstream
S7B	3+950	Moderate summer dilution available	Bearna Stream	Slight Permanent Local Slight downstream
S8	4+000	Low summer dilution available	Bearna Tributary	Slight Permanent Local Slight downstream
S9	4+150	Moderate summer dilution available	Bearna Stream	Slight Permanent Local Slight downstream
S10	4+850	Low summer dilution available	Bearna TributaryTonabrocky	Slight Permanent Local Slight downstream
S11	6+000	Very low summer low flow dilution available	Storm Sewer to Knocknacarra	Slight Permanent Local Slight downstream
S12	6+850	Low summer low flow dilution available	Knocknacarra Tributary	Moderate Permanent Local Slight downstream
S13	7+350	Very low summer low flow dilution available	Knocknacarra Tributary	Slight Permanent Local Slight downstream
S14A	8+300	Very low summer low flow dilution available	Minor River Corrib Stream	Moderate Permanent Local and imperceptible in downstream receiving Corrib waters
S14B	8+550	Very low summer low flow dilution	Minor River Corrib Stream	Slight Permanent Local and imperceptible in downstream receiving Corrib waters
S15	east of N59 link	Very Low summer dilution	Local drainage Ditch to River Corrib	Moderate Permanent Local and imperceptible in downstream receiving Corrib waters
S18A	9+250	Very High Summer low flow dilution	River Corrib	Slight Permanent Local

Network Drainage Ref. No.	Outfall Chainage	Dilution Characteristics	Receiving Water Details	Water Quality Impact
S18B	9+425	Very High Summer low flow dilution	River Corrib	Slight Permanent Local
S21A	12+250	Low Summer dilution Eventually drains to groundwater	Ballindooley Lough	Moderate Permanent Local

4.2.2.2 Transport Dispersion Modelling of River Corrib Outfalls

Two-dimensional transport and dispersion modelling of the outfall discharges in the River Corrib was carried out so as to assess the local impact effects of the plume near the inflow points and downstream, where full mixing with the receiving flow will not have fully occurred. Simulations were carried out modelling the two principal soluble heavy metal pollutants in the drainage effluent, namely copper and zinc and included the proposed first flush stormwater treatment in the wetland and attenuation ponds, which are designed to capture the first flush event of 15mm rainfall runoff and release slowly back to the River Corrib system so that a high percentage of the sediment is removed through settlement. Low flow conditions were modelled in the River Corrib with the river discharge rate set at the 95-percentile low flow of 14 cumec (note median river flow is 82 cumec) and the downstream water level upstream of the Salmon Weir barrage set at 5.7m OD (median 5.9mOD).The event mean runoff concentrations from the HAWRAT model was specified as the storm effluent concentration at the outfalls of 24 µg/l Cu and 67.53 µg/l Zn. The simulation was run for combined outfall discharges on the western side of the River Corrib (outfalls 14A, 14B, 15 and 18A, ref Figures 8.2.6**,** 8.2.7 and 8.2.12 of the NIS). An independent simulation for outfall S18B on the eastern bank of the River Corrib was also run and results combined with the western outfall simulations to predict the overall impact of the proposed road drainage discharge on the River Corrib. Note that the outfall from the proposed NUIG Pitches S44 was not assessed in this combination as this catchment is not a road, therefore routine road runoff water quality characteristics from traffic at this location isn’t applicable.

The drainage discharge plume in the River Corrib migrates with the flowing river downstream towards Galway City and therefore exposure duration is limited to hours as opposed to days. The maximum predicted concentrations throughout the model domain are presented below in **Figures 4** to **9** which show that the plume hugs the near bank side of the river for quite a distance downstream before fully mixing across the river channel. The simulations show that during the River Corrib low flow conditions the stormwater plume does not enter via the small channel east of Jordan’s Island and therefore has very limited effect on the Terryland Water Supply Intake. It is also noted that the plume does not travel up in the Coolagh Lakes system under these conditions. The large dispersion provided by the River Corrib result in rapid dilution and low trace level pollutant concentrations in the receiving water. The potential impact on water quality in Lough Corrib cSAC and Lough Corrib SPA arising from the plume are imperceptible.

Figure 4: Maximum Dissolved Copper Concentrations for First Flush Storm Water Event and 95% River Corrib Low Flow for Outfall 18B at Menlough

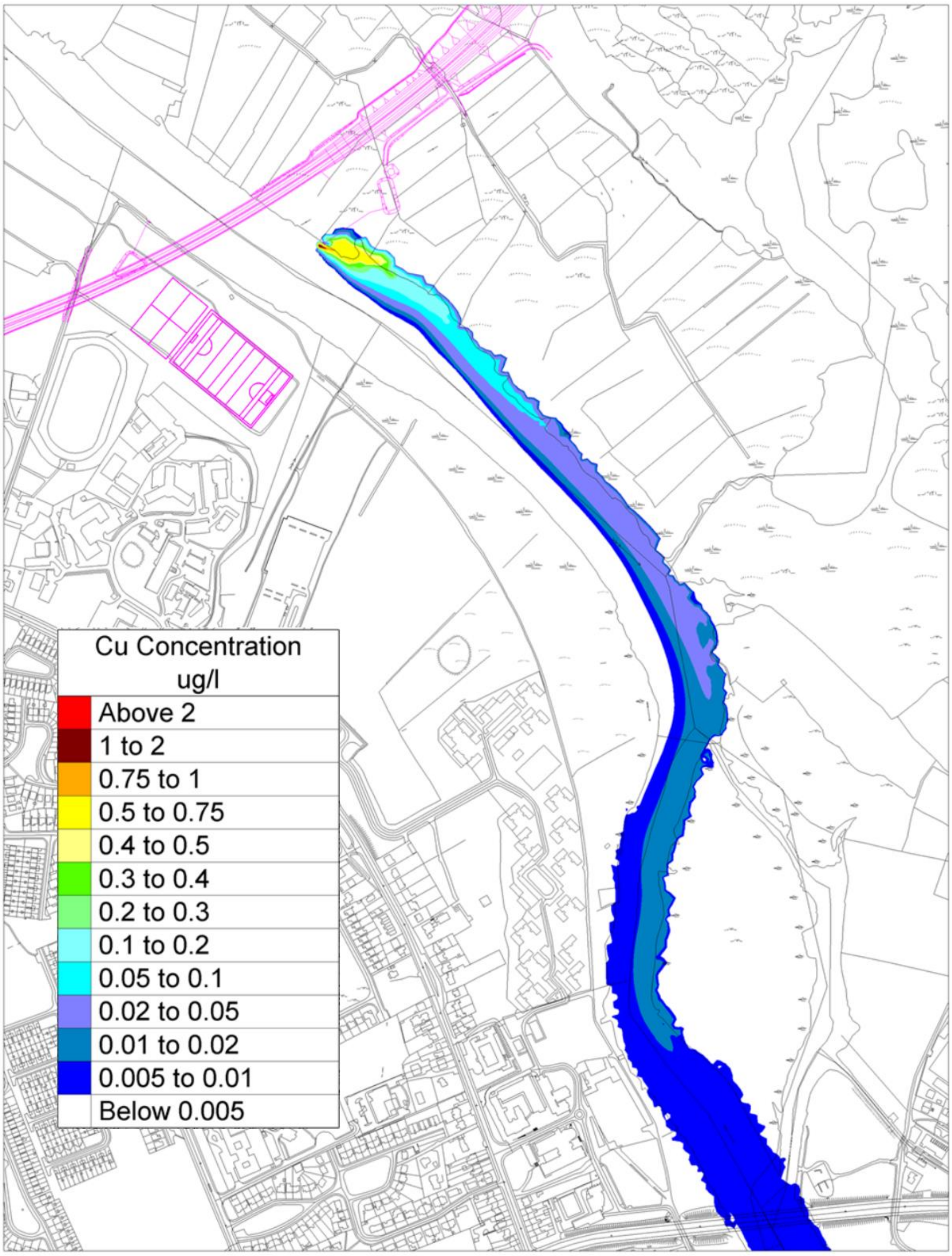


Figure 5: Maximum Dissolved Copper Concentrations for First Flush Storm Water Event and 95% River Corrib Low Flow for Dangan Outfalls (14A,14B 15 and 18A)

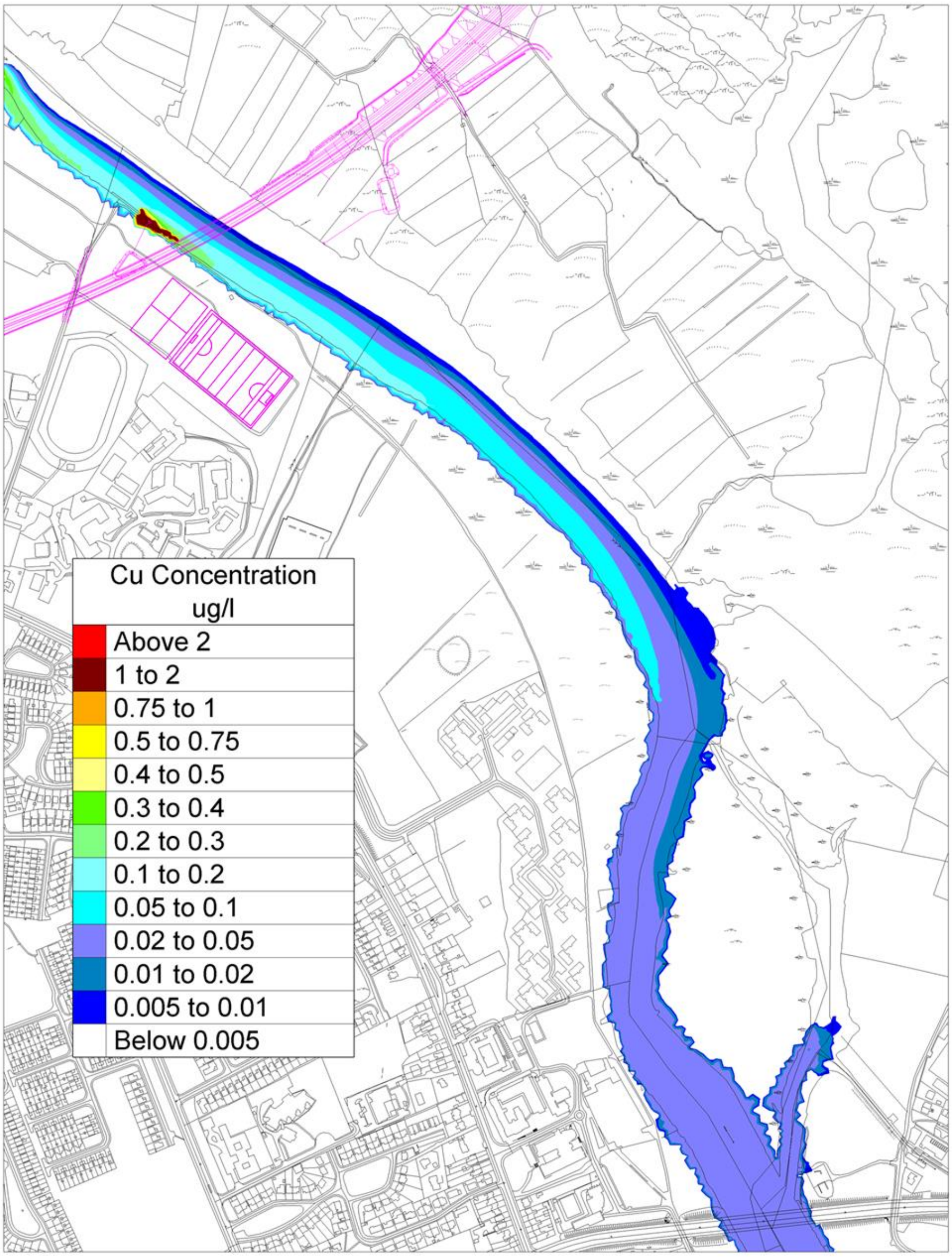


Figure 6: Maximum Dissolved Copper Concentrations for First Flush Storm Water Event and 95% River Corrib Low Flow for all combined Outfalls (14A, 14B, 15, 18A and 18B)

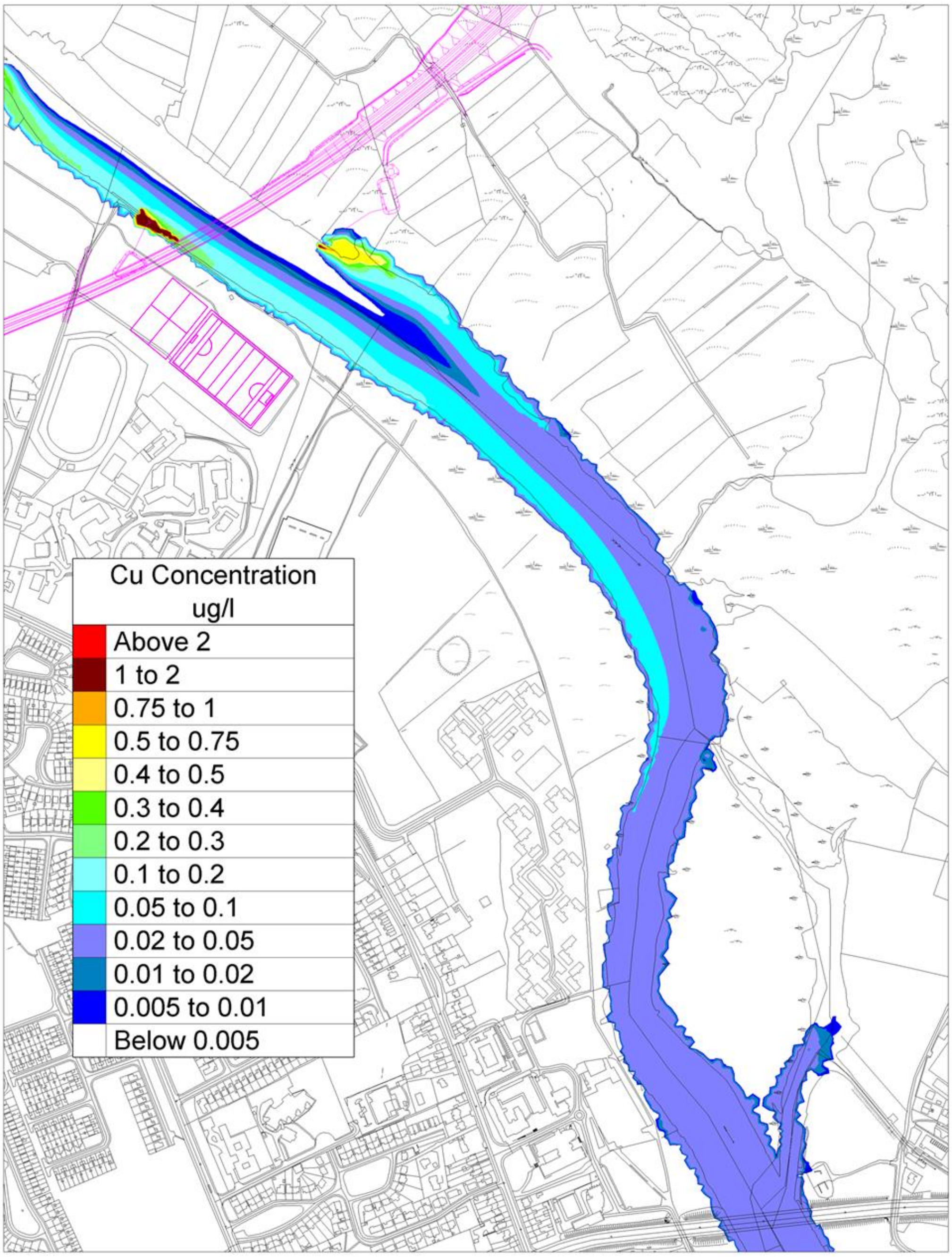


Figure 7: Maximum Dissolved Copper Concentrations for First Flush Rain Storm Event and median River Corrib Flow (82cumec) for all combined Outfalls (14A, 14B, 15, 18A and 18B)

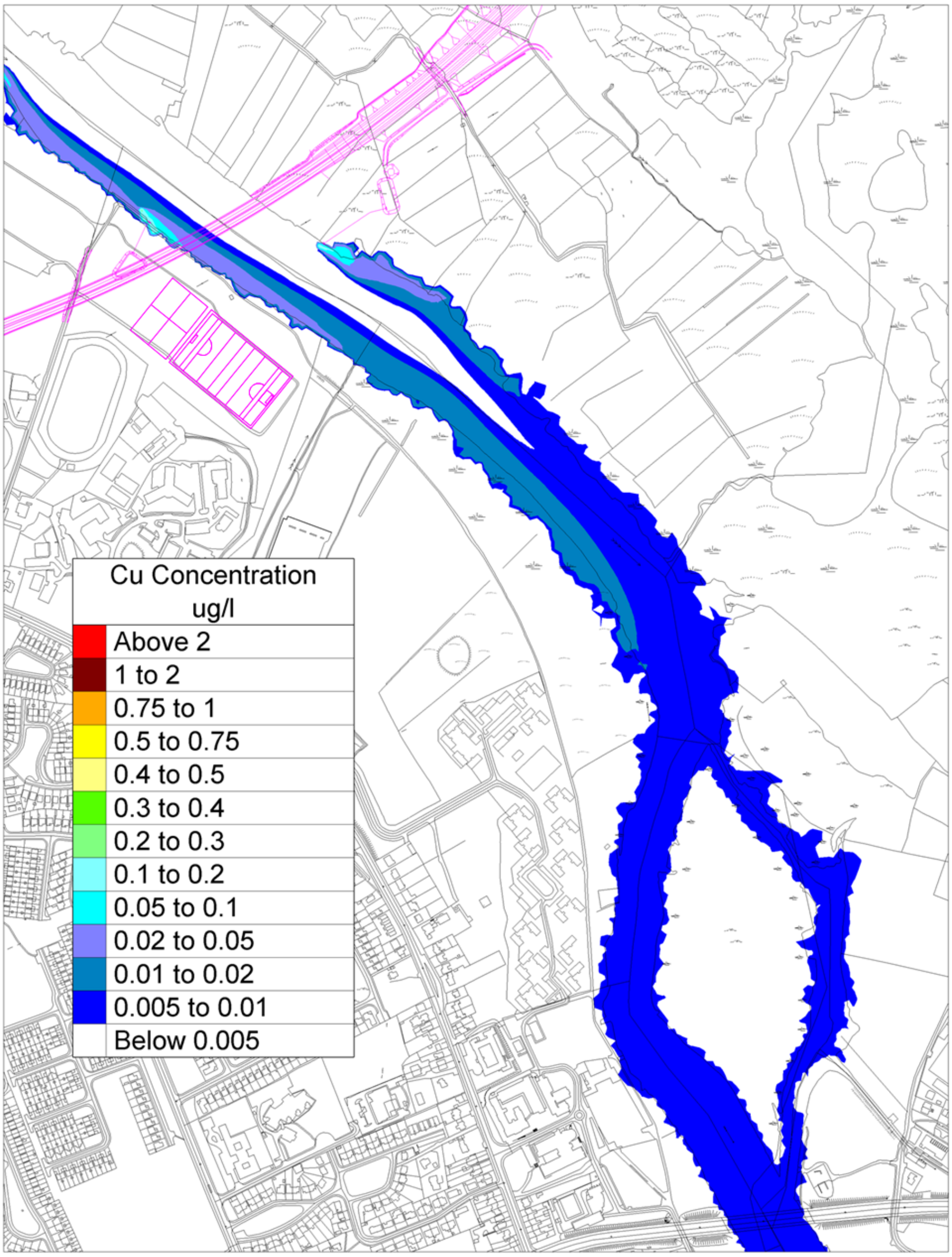


Figure 8: Maximum Dissolved Zinc Concentration for First Flush Rain Storm Event and 95% River Corrib Low Flow (14cumec) for all combined Outfalls (14A, 14B, 15, 18A and 18B)

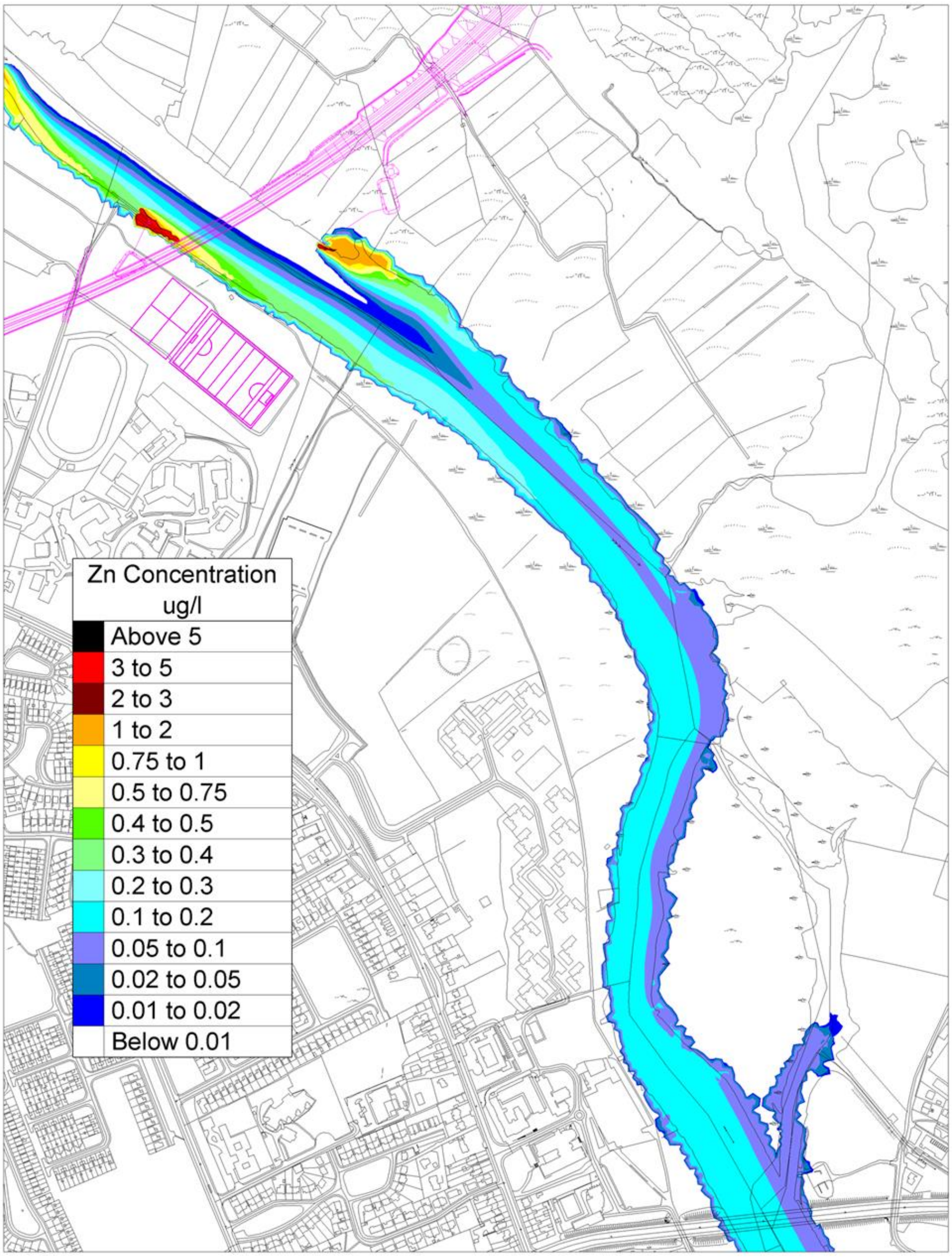
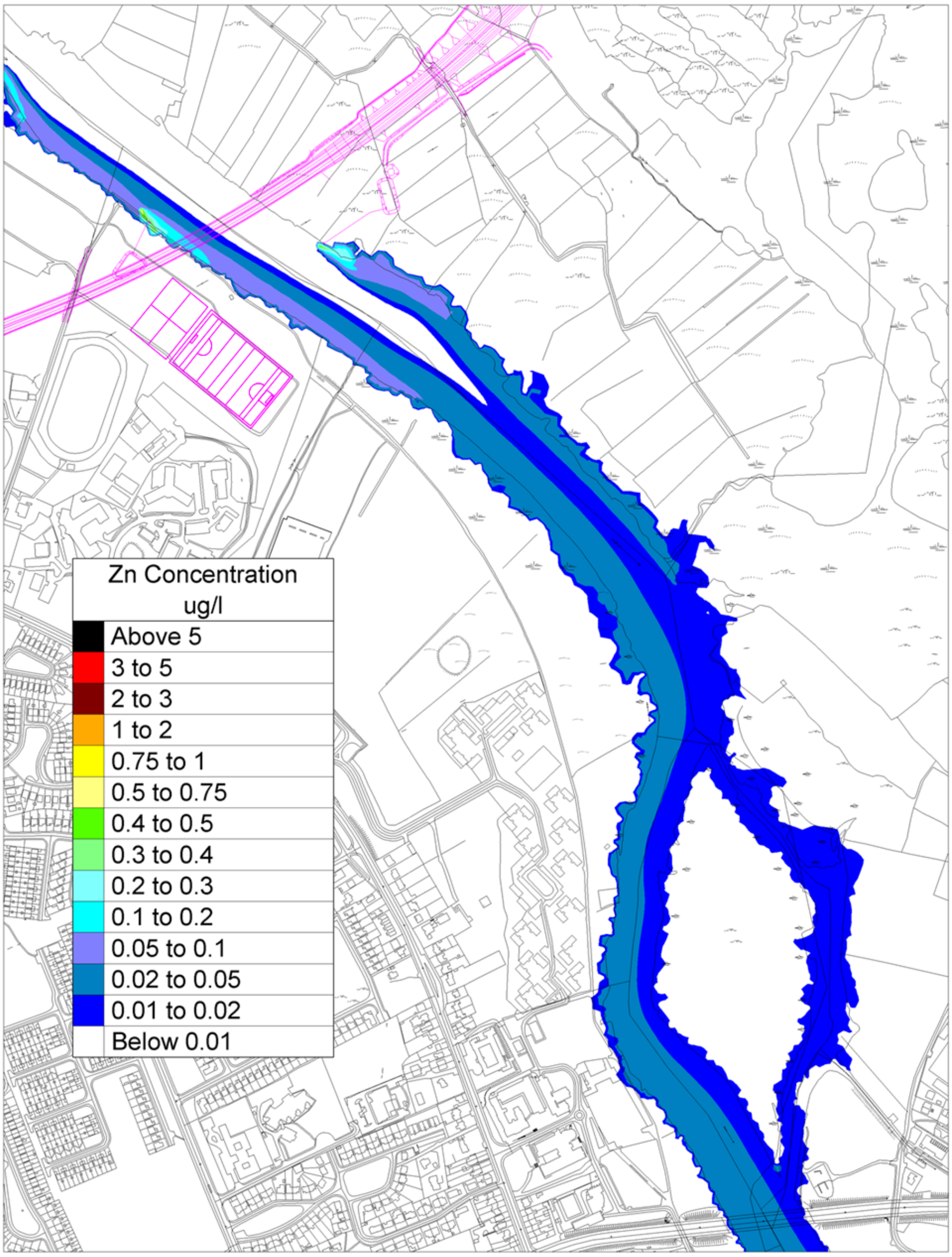


Figure 9: Maximum Dissolved Zinc Concentrations for First Flush Rain Storm Event and median River Corrib Flow (82cumec) for all combined Outfalls (14A, 14B, 15, 18A and 18B)



5 Potential Hydrological Impacts to the Lough Corrib cSAC and SPA

5.1 Introduction

The proposed road development will discharge either directly or indirectly to the Lough Corrib cSAC via a series of proposed road drainage outfalls. A total of 5 outfalls serving 2.625 km of mainline of the proposed road development and 0.625km of the N59 Link Road will discharge to surface waters of the River Corrib system. The conservation objective of the various qualifying interest of the Galway Lough Corrib cSAC and Lough Corrib SPA require that the natural hydrological regime is maintained in terms of the natural flow regime and water quality.

Four of these outfalls are located on the western side of the River Corrib with one being a direct discharge to the River Corrib (S18A) at (528400, 727742 (18A) ref Figures 8.2.6, 8.2.7 and 8.2.12 of the NIS) and the other three being stormwater outfalls to small tributary streams/drains. A second direct stormwater outfall is located on the eastern bank immediately downstream of the proposed bridge crossing at S18B. The road drainage area associated with these outfalls represents a total paved area of 7.112ha and a total drainage area (paved and grassed areas) of 12.42ha. A summary of the outfall details is provided in **Table 14**.

As discussed in **Section 4.2.2** of this report a cumulated HAWRAT water quality assessment of the proposed road development was undertaken. The event statistics for the grouped discharge (S14A, S14B, S18A and S18B) gave a mean event concentration for dissolved Copper and Zinc of < 0.00 (µg/l) and 0.01(µg/l) and 99-percentile event statistics of 0.03 (µg/l) and 0.08 µg/l) dissolved zinc which are considered to represent almost un-detectible, trace concentrations. This analysis was carried out using a 95-percentile low flow estimate for the River Corrib of 14cumec. A first flush runoff rate of 15mm rainfall over a 30minute period gives a potential runoff rate entering the River Corrib of 0.592cumec.

Table 14: Outfall Description

Drainage Reference (Refer to Figures 8.2.1 to 8.2.15)	Approx. length of paved road (m)	Drainage Catchment Area (m^2)	Area of Road Surface (m^2)	Proposed Outfall Easting (ITM)	Proposed Outfall Northing (ITM)
S14A	725	56600	21990	527703	727162
S14B	275	8490	6520	527758	727437
S15	625	18930	7270	527640	728261
S18A	725	17500	15800	528400	727742
S18B	900	22680	19540	528584	727751
S44	0	21162	0	528615	727418
Total	3,250	124,200	71,120		

For the purpose of water quality improvement the storm water drainage from the road pavement will be passed through a wetland prior to outfall. These wetlands are designed to provide primary settlement of sediments. All of these stormwater treatment systems are designed with silt traps and fitted with a petrol and oil interceptors and each pond is designed with a spillage containment volume of 25m^3 to facilitate isolation and containment of storm runoff waters in the event of a serious road spillage. This wetland system will remove the more settleable sediment material with treatment performance to achieve in excess of 60% removal of sediments and associated heavy metal pollutants from the storm water discharge.

5.2 Operational Impacts

5.2.1 Potential Impact of Road Drainage Runoff on River Corrib

A HAWRAT water quality toxicity analysis of the proposed road discharge to the River Corrib was carried out modelling the soluble heavy metal pollutants of copper and zinc. In this analysis the 95percentile low river flow was specified, an AADT Class of >10,000 and < 40,000 and the combined load of all five outfalls having a total road impervious area of 7.08ha and a permeable (Grassed) area of 5.43ha. The annual rainfall was taken as 1250mm, the base flow index as 0.5 the water hardness as medium (50 to 200 CaCO3 mg/l).

The impounded nature of the River Corrib flow gives rise to very low flow velocities particularly during summer low flow conditions (average river channel velocities < 0.05 m/s) and could potentially give rise to accumulation of sediment deposition in the vicinity of the outfalls at the River Corrib bank for outfalls 18A and 18B (ref Figure 8.7 of the NIS), which could potentially give rise to local impacts on sediment. Such accumulations are predicted not to be very extensive based on the deposition index and easily avoided through primary treatment of the storm water prior to outfalling, which is a proposed design measure with expected settlement removal performance in excess of 60% for suspended solids and particulate matter. This will prevent the potential for local accumulation of sediment at the outfall locations with finer sediment being capable of wider dispersal in the receiving waters and avoiding any local impact.

The analysis shows that the potential soluble toxicity levels of copper and zinc in the receiving waters are negligible in terms of the threshold levels for 24 hour and 6-hour exposure periods. The available dilution in the River Corrib at low flow conditions is still very large and therefore the combined discharge from the various outfalls to the reach is very well diluted and does not impact the water quality or quantity in the receiving waters.

Two-dimensional transport and dispersion modelling of the outfall discharges in the River Corrib was carried out to assess the local impact effects of the plume near the inflow points and downstream, where full mixing with the receiving flow will not have fully occurred. Simulations were carried out modelling the two principal soluble heavy metal pollutants in the drainage effluent, namely copper and zinc and included the proposed first flush stormwater treatment in the wetland and attenuation ponds, which are designed to capture the first flush event of 15mm rainfall runoff and release slowly back to the Corrib system so that a high percentage of the sediment is removed through settlement. The potential impact of de-icing agents such as sodium chloride on the receiving water quality of the River Corrib will not result in water quality impact as the dilution is large and particularly so during winter months, which is the high flow period with river flows generally above the median flow which dilutes and rapidly transports the salt load through the lower reaches of the River Corrib out to sea where they are imperceptible and have no effect.

These simulations predict very low far-field concentrations of heavy metal pollutants under the River Corrib 95-percentile low flows of less than 0.05µg/l dissolved copper and less than 0.1µg/l dissolved zinc in the river channel near Jordan's Island. More elevated concentrations are predicted close to the outfalls of S18A and S18B on both River Corrib banks with predicted concentrations with a maximum local concentration of 1.75µg/l dissolved copper and 4.92µg/l dissolved zinc. These locally elevated concentrations are well below any potential exposure threshold levels for heavy metals (refer to **Table 11** for threshold limits) and easily satisfy the surface water and Salmonid Waters Regulations. At mean river flow the concentration both locally at the outfall and fully mixed downstream are significantly lower at almost 6 times lower than the River Corrib low-flow scenario. The water quality impact of the proposed stormwater discharge on the River Corrib, given its high dilution and assimilative capacity, represents only a slight impact immediately local to the outfalls. The high water quality status of the River Corrib will not be affected by the proposed road development and its road drainage discharges.

5.2.2 Proposed River Corrib Bridge Crossing

The proposed road development crosses the River Corrib approximately 160m to the southeast of Menlo Castle on the eastern side and crosses through NUIG Sporting Campus at Dangan on the western side of the river. The proposed structure is a balanced cantilevered structure spanning over the river banks and provides a clear span between support piers of 153m. This clear span is sufficient to allow the support piers to be set back from the channel bank and thereby avoids encroachment of the River Corrib channel and its flood banks and allows for continuous access along the river bank edge on both banks. On the eastern bank the minimum setback distance from the pier face to channel edge is 5m and on the western bank the minimum setback is slightly more than 10m. Such setbacks amply meet IFI requirements for protection of water courses and bank side fishery access.

The bridge deck is to be a post-tensioned in-situ concrete deck which can be built using travelling formwork over river channel and the side spans and therefore constructional impact risks to the Lough Corrib cSAC are minimised as it avoids in-stream works, temporary or otherwise (ref Appendix D of the NIS).

A detailed hydraulic assessment of the River Corrib and the proposed bridge structure was carried out as part of the Section 50 approvals from OPW for the bridge. This assessment involved development of a detailed 2-dimensional hydraulic model of the River Corrib reach from Menlough to the Salmon Weirs Barrage and included the Jordan Island channel and the Coolagh Lakes to predict flood levels and allow testing of various bridge configurations as part of the preliminary design and optioneering studies for the bridge. A summary of the calculated design flood flows and computed flood levels are presented in **Table 15** below.

The modelling of return period flood flows with inclusion for statistical error provided flood levels at the proposed bridge site and these predicted flood levels clearly demonstrate that the proposed bridge structure will have an imperceptible impact on water levels and the flow regime either upstream or downstream nor is there any flood risk issues for the proposed road development with the proposed bridge deck and the storm drainage system sufficiently elevated above extreme flood levels.

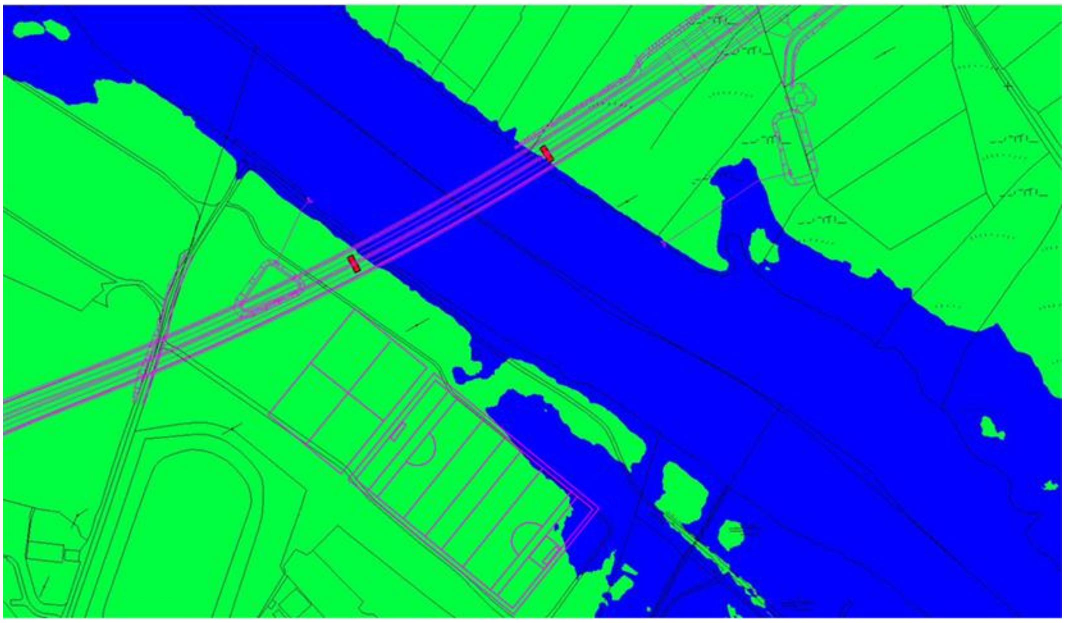
Table 15: Estimated Design Flood Flows and Flood levels at the Proposed River Corrib Bridge Crossing

Return Period **years**	**QT (1)** **Flood Flow** **Cumec**	**Computed** **Flood Level** **m OD**
2yr (Median)	275.3	6.26
10yr	389.3	6.72
100yr	519.5	7.20
1000yr	647.9	7.62
100yr+CC	623.4	7.54

(1) Note the above flow estimates in Table 13 include the standard statistical sampling error so as to reflect the upper 67-percentile confidence interval.

Hydraulic analysis shows no discernible impact on flood levels at the design flood event which is the 100year with inclusion of the current OPW recommended climate change allowance of 20%. The predicted flood level for this design flood condition (100year + CC) is 7.54m OD. At such a flood level both river bank piers will be located just outside of the flood Risk area. At the estimated 1000year flood level of 7.62m OD associated with a peak flood flow of 648 cumec the proposed bridge piers remain just outside the floodplain area in Flood Zone C, refer to **Figure 10** below and therefore no encroachment of the floodplain area will occur at the bridge crossing. The water quality/attenuation ponds are also shown to remain outside the flood risk zones and therefore will not affect the flow regime of the River Corrib.

Figure 10: 1000year flood inundation map of proposed bridge crossing with pier locations shown in red outside of the flood zone.



In order to avoid any potential scour risk associated with the construction of these bridge structures, abutments for bridges will be sufficiently set back from the channel bank edge with foundations located at depth. This will protect the river channel from changes in morphology whereby the channel over time would naturally migrate towards one of the abutments.

There is little potential for bank erosion at the proposed River Corrib crossing location as the river channel is straight, regular and cut into bedrock.

5.2.3 Redevelopment of Pitches at NUIG

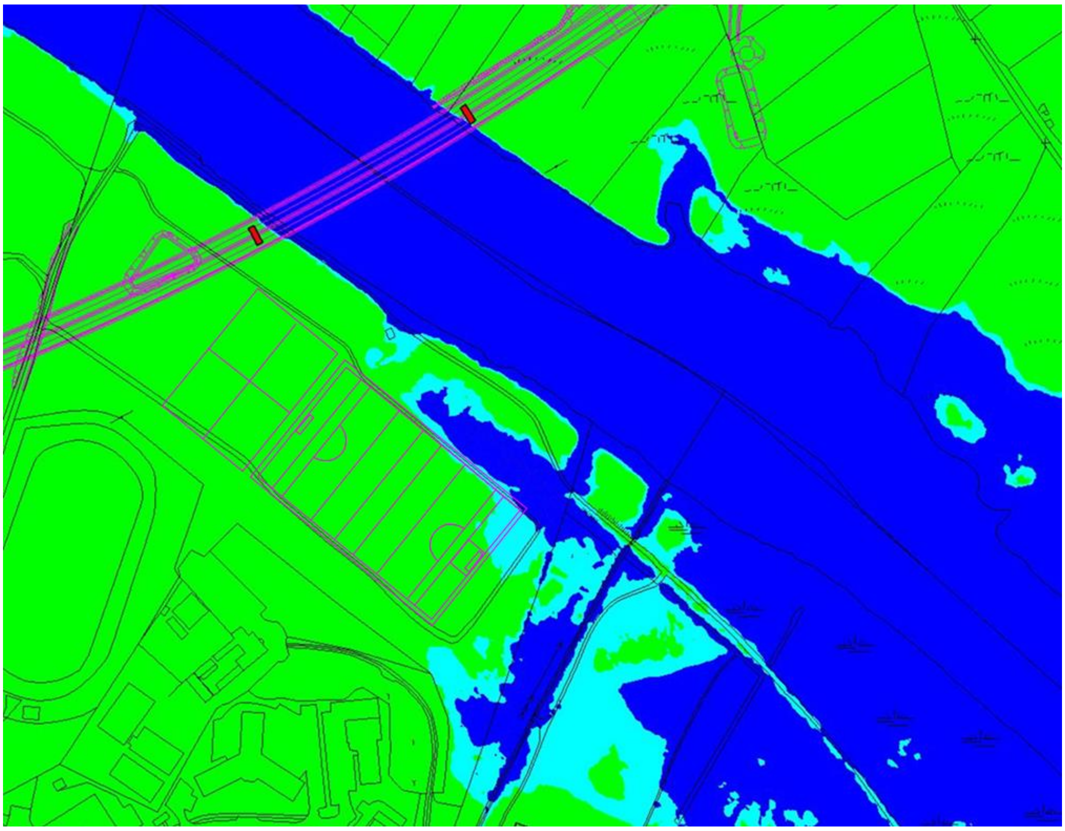
The proposed road development impacts the NUIG Sporting Campus at Dangan with direct impacts on one of the two existing GAA Pitches adjacent to the River Corrib and a Training Pitch to the north of the existing Sports Pavilion. The latter has received planning permission for conversion to an All-weather Sports Pitch (14104) which would be floodlit. To mitigate the impact of the proposed road development to these two pitches, it is proposed to construct an all-weather full size GAA Pitch and a Training Pitch at the location of the existing GAA Pitches adjacent to the River Corrib as shown on Figure 8.2.7.

An all-weather sports pitch utilises artificial surfacing which aims to replicate the appearance of natural grass and facilitates use in all-weather conditions. Its benefits include lesser maintenance on items such as irrigation and trimming.

Flood risk mapping of the River Corrib at Dangan presented in **Figure 11** shows the proposed reconfigured pitches to be generally in Flood Zone C (green shading) (i.e. low risk of flooding) at existing elevations above the predicted 1000year flood level of 7.62m OD Malin. The second, larger playing pitch is shown along its northeast side to be within the 100year (blue shading) Flood Zone A and 1000 year (cyan shading). The development of the pitches is likely to result in the raising of land so that the pitches are free from flooding and can drain effectively. The pitch drainage will be directed to a local existing drainage ditch to the southeast which has ample capacity to discharge the pitch drainage and the local drainage waters to the River Corrib. This drainage network S44 will have no impact on the flow regime or hydrochemistry of the receiving River Corrib waters.

The potential loss of floodplain storage is miniscule in comparison to the available flood storage in the River Corrib system and will not impact the flow regime in the river.

Figure 11: Flood Risk Mapping of proposed NUIG |Pitches at Dangan.



5.2.4 Coolagh Lakes

The proposed road development traverses the Coolagh Lakes catchment from Ch. 9+700 to Ch. 11+800. There are no proposed direct storm water discharges to the Coolagh Lakes with all road drainage discharges to groundwater via engineered infiltration basins. Outfall S18B (ref Figure 8.2.7 of the NIS) which discharges directly to River Corrib includes part of the Coolagh Lakes drainage area between Ch. 9700 to Ch. 10+145 representing a small loss of recharge area of 1.04ha from the Coolagh Lakes system. This represents a very minor loss of recharge water to the lower lake, of 0.44%, which will have no perceptible impact on the flow regime and hydrochemistry of this lake system. Drainage area S19 (ref Figure 8.2.7 of the NIS) from Ch. 10+145 to Ch. 11+169 drains an area of 4.624ha within the Coolagh Lakes catchment area. The S19 outfall is designed to discharge to groundwater via an engineered infiltration. This runoff water drains into the limestone bedrock aquifer and ultimately potentially recharges the Coolagh Lakes system. The proposed Lackagh Tunnel section (F19 Ch. 11+169 to Ch. 11+414 (ref Figure 8.2.8

of the NIS)) is to be sealed and located above groundwater table and consequently will not intercept recharge water for the Coolagh Lakes system. The final drainage area in the vicinity of the Lackagh Quarry S20 (servicing Ch. 11+414 to Ch. 12+017 (ref Figure 8.2.8 of the NIS)) is also designed to discharge to ground via engineered infiltration area and consequently will maintain groundwater recharge to the Coolagh Lakes system. The protection of the groundwater quality is dealt with in detail in the hydrogeology assessment, refer to Appendix A of the NIS, with the infiltration basin and wetlands systems at each of these outfalls designed to remove pollutants and protect the highly vulnerable, regionally important, groundwater aquifer from adverse impacts by the proposed routine road drainage runoff. These groundwater quality design measures through removal of pollutants via provision of a deep soil filter and generous infiltration areas at the relevant outfalls S19 and S20 will also prevent impact to the hydrochemistry of the Coolagh Lakes.

A section of proposed road development embankment encroaches a small section of the Coolagh Lakes/Corrib flood zone at Ch. 9+850 to Ch. 0 9+900. The area of encroachment at the 1000year flood level is 0.27ha and at the 100year it is 0.11ha. The proposed encroachment will not have any perceptible impact on flooding or on the hydrological flow regime or hydrochemistry of the lakes as a result of this very minor encroachment.

5.3 Construction Impacts

The proposed construction method for the River Corrib Bridge crossing, as outlined in Appendix D of the NIS, will avoid works within the river channel, temporary or otherwise except for the installation of drainage outfalls 18A and 18B. These outfalls are on the river bank edge and represent very limited disturbance with the construction works to be carried out from the banks and therefore water quality risks are significantly reduced. The main risk will be associated with the construction of the support piers for the bridge adjacent to the channel bank edge which are setback c. 10m on the western bank and 5m on the eastern bank. The River Corrib is sensitive as a salmonid river, major water supply source, European site designation and important amenity, both locally and downstream through the city and canals. Potential construction accidental spillages of hydrocarbons from plant and spillage of concrete and associated chemicals associated with constructing the riverside piers, bridge deck and storm outfalls represents a potential temporary impact to the waterbody and places risk to the water supply of Galway City, particularly activities on the eastern bank and therefore is categorised as a potential significant impact in the absence of mitigation.

Construction works for outfalls S14A, S14B and S15 located at Dangan/Bushypark on its western bank discharge to the River Corrib via drainage ditches over distances of c. 300 to 800m. These ditches provide an excellent wetland and settlement buffer to protect the River Corrib from construction runoff. Notwithstanding this buffer, the construction erosion and Sediment, Erosion and Pollution Control Plan, in the CEMP contained in Appendix C of the NIS will apply to these watercourses designed to minimise the direct construction runoff to watercourses and minimise disturbance of sediment from in-stream and river bank works.

Construction sediment releases from construction activities associated with the bridge crossing represents a potential temporary impact on the River Corrib water quality both locally and downstream. The potential sediment plume is predicted to hug the river bank edge for quite a distance downstream (approximately 1 to 2km) before fully mixing across the full channel width. There is generally good dilution in the River Corrib throughout the year to minimise the wider impact of sediment releases on fisheries, benthos and on the public water supply source. The low velocities associated with the River Corrib and particularly along its river edge provides the opportunity for released construction sediment to settle out rapidly along the bank edge, giving rise to the potential for locally smothering of the benthos.

Extensive earthworks will be associated with the development of the NUIG pitches at Dangan and given their close proximity to the River Corrib bank edge and to a local drain that discharges to the River Corrib a short distance downstream and the potential for partial flood inundation at the 100year flood a potential for construction runoff pollution of the River Corrib exists. Construction phase mitigation measures are required to protect the sensitive River Corrib waters.

There is a potential for construction impacts on the Coolagh Lakes and supporting habitat from construction site sediment runoff and construction spillages. The natural wetland habitat in the riparian zones of the lakes provides a good buffer between the construction and the permanent lakes. Notwithstanding this buffer zone, construction phase mitigation measures in the form of sediment and pollution control measures are required to protect this sensitive waterbody.

5.4 Mitigation Measures

Mitigation of potential construction impacts will be achieved through the stringent implementation of good construction practice procedures and environmental controls so as minimise the opportunity for contaminated releases of construction water to the River Corrib. Refer to the Construction Environmental Management Plan (CEMP) in Appendix C of the NIS for mitigation measures. As is normal practice the Construction Environmental Management Plan (CEMP) will be finalised by the Contractor in advance of the commencement of construction and the following will be implemented as part this plan:

- An Incident Response Plan detailing the procedures to be undertaken in the event of spillage of chemical, fuel or other hazardous wastes, logging of non-compliance incidents and any such risks that could lead to a pollution incident, including flood risks (Refer to Section 10 of the CEMP in Appendix C)
- A Sediment Erosion and Pollution Control Plan (Refer to Section 8 of the CEMP in Appendix C). This shall include water quality monitoring and method statements to ensure compliance with environmental quality standards specified in the relevant legislation (i.e. surface water regulations and Salmonid Regulations 1988)
- All necessary permits and licenses for instream construction works associated with the provision of culverts, bridges and outfalls. OPW Section 50 consent has been received for all culverts and bridges proposed in the EIA Report

Changes to these structures as part of the detailed design and construction stage will require new Section 50 consent to be obtained

- Inform and consult with OPW Western Arterial Drainage Section who have responsibility for the Corrib-Mask Arterial Drainage scheme and the ongoing control of river and lake levels at the Salmon Weir Barrage in Galway City
- Continue to Inform and consult with Inland Fisheries Ireland (IFI)
- Continue to Inform and consult with National Parks and Wildlife Service (NPWS)

Construction activities will be required to take cognisance of the following guidance documents for construction work on, over or near water:

- Guidelines on Protection of Fisheries During Construction Works in and Adjacent to Waters (Inland Fisheries Ireland, 2016)
- Shannon Regional Fisheries Board – Protection and Conservation of Fisheries Habitat with particular reference to Road Construction
- Requirements for the Protection of Fisheries Habitat during Construction and Development Works at River Sites (Eastern Regional Fisheries Board)
- Central Fisheries Board Channels and Challenges – The Enhancement of Salmonid Rivers
- CIRIA C793 The SUDS Manual
- CIRIA C624 Development and Flood Risk – guidance for the construction industry
- CIRIA C532 Control of Water Pollution from Construction Sites Guidance for Consultants and Contractors
- CIRIA C648 Control of Water Pollution from Linear Construction Projects, technical guidance
- CIRIA C649 Control of Water Pollution from Linear Construction Projects, site guide
- Guidelines for the Crossing of Watercourses during the Construction of National Road schemes (NRA, 2006)
- Road Drainage and the Water Environment DN-DNG-03065 (TII, June 2015)
- Vegetated Drainage Systems for Road Runoff DN-DNG-03063 (TII, June 2015)

Based on the above guidance documents concerning control of construction impacts on the water environment, the following outlines the principal mitigation measures that will be prescribed for the construction phase in order to protect all catchment, watercourse and ecologically protected areas from direct and indirect impacts:

- All constructional compound areas will be required to be located on dry land and set back from river and stream channels and out of floodplain areas. Floodplain areas include the Flood Risk Zones A and B (i.e. outside of the present day 100year and 1000year flood extents)

- The storage of oils, fuel, chemicals, hydraulic fluids, etc. will not occur within 100m of the River Corrib.
- Surface water flowing onto the construction area will be minimised through the provision of temporary berms, diversion channels and cut-off ditches, where appropriate
- 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 the diversion of runoff water off these stockpiles to the construction settlement ponds and avoiding stockpiling of material in vicinity of sensitive watercourses
- Where construction works are carried out adjacent to turloughs, fens, stream and river channels and lakes, protection of such waterbodies from silt load shall be carried out through use of reserved grassed buffer areas, timber fencing with silt fences or earthen berms. These measures will provide adequate treatment of constructional site runoff waters before reaching the watercourses
- Use of settlement ponds, silt traps and bunds and minimising construction activities 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 or sedi-mat
- All watercourses 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 site does not discharge directly to the watercourse. Compounds shall not be constructed on lands designated as Flood Zone A or B in accordance with the OPW's The Planning System and Flood Risk Management Guidelines (November 2009). Site compounds will not be permitted in a European Sites (i.e. Lough Corrib cSAC)
- 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 the TII document "Guidelines for the crossing of watercourses during the construction of National Road Schemes". All chemical and fuel filling locations will be contained within bunded areas and set back a minimum of 10m from watercourses
- Foul drainage from all site offices and construction facilities will be contained and disposed of in an appropriate manner to prevent pollution
- The construction discharge will be treated such that it will not reduce the environmental quality standard of the receiving watercourses
- Riparian vegetation along the identified sensitive watercourses will be fenced off to provide a buffer zone for its protection to a minimum distance of 5m except for proposed crossing points
- The use and management of concrete (which has a deleterious effect on water chemistry and aquatic habitats and species) in or close to watercourses will be carefully controlled to avoid spillage. Where on-site batching is proposed, this activity will be carried out well away from watercourses. Washout from such

mixing plants will be carried out only in a designated contained impermeable area

- All Material Deposition Areas must be adequately bunded and compartmentalised such that the rainwater outflow from these facilities is adequately controlled and treated prior to reaching the receiving surface watercourses. The sediment control requirements are set out in the in the Sediment, Erosion and Pollution Control Construction Management Plan section of the CEMP (refer to Appendix C).

Mitigation of potential construction impacts will be achieved through the stringent implementation of good construction practice procedures and environmental controls so as minimise the opportunity for contaminated releases of construction water to the River Corrib. Refer to the Construction Environmental Management Plan (CEMP) in Appendix C of the NIS for mitigation measures, relevant items of which are summarised below.

Potential construction impacts in the form of sediment impact and spillages to the Lough Corrib cSAC will be mitigated through the use of temporary and the permanent proposed sedimentation ponds and wetland systems with all construction site runoff being passed through such facilities prior to discharge. The provision of continuous double silt fences and temporary settlement ponds in proximity to the River Corrib and its various tributary drains including the Coolagh Lakes will mitigate the potential of construction site runoff pollution during the construction phase. No direct untreated point discharge of construction runoff to the River Corrib, its tributary drains or Coolagh Lakes will be permitted. Construction runoff post settlement treatment shall be discharged to an undisturbed vegetated buffer zone, as opposed to a direct discharge to a watercourse. Such construction discharge zones will be protected from the River Corrib by silt fencing. The regular monitoring of downstream receptor water quality for sediments and hydrocarbons and the inspection of the pollution control facilities will be carried out during construction works. Where a pollution incident is detected, construction works will be stopped until the source of the construction pollution has been identified and remedied. Details of the pollution control facilities and procedures are set out in the Sediment, Erosion and Pollution Control Construction Management Plan section of the CEMP (refer to Appendix C of the NIS). The pollution control and treatment facilities will be installed and the monitoring network including instrumentation and procedures established prior to construction activities taking place on the ground in the vicinity of watercourses and sensitive surface and groundwater receptors. The pollution control facilities will be monitored daily to ensure their continued integrity and desired function.

Construction site runoff discharging to the River Corrib and in particular the sediment concentrations will meet the surface water regulations and continuous monitoring of sediment concentrations in the receiving water during construction activities near the River Corrib will be carried out to ensure compliance and respond immediately to pollution events.

Given the proximity of the proposed road development to the Coolagh Lakes, construction impacts represent a potential source of impact on the water quality of the lake from uncontrolled construction site runoff and potential contamination of the groundwater from construction spillages. This potential impact will be mitigated through the implementation of the Sediment, Erosion and Pollution Management Plan which is part of the CEMP in Appendix C of the NIS.

5.5 Summary

A summary of the potential impacts on the Lough Corrib cSAC are provided in **Table 16** below. The proposed road development via its drainage outfalls will provide a potential pathway for road runoff pollutants to enter the Lough Corrib cSAC and Lough Corrib SPA during construction and operational phases. The potential impacts from the operational phase have been reduced in the design process to slight and imperceptible both in respect to flow regime changes and water quality impact. The potential for constructional phase impacts on water quality in the River Corrib has been reduced to slight and imperceptible through the implementation of a robust and site specific Sediment Erosion and Pollution Control Management Plan included in the CEMP in Appendix C of the NIS.

The impact of the proposed road development on the surface hydrology of the Coolagh Lakes system will be imperceptible. The proposed road development represents a potential pollution hazard and has a residual risk of pollution via contamination of the groundwater at its proposed infiltration basins. Proper management and regular inspection and maintenance of these drainage discharge facilities will significantly reduce the risk of pollution impact on the groundwater and the Coolagh Lakes system.

Table 16: Hydrological Impacts on Lough Corrib cSAC (00297)

Attribute	Impact Stage	Nature of Impact	Impact description	Mitigation
Lough Corrib cSAC (00297), and Lough Corrib SPA River Corrib	Construction	Spillages (hydrocarbons, cement etc.) into watercourses and onto wetlands.	A major bridge construction is proposed across the River Corrib and associated with the bridge deck and the bridge piers will be the pouring of concrete and the use of chemical and grouting agents in close proximity to an internationally important waterbody. Due to the major public water abstraction located only 1.7km downstream on the east bank makes it highly sensitive to construction pollution and potential accidental spillages.	A Sediment Erosion and Pollution Control Management Plan has been prepared for the construction phase to protect watercourses by preventing any construction site runoff directly entering watercourse being treated in sedimentation ponds prior to discharge to water courses. Other measures are also drawn up in this plan which include monitoring, reduction of site runoff through cut-off drains and the use of silt fencing near watercourses.
Lough Corrib cSAC (000297), Lough Corrib SPA (004042) River Corrib Coolagh Lakes	Construction	Silts and sediments arising from works adjacent to watercourses and construction site runoff	Within the River Corrib Catchment, the various streams/drains encountered provide a pathway for silts and sediment laden runoff water from the construction site to reach the Lough Corrib cSAC and cause local increase in suspended solids and turbidity. These activities adjacent to the River Corrib and its floodplain provide a significant source and pathway for sediment laden runoff to enter the River Corrib with little	A Sediment Erosion and Pollution Control Management Plan has been prepared for the construction phase to protect watercourses by preventing any construction site runoff directly entering watercourse being treated in sedimentation ponds prior to discharge to water courses. Other measures are also drawn up in this plan which include monitoring, reduction of site runoff through cut-off drains and the use of silt fencing near watercourses.

Attribute	Impact Stage	Nature of Impact	Impact description	Mitigation
			buffer time available for natural filtering and settlement. The River Corrib Bridge crossing of the Lough Corrib cSAC at Menlo/Dangan will not involve any in-stream works but bridge piers are to be located on either bank close to the river edge which can give rise to site runoff entering the river during works. Two bank side drainage outfalls are to be constructed which given their proximity the river flow make it difficult to prevent local disturbance of sediments. Good dilution in the River Corrib significantly lessens the potential impact on the receiving waters The proposed construction of the NUIG Pitches, as part of the accommodation works for the proposed road development, has the potential during construction to pollute, given their proximity to the River Corrib river bank and to a local drainage ditch located to the southeast that discharges directly into the River Corrib. A section of the proposed pitch is shown to be within the 1 in 100year flood zone and therefore there is a small risk of flood inundation during construction which could further	

Attribute	Impact Stage	Nature of Impact	Impact description	Mitigation
			exacerbate sediment runoff to the River Corrib There is potential for construction impact in the form sediment runoff and pollution associated with the road construction in the vicinity of the Coolagh/Corrib Floodplain at Ch. 9+850 to Ch. 9+900.	
Lough Corrib cSAC (000297), Lough Corrib SPA (004042) River Corrib Coolagh Lakes	Operational	Changes to Flow regime within the River Corrib	The proposed road development slightly encroaches the River Corrib floodplain near Menlo/Coolagh Lakes at Ch. 9+850 to Ch. 0 9+900. The area of encroachment at the 1000year flood level is 0.27ha and at the 100year it is 0.11ha. The proposed encroachment will not have any perceptible impact on flooding or on the hydrological flow regime. Potential encroachment of the 100year flood extents will also occur at Dangan associated with the redevelopment of the NUIG Pitches. The pitches will infill this floodplain area to achieve a free draining pitch These encroachments are very small and the potential flood storage loss from infilling will be miniscule in relation to the River Corrib flood area and flood volume and there	None

Attribute	Impact Stage	Nature of Impact	Impact description	Mitigation
			will be no perceptible impact on flooding or flow regime in the River Corrib, the Lough Corrib cSAC and Lough Corrib SPA. A number of road outfalls discharge directly and indirectly to the Lough Corrib cSAC (outfalls S14A, S14B, S15, S18A, S18B) and Lough Corrib SPA (outfall S15). These outfalls relative to the River Corrib drain a miniscule area and will have no perceptible effect on the flow rate or water depth of the River Corrib.	
Lough Corrib cSAC (000297), Lough Corrib SPA (004042) River Corrib Coolagh Lakes	Operational	Impact on Receiving Water Quality of Corrib from Road Drainage at proposed road drainage outfalls	Within the River Corrib Catchment, the various streams/drains encountered provide a permanent pathway for pollutants from the road drainage waters to enter the River Corrib. The potential impact by the road drainage outfalls on the Lough Corrib cSAC and SPA have been assessed as having a local minor to imperceptible impact and will not affect the “Good” water quality status of the River Corrib. The potential risk of impact to the River Corrib by serious accidental road spillage has been assessed as extremely low risk and is further reduced in the design process	None

Attribute	**Impact Stage**	**Nature of Impact**	**Impact description**	**Mitigation**
			through the provision of containment facilities in the form of petrol and oil interceptors and wetland areas upstream of the drainage outfalls	

6 Potential Impacts on Ballindooley Lough

6.1 Introduction

Ballindooley Lough is located within the Clare-Corrib Groundwater Body. The Lough has no surface stream inflows or outflows and is recharged by local overland flow and interflow from the surrounding hill slopes and by groundwater flow from the regionally important Corrib/Clare groundwater body, with groundwater flow from the west, east and north directions. Its groundwater outflow is via groundwater flow southwards in the direction of the Terryland River (based on groundwater table measurements). In summer periods the lake level is perched and outflow is via surface evaporation and some leakage to the groundwater whose level has fallen below the lake level. To ensure continued use of Ballindooley Lough by wintering bird species (some of which are listed as SCI of Inner Galway Bay SPA & Lough Corrib SPA) the natural hydrological regime of Ballindooley Lough is required to be maintained.

The proposed road development traverses to the south of Ballindooley Lough and a section of the road embankment slightly encroaches the 100year flood zone of the lough. The effect of this encroachment on the water balance and flow regime within the lough will be imperceptible given the very minor scale of encroachment and loss of flood storage (fraction of 1 percent).

6.2 Operational Impacts

The section of the mainline of the proposed road development from N84 Headford Road Junction to N17 Tuam Road Junction will be serviced by outfall S21B (Refer to Figure 8.2.9) which is designed to discharge to groundwater in the vicinity of Ballindooley Lough where the groundwater flow gradient is southwards away from the lough. As a consequence there will be no water quality or flow regime impacts on the lough from the mainline carriageway of proposed road development during the operational phase.

A single outfall S21A servicing the on-off slip roads and 250m of the existing N84 Headford Road at the N84 Headford Road Junction will discharge via a ditch to Ballindooley Lough. The total drainage area for this section is 3.31ha and the impervious road area is 1.36ha. This represents an average inflow rate of 0.3l/s and the annual average catchment drainage inflow is 20l/s from its 225ha catchment area presenting an average dilution of 67. Ballindooley Lough potentially represents a sink for sediment with the lake rising and falling with the groundwater table and in dry weather periods its water level remains perched above the receding groundwater table.

This proposed outfall is designed with pollution control measures that include a spillage containment volume, a petrol-oil interceptor, a wetland and an attenuation pond. These measures will reduce the potential sediment load on Ballindooley Lough by well over 60%. Circa 1.4km of the existing N84 Headford Road carriageway discharges untreated and uncontrolled into Ballindooley Lough via road side trenches and a storm pipe.

An assessment of the predicted loads and concentrations from road runoff from this outfall are presented in **Table 17** below. The annual mean concentrations of dissolved copper and zinc will rise by 0.399 and 1.417 µg/l respectively based on Event Mean concentrations and loads for significant road drainage pollutants in accordance with Table 3.1 of the TII publications DNS-03065. All other parameters considered below in **Table 17** represent minor increases and will not affect the water quality status of Ballindooley Lough.

Table 17: Predicted mean loads and concentrations of stormwater Pollutants to Ballindooley Lough from Outfall S21A

Main Road Drainage Pollutants	Road Runoff Load	Road Runoff Event Mean Concetration	Pollution Control Performance	Lake mean storm Inflow Concentration	Mean Lake Concentration increase
	kg/yr	µg/l	%reduction	µg/l	µg/l
Total Copper	863	91.2	60%	36.48	0.547
Dissolved CU	296	31.3	15%	26.605	0.399
Total Zinc	3336	352.6	60%	141.04	2.116
Dissolved ZN	1051	111.1	15%	94.435	1.417
Total Cadmium	5.96	0.63	60%	0.252	0.004
Total Fluoranthene	9.65	1.02	60%	0.408	0.006
Total Pyrene	9.74	1.03	60%	0.412	0.006
Total PAH	71.1	7.52	60%	3.008	0.045

Please note the predicted lake concentrations in **Table 15** above do not take reducing factors such as filtration and absorption and settlement within the lake, or of plant uptake and natural biodegradation

6.3 Construction Impacts

During construction there is a potential for uncontrolled site runoff to enter the lake with the potential for carrying construction related pollutants, principally increased sediment into the lake body.

Construction impacts, given the proximity of the proposed road development to the Ballindooley Lough, also represents a potential source of impact on the water quality of the Lough from uncontrolled construction site runoff.

6.4 Mitigation Measures

Mitigation of such potential construction impacts will be achieved through the stringent implementation of good construction practice procedures and environmental controls so as minimise the opportunity for contaminated releases of construction water to the River Corrib. Refer to the Construction Environmental Management Plan (CEMP) in Appendix C of the NIS for mitigation measures, relevant items of which are summarised below.

Potential construction impacts in the form of sediment impact and spillages to Ballindooley Lough will be mitigated through the use of temporary and the permanent proposed sedimentation ponds and wetland systems with all construction site runoff being passed through such facilities prior to discharge. The provision of continuous double silt fences and temporary settlement ponds in proximity to the lough and its various tributary drains will mitigate the potential of construction site runoff pollution during the construction phase. No direct untreated point discharge of construction runoff to Ballindooley Lough or its tributary drains will be permitted.

Construction runoff post settlement treatment shall be discharged to an undisturbed vegetated buffer zone, as opposed to a direct discharge to a watercourse. Such construction discharge zones will be protected from the lough by silt fencing. The regular monitoring of receptor water quality for sediments and hydrocarbons and the inspection of the pollution control facilities will be carried out during construction works. Where a pollution incident is detected, construction works will be stopped until the source of the construction pollution has been identified and remedied. Details of the pollution control facilities and procedures are set out in the Sediment, Erosion and Pollution Control Construction Management Plan section of the CEMP (refer to Appendix C of the NIS), relevant items of which are summarised below.

- The pollution control and treatment facilities will be installed and the monitoring network including instrumentation and procedures established prior to construction activities taking place on the ground in the vicinity of watercourses and sensitive surface and groundwater receptors. The pollution control facilities will be monitored daily to ensure their continued integrity and desired function.
- Construction site runoff discharging to Ballindooley Lough and in particular the sediment concentrations will meet the surface water regulations and that continuous monitoring of sediment concentrations in the receiving water during construction activities near the lough will be carried out to ensure compliance and respond immediately to pollution events.

6.5 Summary

The proposed road development and its drainage system both during construction and operation will have imperceptible residual hydrological impact on Ballindooley Lough. This is achieved through design of appropriate pollution control measures at its road drainage outfalls and the implementation at the construction phase of robust sediment, erosion and pollution control mitigation measures.

7 Potential Impacts to the Galway Bay Complex cSAC and Inner Galway Bay SPA

7.1 Introduction

The Galway Bay Complex cSAC and Inner Galway Bay SPA is a large coastal and transitional zone waterbody that represents the entire inner Galway Bay area and is located typically 1 to 2km down gradient of the proposed road development. The proposed road development from Ch. 2+850 to Ch. 17+460 is located within the freshwater catchment (groundwater and surface water) that discharges to the Galway Bay Complex cSAC and Inner Galway Bay SPA. The Galway Bay Complex cSAC and Inner Galway Bay SPA represents a waterbody having a volume at mean sea level of c. 1100 million m^3 and a water surface area of c. $140km^2$. The contributing freshwater catchment area from east of Blackhead near Ballyvaughan County Clare to Silverstrand to the east of Bearna Village County Galway is estimated at c.$4200km^2$. The Corrib catchment at Galway City is the most significant catchment at $3{,}136km^2$. The proposed surface drainage area of the proposed road development is 92ha (c. 1 km^2). This represents a very small fraction of the total catchment area of the River Corrib that discharges to the Galway Bay Complex cSAC and Inner Galway Bay SPA at approximately 0.03%.

7.2 Operational Impacts

For the entire length of the proposed road development potential pathways for pollutants to enter the Galway Bay Complex cSAC and Inner Galway Bay SPA exist via local surface streams and rivers discharging into Galway Bay and via the groundwater. These potential pathways exist for the current “Do-Nothing” scenario also. Such pathways apply both to the Construction Phase and the Operational Phase of the proposed road development.

The proposed road development is designed to TII standards and will provide a safer, less congested road that has significantly improved stormwater treatment over the existing road network. Consequently, it is concluded that the proposed road development is likely to have a slight beneficial impact on water quality in the downstream Galway Bay Complex cSAC and Inner Galway Bay SPA over the existing “Do-Nothing” scenario as all storm drainage runoff will be appropriately treated using sustainable drainage systems, petrol interceptors, wetland treatment systems and attenuation ponds and infiltration basins prior to discharge to receiving waters.

There is significant buffering between the proposed road development and the Galway Bay Complex cSAC and Inner Galway Bay SPA which minimises the potential impact of pollution runoff on these sites. The overall scale of the Galway Bay Complex cSAC and Inner Galway Bay SPA and the large flushing by tidal waters over spring and neap tides eliminates any potential impact that the proposed road development could have on the water quality of the Galway Bay Complex cSAC and Inner Galway Bay SPA. In the eastern section of the proposed road development drainage discharge is to groundwater, which is a karstified limestone conduit flow aquifer system and likely to have underground preferential flow pathways to the Galway Bay Complex cSAC. Refer to Appendix A (Hydrogeology) for further details. Similar to the freshwater system the tidal mixing available will ensure that pollutant impacts by the proposed road development during the construction and operation phases will be negligible and particularly so given the proposed storm water treatment for treatment of road runoff waters prior to discharge and the environmental pollution control measures for the construction phase. Refer to CEMP in Appendix C of the NIS for further details.

A road accident spillage risk assessment has been carried out for the proposed road development using the mid-range traffic growth figures and this shows an overall low risk of a significant spillage. This risk is further reduced through the provision of petrol interceptors and bunded spillage containment areas that can be closed off to contain the contamination.

As a consequence of the small scale of the proposed road development surface area relative to the overall freshwater catchment that discharges to the Galway Bay Complex cSAC and Inner Galway Bay SPA at Galway City, there will be no perceptible impact on the flow regime within this cSAC/SPA at either local or regional scale. The conservation objective of the various qualifying interest of the Galway Bay Complex cSAC and Inner Galway Bay SPA at Galway City require that the natural hydrological regime is maintained in terms of the natural tidal regime, salinities, sediment supply and water quality. The drainage design proposed minimises the potential for local change in runoff and recharge rates having 31 outfalls over the 17.5km mainline length and the provision of storm water treatment and attenuation upstream of these outfalls to throttle discharge rates to greenfield runoff rates, to remove particulate pollutants and provide petrol interceptors. Therefore the proposed road development will have no perceptible hydrological impact on Galway Bay Complex cSAC and Inner Galway Bay SPA

7.3 Construction Impacts

For the entire length of the proposed road development potential pathways for pollutants to enter the Galway Bay Complex cSAC and Inner Galway Bay SPA exist via local surface streams and rivers discharging into Galway Bay and via the groundwater. These potential pathways exist for the current “Do-Nothing” scenario also.

Through these pathways there is potential for silts and sediments arising from in stream works and works adjacent to watercourses and construction site runoff to reach the Galway Bay Complex cSAC and Inner Galway Bay SPA. Similarly, there is a risk of spillages during construction of contaminants such as hydrocarbons, cement etc. into watercourses and onto wetlands.

There is no direct encroachment of the Galway Bay Complex cSAC and Inner Galway Bay SPA by the proposed road development and therefore there is no potential for disturbance due to construction machinery or direct impacts to the flow regime by the proposed road development.

7.4 Mitigation Measures

Potential construction pollution impacts which have a pathway via the surface water courses, and existing storm and combined sewers have an opportunity to enter the Galway Bay Complex cSAC and Inner Galway Bay SPA. Mitigation of these impacts will be achieved through the stringent implementation of good construction practice procedures and environmental controls so as minimise the opportunity for contaminated releases of construction water to the River Corrib. Refer to the Construction Environmental Management Plan (CEMP) in Appendix C of the NIS relevant items of which are summarised below.

Potential construction impacts in the form of sediment impact and spillages to receiving watercourses and groundwater will be mitigated through the use of temporary and permanent sedimentation ponds and wetland systems with all construction site runoff being passed through such facilities prior to discharge. The provision of continuous double silt fences and temporary settlement ponds in proximity to watercourses will mitigate potential construction pollution risks. No direct untreated point discharge of construction runoff to watercourses will be permitted.

Construction runoff post settlement treatment shall be discharged to an undisturbed vegetated buffer zone, as opposed to a direct discharge to a watercourse. The regular monitoring of receptor water quality for sediments and hydrocarbons and the inspection of the pollution control facilities will be carried out during construction works. Where a pollution incident is detected, construction works will be stopped until the source of the construction pollution has been identified and remedied. Details of the pollution control facilities and procedures are set out in the Sediment, Erosion and Pollution Control Construction Management Plan section of the CEMP (refer to Appendix C of the NIS).

The pollution control and treatment facilities will be installed and the monitoring network including instrumentation and procedures established prior to construction activities taking place on the ground in the vicinity of watercourses and sensitive surface and groundwater receptors. The pollution control facilities will be monitored daily to ensure their continued integrity and desired function).

7.5 Summary

The proposed road drainage treatment, the good natural buffering from the receiving watercourses before reaching the Galway Bay Complex cSAC and Inner Galway Bay SPA and the natural high dilution within the coastal and transitional waters of these European sites ensures that the residual impact on flow and water quality within the Galway Bay Complex cSAC and Inner Galway Bay SPA both locally and regionally will be negligible.

Construction impacts arising from the proposed road development represent a relatively low risk to water quality within the Galway Bay Complex cSAC and Inner Galway Bay SPA due to the available buffering by the watercourses and by the high dilution within these European sites. To minimise further this risk of contamination to the Galway Bay Complex cSAC a detailed Sediment, Erosion and Pollution Control Management Plan and incident response plan, both of which are detailed in the CEMP (Appendix C of the NIS), for the construction phase has been developed for this project which provides for avoidance, reduction, mitigation and monitoring. Construction hydrological and water quality impacts on the Galway Bay Complex cSAC and Inner Galway Bay SPA will be avoided.

The proposed road development and its drainage system both during construction and operation will have imperceptible residual hydrological impact on Galway Bay Complex cSAC and Inner Galway Bay SPA. This is achieved through design of appropriate pollution control measures at its road drainage outfalls and the implementation at the construction phase of robust sediment, erosion and pollution control mitigation measures.

A summary of the potential impacts on the Galway Bay Complex cSAC and Inner Galway Bay SPA is provided in **Table 18** below.

Table 18: Hydrological Impacts on Galway Bay Complex cSAC and Inner Galway Bay SPA

Attribute	Phase	Source	Impact description	Mitigation
Galway Bay Complex cSAC (00268) Inner Galway Bay SPA (04031)	Construction	Silts and sediments arising from in stream works and works adjacent to watercourses and construction site runoff.	The various streams encountered all along the proposed road development provide a pathway for silts and sediments runoff from the construction site to reach the Galway Bay Complex cSAC and Inner Galway Bay SPA at Galway City which is typically located 1 to 2km downstream of the proposed road development and therefore at risk of indirect water quality impacts.	A Sediment Erosion and Pollution Control Management Plan has been prepared for the construction phase to protect watercourses by preventing any construction site runoff directly entering watercourse being treated in sedimentation ponds prior to discharge to water courses. Other measures are also drawn up in this plan which include monitoring, reduction of site runoff through cut-off drains and the use of silt fencing near watercourses.
	Construction	Spillages (hydrocarbons, cement etc.) into watercourses and onto wetlands.	Construction spillages similar to silts and sediments can reach the Galway Bay Complex cSAC and Inner Galway Bay SPA at Galway City via surface runoff and via groundwater.	A Construction Environmental Management Plan (CEMP), refer to Appendix C, for the construction phase has been developed to minimise the risk of serious spillages entering the groundwater and surface watercourses
	Construction	Disturbance due to construction machinery and carrying out of temporary works (cofferdams, culverts, channel diversions, sediment ponds, silt fences etc.).	There is no direct encroachment of the Galway Bay Complex cSAC and Inner Galway Bay SPA at Galway City by the proposed road development.	None
	Operational	Road drainage and outfalls impacting on the water quality Regime: - Routine road runoff discharges - Accidental fuel spills from road	There are no direct discharges from road drainage outfalls to the Galway Bay Complex cSAC and Inner Galway Bay SPA at Galway City but most the road outfalls discharge to watercourses and	None

Attribute	Phase	Source	Impact description	Mitigation
			groundwater aquifer that outfall to this cSAC/SPA and therefore provide a pathway for contaminants to reach the cSAC/SPA. The probability of accidental road accident spillages is shown to be very low and sufficient dilution available to minimise the impact of routine runoff on the Galway Bay Complex cSAC and Inner Galway Bay SPA at Galway City.	
	Operational	Changes to watercourse channel morphology because of culverting, diversions, channel regrading works and outfall discharges giving rise to short term erosion and deposition and morphological changes.	The proposed road development will not impact on morphological processes in the Galway Bay Complex cSAC and Inner Galway Bay SPA and particularly so as outfall discharges will be attenuated which will limit any local increase in flood runoff rates that could cause increased channel erosion. The sediment yields to the Galway Bay Complex cSAC and Inner Galway Bay SPA at Galway City will not be perceptibly changed given the proposed works involved and the scale of the overall contributing catchments to the Galway Bay Complex cSAC and Inner Galway Bay SPA at Galway City relative to the	None

Attribute	Phase	Source	Impact description	Mitigation
			footprint of the proposed road development.	

8 Conclusion

The proposed road development crosses the Lough Corrib cSAC and Lough Corrib SPA and is adjacent to the Galway Bay Complex cSAC and Inner Galway Bay SPA. The potential hydrological impacts of the proposed road development on these European sites has been assessed in respect to hydrology and the hydrological impacts on these sites.

In respect to the Galway Bay Complex cSAC and Inner Galway Bay SPA there is no direct encroachment within or adjacent to the cSAC and SPA boundaries and the potential impacts arise from indirect discharges to Galway Bay Complex cSAC and Inner Galway Bay SPA. Pathways via surface watercourses, groundwater flow and via existing urban foul and storm drainage systems exist for both the constructional runoff waters and operational road drainage waters to enter the Galway Bay Complex cSAC and Inner Galway Bay SPA .

The assessment concludes that both operationally and during construction there will be no changes to the flow regime discharging to the Galway Bay Complex cSAC and Inner Galway Bay SPA and therefore no changes to hydrological regime within these sites in terms of the flow rate, flow depth, velocity or to its physical characteristics of temperature and salinity is predicted.

The routine run-off from the road and first flush events could potentially have raised levels of heavy metals, hydrocarbons, suspended solids and salts which have a potential to impact the water quality at the local scale. The proposed road drainage design will include for spillage containment and storm water treatment facilities upstream of all proposed road drainage outfalls that discharge both to surface and groundwater systems. This water treatment will include treatment ponds and wetlands designed to capture the first flush rainfall event and will be fitted with a petrol and oil interceptor for hydrocarbon removal and a separate spillage containment volume.

The two proposed tunnel sections will have the road drainage water discharged to the public foul sewer where it will ultimately be treated at the Mutton Island Waste Water Treatment Plant before discharging to Galway Bay from Mutton Island. This volume for treatment is miniscule (fraction of a percent) in comparison to the overall sewage and combined storm volume treated at the Mutton Island Plant and discharged to the Galway Bay via the Mutton Island marine outfall and therefore will have no perceptible impact on the flow regime and water quality of the receiving Galway Bay Complex cSAC and Inner Galway Bay SPA.

The proposed road drainage treatment, the good natural buffering from the receiving watercourses before reaching the Galway Bay Complex cSAC and Inner Galway Bay SPA and the natural high dilution within the coastal and transitional waters of these European sites ensures that the residual impact on flow and water quality within the Galway Bay Complex cSAC and Inner Galway Bay SPA both locally and regionally will be negligible.

Construction impacts arising from the proposed road development represent a relatively low risk to water quality within the Galway Bay Complex cSAC and Inner Galway Bay SPA due to the available buffering by the watercourses and by the high dilution within these European sites. To minimise further this risk of contamination to the Galway Bay Complex cSAC a detailed Sediment, Erosion and Pollution Control Management Plan for the construction phase has been developed for this project which provides for avoidance, reduction, mitigation and monitoring. Construction hydrological and water quality impacts on the Galway Bay Complex cSAC and Inner Galway Bay SPA will be avoided.

The proposed road development will discharge directly and indirectly to the Lough Corrib cSAC via a series of proposed road drainage outfalls. Run-off waters from four such outfalls will enter the River Corrib on its western bank at Dangan and a fifth outfall will discharge to its eastern bank south of Menlo Castle. Two further outfalls to the east of Menlo Castle will discharge to groundwater and are within the catchment of Coolagh Lakes which are also part of the Lough Corrib cSAC. All road drainage outfall discharges will undergo first flush water quality treatment in a wetland and pond system and will be fitted with an oil and petrol interceptor to capture hydrocarbons. Assessment of the potential impact both at individual outfalls and the cumulative load from the five surface outfalls on the water quality of the River Corrib was assessed using two-dimensional hydrodynamic and transport dispersion modelling and using the TII HAWRAT package. The findings from this assessment clearly show that the proposed routine discharge and first flush events will be sufficiently diluted by the River Corrib flow, even during low flow conditions, as not to have any perceptible impact on the water quality status of the Lough Corrib cSAC either upstream, locally or downstream. The assessment shows that water quality treatment of the first flush event through detention and wetland filtering is an important pollution control measure to reduce any potential localised impacts near the outfall point such that predicted heavy metal and suspended sediment concentrations do not exceed environmental threshold levels and easily satisfy the surface water regulations. The residual impact of the road drainage discharge on water quality in the River Corrib is assessed as imperceptible.

The proposed road development traverses close to the Coolagh Lakes located just to the north of its winter flood extent area. There is no direct discharge of road drainage runoff proposed to the Coolagh Lakes with the proposed road drainage discharge at two outfalls directed to groundwater via a two large engineered infiltration basins within the Coolagh Lake Catchment area. These engineered infiltration fields are designed to protect groundwater quality through soil filtering in a 2m minimum deep infiltration zone of suitably permeable soil filter class. It is expected that this treated road drainage water may eventually contribute as groundwater baseflow to the Coolagh Lakes or the River Corrib further downstream. The design of the infiltration basins, coupled with the inclusion of a hydrocarbon interceptor and containment area, will provide an appropriate level of protection to prevent contamination of groundwater from the infiltration basins. Refer to the Appendix A (Hydrogeology) of the NIS for further details.

The proposed road traverses close to Ballindooley Lough with a potential slight encroachment of its extreme 100year flood zone by the road embankment. This will have no measurable impact of the flow and flooding regime within the lake.

A single outfall S21A servicing the on-off slip roads and 250m of the existing N84 Headford Road at the N84 Headford Road Junction will discharge via a ditch to the Ballindooley Lough system. This proposed outfall is designed with pollution control measures that include a spillage containment volume, a petrol-oil interceptor, a wetland and an attenuation pond. These measures will reduce the potential sediment loading on Ballindooley Lough by well over 60%. The existing N84 Headford Road carriageway for c. 1.4km currently discharges untreated and uncontrolled into Ballindooley Lough via road side trenches and a storm pipe. An assessment of the impact of the proposed road storm discharge on water quality in Ballindooley Lough shows very minor increases in pollutant concentrations within the lough and such increases will not affect the water quality status of the lough.

The construction phase of the proposed road development in the absence of construction pollution control measures has the potential to impact water quality within the lough from uncontrolled site runoff. This will be mitigated by ensuring no direct uncontrolled site runoff to the lough is permitted with all site runoff collected and suitably treated in sedimentation ponds prior to discharge.

Flow regime change in the River Corrib either from the proposed bridge crossing or from the proposed outfalls will not occur with the outfall discharge rates being minor in respect to the River Corrib flows and the proposed bridge structure avoiding, through its very large 153m bridge span, the effective conveying floodplain of the River Corrib with no in-stream piers proposed.

Construction impacts in the form of sediment releases and spillages on the Lough Corrib cSAC that includes its tributaries, the River Corrib and the Coolagh Lakes represents a potential temporary impact to water quality of these surface waters. Given their protection status construction mitigation is proposed in the form of implementing, robust and targeted pollution control measures.

A Construction Erosion Management Plan, refer to Appendix C, has been prepared to mitigate all potential construction impacts on the water quality of the Lough Corrib cSAC including the River Corrib and the Coolagh Lakes. Within the CEMP various avoidance, reduction, mitigation and monitoring measures are presented. The measures are specifically designed to prevent any untreated construction runoff water entering directly the River Corrib or the Coolagh Lakes systems. Construction site run-off water discharging to the River Corrib will be treated using construction settlement ponds, silt fencing and vegetated buffer areas prior to entering the River Corrib or its tributaries and the construction discharges will satisfy the surface water regulations.

The residual impact of the proposed road development during the construction phase on the Lough Corrib cSAC under the proposed mitigation will be imperceptible.

9 References

CIRIA. (1993) *"Design of Flood Storage Reservoirs"* Report No B14.

CIRIA. (1994) *"Control of Pollution from Highway Discharges"* Report No C142.

CIRIA. (2001) *"Sustainable Urban Development Systems"* – best Practice Manual for England, Scotland, Wales and Northern Ireland – C523.

CIRIA. (2006) *"Control of Water Pollution from Linear Construction projects"* C648.

DoEHLG. (Nov 2009) *Flood Risk Management and the Planning System Guidance document*.

Inland Fisheries Ireland. (IFI) (2016) *Fishery Construction Project Guidelines*.

NRA. (2008) *Guidelines on Procedures for the Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes*.

NRA. (2004) *Environmental Impact Assessment of National Roads Schemes – A Practical Guide*, November 2004.

NRA (2005) *"Guidelines for the Crossing of Watercourses during Construction of National Road Schemes"*.

OPW. (2015) Western CFRAM Unit of Management 30 – Corrib – *Hydrology Report*, March 2015.

OPW. (2015) Western CFRAM Unit of Management 30 – Corrib – *Hydraulics Report*, March 2015.

OPW. (2014) *FSU web portal Flood Flow and rainfall estimation site.*

SEPA. (1996) *"Guidelines for Water Pollution Prevention from Civil Engineering Contracts"* Scottish Environmental Protection Agency.

TII Publications. (2015) *"Vegetated Drainage Systems for Road Runoff (including Amendment No. 1 dated June 2015)*, DN-DNG-03063.

TII Publications. (2015) *Road Drainage and the Water Environment (including Amendment No.1 dated June 2015)*, DN-DNG-03065.