Chapter 6 - Hydrology and Drainage

- Appendix 6.1 – Hydrology and Drainage
- 32103901/EAR/Figure 6.1- Surface Water Features and Mitigation
6 Hydrology and Drainage

6.1 Introduction

This chapter considers and assesses the impact of the proposed development on the surface water environment, which includes water quality and drainage.

The surface water environment is intrinsically linked to ecological and groundwater receptors which are assessed in Chapter 5 Ecology and Chapter 7: Soils, Geology and Hydrogeology, respectively. The Surface Water, Groundwater and Ecology specialists worked closely together throughout the assessment process to assess interactions between these topics and cross-referencing is provided within this section where relevant.

6.2 Methodology

6.2.1 Legislative Background

The 2000/60/EC Water Framework Directive (WFD) came into force on the 22 December 2000 and was transposed into Irish legislation through Statutory Instrument (S.I.) 722 of 2003, European Communities (Water Policy) Regulations 2003. The Directive requires that member states must implement the necessary measures to prevent deterioration of the status of all bodies of inland water.

To help fulfil the aims of the WFD, River Basin Management Plans (RBMPs) have been published for all River Basin Districts in Ireland, and these outline how the water environment will be managed and improved to meet the objectives of the WFD; i.e. all water bodies to achieve or maintain an overall status of ‘good’ by 2015 or over agreed timescales, up to 2027.

In addition, the Integrated Pollution Prevention and Control (IPPC) Directive (96/61/EC) was adopted into Irish law and was enacted as Protection of the Environment (PoE) Act 2003. The PoE Act came into effect as of 12 July 2004 and included a requirement that best available techniques must be utilised to prevent or reduce pollution and to reduce accidental spillages (Bruen et al., 2006).

6.2.2 Existing Environment (Desk Study)

The study area for this assessment includes an area 250m either side of the centreline of the proposed development (refer to 32103901/EAR/Figure 6.1).

A desk study was carried out to collate baseline information. The following principal sources were consulted:

- Environmental Protection Agency (EPA) website;
- National Flood Hazard Mapping website;
- Natural Environment Research Council (1975). Flood Studies Report (Volumes 1-5); and

A review of the information held by the EPA was carried out to inform the baseline condition of water bodies, following a risk-based classification system in line with the 2000/60/EC WFD. This assessment is based on the WFD ecological classification system, which includes five quality classes/status (‘high’, ‘good’, ‘moderate’, ‘poor’ and ‘bad’).

The National Flood Hazard Mapping website was utilised to assess the frequency and extent of reported flooding events in the vicinity of the proposed development.

The ‘Design and Analysis of Urban Storm Drainage: the Wallingford Procedure: Volume 4: the Modified Rational Method, (1981)’ was used to calculate the estimated peak runoff from the existing and proposed road footprints. In addition, the IH124 method was used to calculate the overland runoff within the greater catchment area in each scenario (i.e. the Un-named turlough catchment area excluding the road footprints). These were then combined for both scenarios to provide the overall peak runoff flows for a range of % Annual Exceedance Probabilities (AEPs) (or 1 in X return period flood events).

In addition, consultation was undertaken with Inland Fisheries Ireland (IFI) and the Development Application Unit of the Department of Arts, Heritage and the Gaeltacht. Information obtained from this consultation, such as measures to protect the water environment, has been included within this section, where relevant.

**6.2.3 Assessment Methodology**

The assessment has been carried out in accordance with the National Roads Authority (NRA) Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes (2008) and the Design Manual for Roads and Bridges (DMRB) HD 45/09 (Highways Agency et al., 2009). Any assumptions and deviations from these standards within this assessment are provided in Section 6.7.

The sensitivity/importance of an attribute of a surface water feature was categorised on a scale of ‘Extremely High’ to ‘Low’, in accordance with the criteria provided in Table 6.1. The magnitude of impact is influenced by the timing, scale, size and duration of change to the baseline conditions, and can be either adverse or beneficial, as defined in Table 6.2. The significance of impact was determined as a function of the sensitivity of the feature and the magnitude of the impact, as outlined in Table 6.3. The criteria provided in Tables 6.1 to 6.3 were defined using the NRA (2008) and DMRB (Highways Agency et al., 2009) guidelines.

The magnitude and significance of the potential impacts are based on consideration of the proposed works, during both construction and long term operation of the proposed development. Impacts can be direct, indirect, secondary or cumulative, and can be permanent or temporary.
### Importance

<table>
<thead>
<tr>
<th>Importance</th>
<th>Criteria</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extremely High</td>
<td>Attribute has a high quality or value on an international scale</td>
<td>River, wetland or surface water body ecosystem protected by EU legislation e.g. 'European sites' designated under the Habitats Regulations or 'Salmonid waters' designated pursuant to the European Communities (Quality of Salmonid Waters) Regulations, 1988.</td>
</tr>
<tr>
<td>Very High</td>
<td>Attribute has a high quality or value on a regional or national scale</td>
<td>River, wetland or surface water body ecosystem protected by national legislation – NHA status Regionally important potable water source supplying &gt;2500 homes Quality Class A (Biotic Index Q5, Q4-5, Q4) Flood plain protecting more than 50 residential or commercial properties from flooding Nationally important amenity site for wide range of leisure activities</td>
</tr>
<tr>
<td>High</td>
<td>Attribute has a high quality or value on a local scale</td>
<td>Salmon fishery Locally important potable water source supplying &gt;1000 homes Quality Class B (Biotic Index Q3-4) Flood plain protecting between 5 and 50 residential or commercial properties from flooding Locally important amenity site for wide range of leisure activities</td>
</tr>
<tr>
<td>Medium</td>
<td>Attribute has a medium quality or value on a local scale</td>
<td>Coarse fishery Local potable water source supplying &gt;50 homes Quality Class C (Biotic Index Q3, Q2-3) Flood plain protecting between 1 and 5 residential or commercial properties from flooding</td>
</tr>
<tr>
<td>Low</td>
<td>Attribute has a low quality or value on a local scale. An impact capable of measurement but without noticeable consequences</td>
<td>Locally important amenity site for small range of leisure activities Local potable water source supplying &lt;50 homes Quality Class D (Biotic Index Q2, Q1-2, Q1) Flood plain protecting 1 residential or commercial property from flooding Amenity site used by small numbers of local people</td>
</tr>
</tbody>
</table>

### Table 6.1: Importance of Attributes of a Surface Water Feature (Source: NRA, 2008)

<table>
<thead>
<tr>
<th>Magnitude of Impact</th>
<th>Criteria</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large Adverse</td>
<td>Results in loss of attribute and/or quality and integrity of attribute</td>
<td>Increase in predicted peak flood level &gt;100mm Extensive loss of fishery Calculated risk of serious pollution incident &gt;2% annually Extensive reduction in amenity value</td>
</tr>
<tr>
<td>Moderate Adverse</td>
<td>Results in impact on integrity of attribute or loss of part of attribute</td>
<td>Increase in predicted peak flood level &gt;50mm Partial loss of fishery Calculated risk of serious pollution incident &gt;1% annually Partial reduction in amenity value</td>
</tr>
<tr>
<td>Small Adverse</td>
<td>Results in minor impact on integrity of attribute or loss of small part of attribute</td>
<td>Increase in predicted peak flood level &gt;10mm Minor loss of fishery Calculated risk of serious pollution incident &gt;0.5% annually Slight reduction in amenity value</td>
</tr>
<tr>
<td>Negligible</td>
<td>Results in an impact on attribute but of insufficient magnitude to affect either use or integrity</td>
<td>Negligible change in predicted peak flood level Calculated risk of serious pollution incident &lt;0.5% annually Slight reduction in amenity value</td>
</tr>
<tr>
<td>Minor Beneficial</td>
<td>Results in minor improvement of attribute quality</td>
<td>Reduction in predicted peak flood level &gt;10mm Calculated reduction in pollution risk of 50% or more where existing risk is &lt;1% annually</td>
</tr>
<tr>
<td>Moderate Beneficial</td>
<td>Results in moderate improvement of attribute quality</td>
<td>Reduction in predicted peak flood level &gt;50mm Calculated reduction in pollution risk of 50% or more where existing risk is &gt;1% annually</td>
</tr>
<tr>
<td>Major Beneficial</td>
<td>Results in major improvement of attribute quality</td>
<td>Reduction in predicted peak flood level &gt;100mm</td>
</tr>
</tbody>
</table>

### Table 6.2: Magnitude of Impact (Source: NRA, 2008; Highways Agency et al., 2009)
### 6.2.4 Water Quality Routine Runoff Assessment

The potential short term ecological impacts of routine runoff on a surface waters quality during the long term operational phase of a road scheme can be assessed using the methods set out in the DMRB HD 45/09, Methods A and B (Highways Agency et al., 2009). This assessment can be used to determine whether mitigation is required to protect the water quality and ecological status of water bodies receiving road drainage. A routine runoff assessment (DRMB HD 45/09, Methods A and B) was considered not applicable to the proposed development (further discussed in Section 6.4 below).

### 6.2.5 Water Quality Spillage Risk Assessment

This assessment included a calculation of the risk of an accidental spillage (resulting in a serious pollution incident) occurring during the long term operational phase of the proposed development. This was based on the method prescribed in the DMRB HD 45/09 (Highways Agency et al., 2009) guidance (Method D). The spillage risk assessment is most applicable to roads with a direct drainage outfall to a watercourse, however has it been included in this assessment for risk comparison purposes and to inform whether mitigation in the form of spillage containment is required.

The assessment is initially based on untreated road runoff without any form of treatment or spillage reduction measures and maximum estimated traffic volumes. This therefore represents a worst-case scenario of the potential impacts associated with a vehicular spillage.

Along any road, there is a risk of vehicular collision that could result in the spillage of fuels, oils or chemicals, particularly if tankers are involved. The risk was calculated assuming that an accident involving spillage of pollutants onto the carriageway would occur at an assumed frequency, expressed as annual probabilities, based on current/estimated traffic volumes along this section of the N60 and the type of road / junction (Table 6.4). It is also assumed that pollutants spilled onto the carriageway would subsequently pass through the road drains and cause a pollution incident in
the receiving watercourse without mitigation measures in place. The annual probability of a serious accidental spillage leading to a serious pollution incident also depends upon the emergency services response time. A risk factor is applied depending on the location and likely response time and the type of receiving water body (Table 6.5).

<table>
<thead>
<tr>
<th>Receiving Water Body</th>
<th>Motorways</th>
<th>Rural Trunk Roads</th>
<th>Urban Roads</th>
<th>Trunk</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Junction</td>
<td>0.36</td>
<td>0.29</td>
<td>0.31</td>
<td></td>
</tr>
<tr>
<td>Slip Road</td>
<td>0.43</td>
<td>0.83</td>
<td>0.36</td>
<td></td>
</tr>
<tr>
<td>Roundabout</td>
<td>3.09</td>
<td>3.09</td>
<td>5.35</td>
<td></td>
</tr>
<tr>
<td>Crossroad</td>
<td>n/a</td>
<td>0.88</td>
<td>1.46</td>
<td></td>
</tr>
<tr>
<td>Side Road</td>
<td>n/a</td>
<td>0.93</td>
<td>1.81</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>0.37</td>
<td>0.45</td>
<td>0.85</td>
<td></td>
</tr>
</tbody>
</table>

*Table 6.4: Serious Accidental Spillages per Billion HGV (km/year) - Source: DMRB HD 45/09 (Highways Agency et al., 2009).*

<table>
<thead>
<tr>
<th>Receiving Body</th>
<th>Urban (response time &lt; 20 mins)</th>
<th>Rural (response time &lt; 1 hour)</th>
<th>Remote (response time &gt; 1 hour)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface Watercourse</td>
<td>0.45</td>
<td>0.6</td>
<td>0.75</td>
</tr>
<tr>
<td>Groundwater</td>
<td>0.3</td>
<td>0.3</td>
<td>0.5</td>
</tr>
</tbody>
</table>

*Table 6.5: Probability of a Serious Accidental Spillage Leading to a Serious Pollution Incident - Source: DMRB HD 45/09 (Highways Agency et al., 2009).*

The probability of a serious accidental spillage was calculated as follows:

\[
P_{SPL} = RL \times SS \times (\text{AADT} \times 365 \times 10^{-9}) \times (\% \text{HGV} \div 100)
\]

Where:

- \(P_{SPL}\) = probability of a serious accidental spillage in 1 year over a given road length.
- \(RL\) = road length in kilometres.
- \(SS\) = serious spillage rates from Table 1.4 (or local data if available).
- \(\text{AADT}\) = Annual Average Daily Traffic.
- \(\% \text{HGV}\) = percentage of Heavy Goods Vehicles.

The probability that a spillage will cause a pollution incident (\(P_{INC}\)) is calculated thus:

\[
P_{INC} = P_{SPL} \times P_{POL}
\]

Where:

- \(P_{POL}\) = the risk reduction factor, dependent upon emergency services response times, which determines the probability of a serious spillage leading to a serious pollution incident (Table 6.5).

In line with the DMRB (Highways Agency et al., 2009), where spillage risk is calculated as less than 1% Annual Exceedance Probability (AEP) (i.e. less frequent than 1 in 100 years), the spillage falls within acceptable limits and no further spillage prevention measures will be required. Where assessed to be greater than 1% AEP (i.e. more frequent than 1 in 100 years), the risk is unacceptable and mitigation will be required to reduce the risk of an impact occurring.
Higher levels of protection are afforded where road runoff discharges within close proximity (i.e. within 1km) to designated wetlands or designated conservation sites, such as Special Areas of Conservation (SACs) or salmonid waters. In these cases, it is considered more appropriate to achieve a spillage risk of less than 0.5% AEP (less frequent than 1 in 200 years), and to implement mitigation where spillage risk is calculated to be more frequent.

6.2.6 Assessment of Flood Risk Impacts

The potential flood impacts can be assessed using the methods set out in the DMRB HD 45/09, Method F (Highways Agency et al., 2009). This assessment can be used to calculate flood levels and extents along a modelled stretch of watercourse to determine if there is an increased flood risk potential to the road scheme or upstream/downstream receptors and to inform whether mitigation, e.g. compensatory flood storage or structural defences, is required. A flood risk assessment (DMRB HD 45/09, Method F) has been omitted from the assessment (refer to Section 6.7 - Limitations to Assessment).

6.3 Existing Environment

6.3.1 Surface Water Features

The proposed development is situated within the Moy River Catchment and within the Western River Basin District. There are no watercourses within the vicinity of the proposed development and no known surface water abstractions within the study area. For information on private water supplies fed by groundwater, refer to Chapter 7 (Soils, Geology and Hydrogeology).

There are two turloughs situated in close proximity to the proposed development. A turlough can be best described as a disappearing lake; these ephemeral surface water features are mostly found in areas of exposed limestone (karst) and are predominantly fed by groundwater. These topographic depressions are seasonally inundated during wet conditions. The study area is also characterised by numerous other small ground depressions and temporary ponding areas. The main surface water features within the study area are presented on 32103901/EAR/Figure 6.1.

The larger of the two surface features, Balla Turlough, lies immediately to the north west of the proposed development (see 32103901/EAR/Figure 6.1) and is designated as a candidate Special Area of Conservation (cSAC) under the EU Habitats Directive (92/43/EEC). Refer to Chapter 5: Ecology for information on the qualifying features of the Balla Turlough cSAC/pNHA. Although there are no watercourses within the vicinity of the proposed development, there are a number of artificial drainage ditches which are considered to be hydrologically-linked to Balla Turlough cSAC/pNHA.

A small Un-named turlough is situated to the east of the Balla Turlough cSAC/pNHA, immediately to the north of the proposed development. See 32103901/EAR/Figure 6.1. The hydrological connectivity of the Un-named turlough and the Balla Turlough cSAC/pNHA are not well understood, and therefore taking a worst case scenario, it is assumed that the two turloughs are also hydrologically-linked by surface and/or groundwater pathways.

Available information indicates that there have been infrequent flood events along the N60 within the study area. The most recent incidence of road flooding along the N60 occurred in November 2009 at Carrowgarve and Brees/Barnreggaun. In
addition, there are recorded flooding events in the vicinity of Balla Turlough cSAC/pNHA, the most recent of which occurred in April 2005 (www.floodmaps.ie).

It is considered likely that the turloughs receive untreated runoff from surrounding agricultural land and untreated road drainage from the existing N60, R324 and other minor side roads in the vicinity of the features.

Based on the cSAC designation under the EU Habitats Directive (92/43/EEC), and the assumed hydrological connectivity of the turloughs, the ‘attributes’ of the Balla Turlough cSAC/pNHA and Un-named turlough are summarised below, in line with the criteria specified in Table 6.1.

- **Attribute: Conveyance of Flow.** The Balla Turlough cSAC/pNHA and Un-named turlough are considered to be of ‘Extremely High’ and ‘Very High’ importance, respectively.
- **Attributes: Water quality and Biodiversity.** The Balla Turlough cSAC/pNHA and Un-named turlough are considered to be of ‘Extremely High’ and ‘Very High’ importance, respectively.

### 6.3.2 Existing Drainage

There is no formal drainage system, or treatment/attenuation of runoff, on the existing section of the N60 and untreated road runoff generally discharges over the edge on to the surrounding land. Based on the natural topography in this area, much of this discharge will drain to the Un-named turlough. As discussed above, it is assumed that the two turloughs are connected by surface and/or groundwater pathways. As a result, it is considered in terms of this assessment that any pollutants that currently accumulate in the Un-named turlough may ultimately enter the Balla Turlough cSAC/pNHA.

The estimated pre-development ‘greenfield’ (i.e. existing situation), peak flows that are received by the Un-named turlough were calculated for the 1 year and 50 year return period flows, as summarised in Table 6.6. It was assumed that as the existing drainage system utilises over the edge drainage onto surrounding land, the runoff rates with the existing N60 scheme in place would be very similar to the Greenfield runoff rate (prior to any road) as the road is not considered to be impeding overland flow.

<table>
<thead>
<tr>
<th>Receiving Body</th>
<th>Water Body</th>
<th>Turlough Catchment Area</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Excluding Existing N60 Road Footprint (ha)</td>
<td>Including Existing N60 Road Footprint (ha)</td>
</tr>
<tr>
<td>Un-named Turlough</td>
<td>93.17</td>
<td>0.96 (hardstanding) 0.25 (verges, embankments)</td>
</tr>
</tbody>
</table>

*Table 6.6: Baseline Hydrological Peak Flows*

### 6.4 Assessment of Potential Impacts

#### 6.4.1 Construction Phase Impacts (in the essence of)

Potential impacts are likely to present the greatest risk during the construction phase when there is most activity on site and highest potential for pollution of surface water bodies.
The proposed development involves the improvement of approximately 3.6km of the N60, with associated junction upgrades. See 32103901/EAR/Figure 2.1-2.2. The construction works associated with the scheme, including earthworks and drainage provision, could result in the following potential impacts on the surface water environment.

- Alterations to existing drainage patterns could temporarily increase the peak runoff and runoff volume to the drainage system during a rainfall event. This may be caused by an increase in impermeable surfaces, soil compaction due to heavy machinery, landforming works, vegetation removal and equipment/obstacles placed within the catchment. These construction works may temporarily increase the flood risk potential to the N60 road scheme and downstream turloughs. In terms of the attribute ‘Conveyance of Flow’, these impacts are considered to be of ‘small’ magnitude, resulting in an impact significance of ‘significant/moderate’ and ‘significant’ on the Un-named turlough and Balla Turlough cSAC/pNHA, respectively.

- Increased fine sediment supply to the drainage system could occur during construction works as a result of soil stripping, vegetation removal and increased exposure of bare surfaces, construction of temporary haul roads, site compound preparation, stockpiling of materials, plant and vehicle washing, and excavations/earthworks required for road and drainage installations. The requirement for new/modified drainage culverts could result in increased sediment supply to the downstream turloughs. In terms of the attributes ‘Water quality and Biodiversity’, these impacts are considered to be of ‘small’ magnitude, resulting in an impact significance of ‘significant/moderate’ and ‘significant’ on the Un-named turlough and Balla Turlough cSAC/pNHA, respectively.

- Chemical pollution could occur due to the spillage, uncontrolled release or leakage of chemicals, fuel, oil, lubricants and unset cement from construction plant, storage tanks and construction works on temporary haul roads and within the site compound. There is the potential for direct entry of a polluting substance into the drainage system. In addition, there is the potential for wastewaters to affect surface water quality if not treated before discharge; discharge of highly alkaline wastewater, associated with concreting works, could have an adverse effect on water quality and ecology through elevation of water pH. In terms of the attributes ‘Water quality and Biodiversity’, these impacts are considered to be of ‘moderate’ magnitude, resulting in an impact significance of ‘profound/significant’ and ‘profound’ on the Un-named turlough and Balla Turlough cSAC/pNHA, respectively in the absence of mitigation.

- Accidental / uncontrolled release of sewage from on-site welfare facilities, could enter the drainage system and pollute the downstream turloughs and groundwater. In terms of the attributes ‘Water quality and Biodiversity’, these impacts are considered to be of ‘moderate’ magnitude, resulting in an impact significance of ‘profound/significant’ and ‘profound’ on the Un-named turlough and Balla Turlough cSAC/pNHA, respectively.

- The disturbance of contaminated land has the potential to mobilise contaminants, which could reach surface watercourses and have adverse effects on ecological and groundwater receptors. No areas of contaminated land have been identified in the vicinity of the scheme and therefore no associated impacts are anticipated on the turloughs.

- Lower water levels could potentially have a negative effect on water quality and associated ecology as a result of lowered pollutant dilution/dispersion capacity and turloughs levels. Limited groundwater is anticipated to be intercepted in the vicinity of the turloughs and therefore no associated
impacts are anticipated on the turloughs. Refer to Chapter 7: Soils, Geology and Hydrogeology for further information.

6.4.2 Operational Phase Impacts (in the absence of mitigation)

The proposed development includes road improvements, modified junctions and associated cuttings and embankments, as well as a permanent drainage system. The potential operational impacts on the surface water environment associated with the scheme include the following:

- New or increased impermeable areas are likely to increase the overall volume of water reaching the drainage system, as less is lost to infiltration. Permanent alterations to the hydrological regime of the area may occur if there is no suitably designed attenuation of surface water runoff. This would lead to the flood response of the catchment becoming more ‘flashy’, resulting in an increased flood potential to the N60 road scheme and downstream turloughs. In terms of the attribute ‘Conveyance of Flow’, these impacts are considered to be of ‘small’ magnitude, resulting in an impact significance of ‘significant/moderate’ and ‘significant’ on the Un-named turlough and Balla Turlough cSAC/pNHA, respectively.

- A future increase in traffic volumes could lead to an increase in the volume of contaminated road runoff entering the drainage system and downstream turloughs. There are a wide range of pollutants found in road runoff which may have an effect on the receiving waters and associated ecology, including suspended solids and contaminants bound to them (such as metals and phosphorus); biodegradable organic materials (such as debris and grass cuttings); diffuse sources with high levels of nutrients (nitrogen and phosphorus); de-icing salt (chloride); and oil and related compounds.

- However, it is likely that the proposed development would result in beneficial impacts due to the higher standard of highway design, including improved drainage and is likely to reduce the risk of accidental spillage arising from road traffic accidents. This is discussed in more detail below and in Section 6.5.2. In terms of the attributes ‘Water Quality and Biodiversity’, these impacts are considered to be of ‘minor beneficial’ magnitude, resulting in an impact significance of ‘significant/moderate beneficial’ and ‘significant beneficial’ on the Un-named turlough and Balla Turlough cSAC/pNHA, respectively.

As highlighted in Section 6.7, the scheme drainage design includes petrol interceptors and includes discharges to soakaways, with the exception of one drainage run (Run C), which utilises a swale prior to discharge to the Un-named turlough. A ‘worst-case’ spillage risk assessment has been undertaken for drainage Run C, using the maximum estimated traffic capacity of the proposed development, and the resulting indirect spillage risk to the Un-named turlough has been considered. The proposed drainage run in this area is shown on 32103901/EAR/Figure 6.1.

In addition to the input parameters detailed in Section 6.2.4, the assessment of spillage risk required the following inputs as follows:

- Length of road draining to outfall: 950m.
- Two-way AADT: 8,600 (maximum estimated capacity of the improved road taken from NRA, 2012).
The spillage risk assessment is summarised in Table 6.7 below. The calculation spreadsheet is provided in Appendix C.

<table>
<thead>
<tr>
<th>Receiving Water Body</th>
<th>Threshold of Acceptability</th>
<th>Spillage Risk (%AEP Return 1:X years)</th>
<th>Within Acceptable Limits?</th>
<th>Potential Impact (unmitigated)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Un-named Turlough (indirect)</td>
<td>1:200</td>
<td>0.00003</td>
<td>YES</td>
<td>Negligible</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1:37,789</td>
<td></td>
<td>Imperceptible</td>
</tr>
</tbody>
</table>

Table 6.7: Summary of Risk of Accidental Spillage

As shown in Table 6.7, the spillage risk assessment indicates that the worst-case spillage risk return period for this scheme is 1 in 37,789 years which is considerably below the threshold risk of 1 in 100 years (most water bodies) and 1 in 200 years (discharges near designated conservation sites). In terms of the attributes ‘Water quality and Biodiversity’, the impact of accidental spillage risk is therefore considered to be of ‘negligible’ magnitude, resulting in an impact significance of ‘imperceptible’ on the Un-named turlough, which would indirectly receive the polluted runoff. Using DMRB guidance, mitigation would not be required for the proposed development. However, mitigation, in the form of the drainage design Systems (SUDS), is considered best practice for new and improved road schemes and is required under the PoE Act 2003 (Bruen et al., 2006); the scheme drainage design is considered in more detail in Section 6.5 (Mitigation).

6.4.3 Do-Nothing Impact

In the event that the proposed development were not to be constructed, untreated road runoff from the existing N60 would continue to discharge over the edge onto surrounding land and ultimately drain through surface and groundwater pathways to the Un-named turlough. Future anticipated increases in traffic volumes would steadily increase the volume of polluted runoff washed off the road surface during rainfall events and increase the risk of pollution to the Un-named turlough and ultimately the Balla Turlough cSAC/pNHA.

6.4.4 Worst-Case Scenario Impact

The worst-case scenario relates to the potential impacts of the scheme without mitigation measures in place and assumes worst-case traffic conditions, as assessed in Section 6.4 and in the spillage risk assessment undertaken in Section 6.4.2. As stated above, the impact of accidental spillage risk on the attributes ‘Water quality and Biodiversity’ has been assigned a magnitude of ‘negligible’ and ‘imperceptible’ impact significance on the Un-named turlough, which would indirectly receive the polluted spillage runoff.

6.4.5 Indirect Impacts

Any indirect impacts associated with road drainage to the Un-named turlough are discussed in Section 6.4.2. Provided that the mitigation measures outlined in Section 6.5 are fully implemented, indirect impacts are considered to be of ‘negligible’ magnitude, resulting in an impact significance of ‘imperceptible’ on the turloughs. Refer to Chapter 5: Ecology and Chapter 7: Soils, Geology and Hydrogeology for an assessment of indirect impacts to ecological and groundwater receptors, respectively.
6.4.6 Cumulative Impacts

Other proposed infrastructure projects in the locality include proposals for the upgrade of other sections of the N60, proposals to extend the Lough Mask Regional Water Supply Scheme from Balla to Kiltimagh, and the planned extension of the burial ground at Balla (Objective O/HC-BG 1). However as none these projects have planning approval or are in construction, cumulative impacts are not anticipated.

6.5 Proposed Mitigation and Avoidance Measures

The implications of the 2000/60/EC WFD have been taken into account in the formulation of mitigation measures, i.e. measures aimed to achieve and preserve 'good' ecological status of all water bodies by 2015, or by agreed timescales up to 2027.

Consultation responses were received from Inland Fisheries Ireland (IFI) and the Development Applications Unit of the Department of Arts, Heritage and the Gaeltacht to inform the type and detail of mitigation required.

6.5.1 Construction Phase Mitigation

During construction, the Contractor’s Environmental Site Manager or a suitably qualified member of the construction team, will ensure that the mitigation measures identified within this Environmental Assessment Report (EAR) are fully implemented and activities carried out in such a manner as to prevent or reduce impacts on the surface water environment.

Highest standards of site management will be maintained to prevent accidental contamination or unnecessary disturbance to key receptors during construction, including published good construction practices. Construction Method Statements (CMS) will be prepared for any works that could affect the water quality entering the turloughs as detailed in section 5.5.1.

The programming of mitigation measures will be carefully considered so that their use is most effective. For example, topsoil stripping will be undertaken outside the bird breeding season (refer to Chapter 7: Hydrology and Drainage and Chapter 5: Ecology for further information).

The grassed surface water channel, interceptor ditch and filter drain with 25m centre outfalls and petrol interceptor (as detailed in 32103901/PDD/Figure 01) between Ch1000 and Ch 1500 on the south western side of the carriageway, will be constructed and operating prior to excavation of Cutting 1 (Ch 1260 to 1340). These drainage features are adjacent to Balla Turlough SAC, to facilitate the controlled discharge of any intercepted groundwater back into the turlough habitats in the case of the water being intercepted during excavations. The outfalls to the turlough will be open during construction only, and closed during operation.

The following Construction Industry Research and Information Association (CIRIA) best practice guidance will be adhered to:

- CIRIA C648 – Control of Water Pollution from Linear Construction Projects.
- CIRIA C649 – Control of Water Pollution from Linear Construction Projects: Site Guide.
- CIRIA C698 – Site handbook for the construction of SUDS.
In addition, measures to control changes to runoff, erosion and sedimentation will be compiled into a Sediment and Erosion Control Plan by the Contractor and will include the following:

- To reduce potential increases in flows into the drainage system and downstream turloughs during construction, the period of exposure of bare areas and uncontrolled runoff from new hardstanding areas will be limited. Early covering/seeding/planting of exposed surfaces will be undertaken;
- During construction works consideration will be given to impacts of flooding. The aim will be for temporary construction works to be resistant to flood effects in order to prevent movement or damage during potential flooding events;
- To prevent contaminated or silt-laden runoff being released from site (from entering the turloughs) during construction and advanced drainage system construction prior to excavation of cutting 1 (See section 6.5.1), a range of temporary measures will be implemented such as silt fences, cut-off ditches, silt traps, straw bales, entrapment matting;
- Material stockpiles will be kept to a minimum size, covered and located at least 10m from the drainage system and 100m from turloughs;
- Runoff will be controlled and, if required, directed to settlement ponds or sumps. Any temporary attenuation and treatment facilities will be designed and implemented in accordance with CIRIA C697 (2007). All temporary treatment systems will be regularly inspected and maintained;
- The extent of construction activities will be controlled to limit vegetation removal and the exposure and/or compaction of soils. Land surrounding the immediate construction area will be fenced off, or otherwise demarcated, to prevent inadvertent intrusion from construction plant;
- The scheme drainage system will be inspected daily, or after storm events, to check for blockages during construction; and
- Construction works will be avoided during prolonged periods of very heavy rainfall adjacent to the Balla Turlough SAC/pNHA and Un-named Turlough.

Measures to avoid, reduce or control pollution of surface and groundwaters will include:

- All fuel, oils and chemicals will be stored in secure areas on an impermeable base, at least 10m and 100m away from the scheme drainage system and turloughs, respectively. Fuel storage areas will be bunded to provide adequate retention capacity in the event of a leak or spillage occurring;
- Refuelling of plant and vehicles will ideally be undertaken offsite. Where this is not practicable, refuelling activities will be undertaken on an impermeable base, at least 10m and 100m from the scheme drainage system and turloughs, respectively;
- Stationary plant will be fitted with drip trays and emptied regularly and plant machinery will be properly maintained;
- Machinery/plant must not enter the turlough habitat and the site compound/storage area will not be placed within 100m of the turloughs;
- Spillage kits including oil booms, will be stored at high risk and sensitive sites and regularly checked and restocked;
- Concrete mixing and washing areas will be located in a secure area (at least 100m from the turloughs). In addition, wheel wash and plant washing discharges will not be allowed to enter the water environment and will be collected and disposed of appropriately;
- Any activities involving the pouring of concrete will be carried out in dry weather conditions;
- Untreated sewage will not be allowed to discharge to the drainage system or downstream turloughs and will be disposed of off site via a licenced contractor;
- Monitoring of turbidity (suspended solids) levels in Balla Turlough SAC and the Un-named Turlough will be undertaken on a monthly basis for a minimum of 6 months prior to construction and will include monitoring during the winter season when turlough water levels are most likely to be present. Monitoring will also be undertaken on a weekly basis during construction for turbidity (suspended solids). In the event of suspended solids concentrations that are higher than the 95th %ile of those monitored during the pre-construction monitoring period, a review of the Sediment and Erosion Control measures and plan will be implemented and additional sediment control measures put in place as required. Daily visual inspections of Balla Turlough SAC and the Un-named Turlough will also be undertaken during the construction phase to confirm the absence of sediment from construction works.

### 6.5.2 Operational Phase Mitigation

The carriageway runoff will generally be collected by Grassed Surface Water Channels (GSWC), or by filter drains in areas where GSWC are constrained by side road access and road alignment. GSWC, in combination with interceptor ditches, will also collect field runoff which naturally drains towards the proposed development, and this non-carriageway related runoff will also be routed through the scheme drainage system.

The scheme drainage design includes provision for three levels of treatment prior to the discharge of carriageway runoff and field runoff. In Ireland, these attenuation/pollution control devices are commonly referred to as Structural Best Management Practices (BMPs) (Bruen et al., 2006). The first level of treatment shall be provided by the GSWC and/or filter drains. Oil/petrol interceptors will provide the second level of treatment, followed by discharge to soakaways in the majority of cases.

Drainage Run C differs slightly in that it utilises a swale prior to discharge to the Un-named turlough (refer to 32103901/EAR/Figure 6.1). A gabion mattress will be positioned at the outfall from the swale to provide scour protection and prevent any risk of sedimentation at the outfall to the Un-named turlough (see 32103901/PDD/Figure 01 - 32103901/PDD/Figure 05: Drainage Design).

Soakaways were chosen as the preferred solution for discharging treated runoff due to the lack of watercourses in the area; these have been sized according to the catchment area to be drained and the underlying geological conditions. A swale is the preferred environmental solution to outfall to the Un-named turlough due high pollutant removal efficiencies.

The scheme drainage system has been designed in accordance with Bruen et al. (2006) and CIRIA C609 (2004) and C697 (2007) guidance. A description and intended function of each treatment method used for drainage Run C is described below. Different stages of the ‘treatment train’ (pre-treatment, conveyance, source, site or regional control), depending on their primary functions and their pollutant removal capability/potential, as summarised in Tables 6.8 and 6.9.
Drainage Design Treatment System | Description | Component | Primary Functions and Capabilities
--- | --- | --- | ---
Filter Drains | Linear drains/trenches filled with a permeable material, often with a perforated pipe in the base of the trench. | Management Train Suitability | Conveyance, Source Control
| | | Water Quantity | Conveyance, Detention
| | | Water Quality | Filtration, Adsorption, Biodegradation, Volatilisation
Swales | Shallow vegetated channels that conduct and/or retain water (and can permit infiltration when un-lined). The vegetation filters particulates. | Management Train Suitability | Conveyance, Source Control, Site Control
| | | Water Quantity | Conveyance, Detention
| | | Water Quality | Sedimentation, Filtration, Adsorption, Biodegradation

Table 6.8: Descriptions, Primary Functions and Capabilities of SUDS Techniques included within the Proposed Development (Source: CIRIA C697, 2007)

| Drainage Design Treatment System | Pollutant Removal Efficiency | Peak Flow Attenuation | Spillage Risk Reduction (%) |
| --- | --- | --- | ---
| | Total Suspended Solids | Hydrocarbon | Heavy Metals | Dissolved Pollutants |
| Filter Drains | Moderate-High | Low - Moderate | Moderate-High | No data | Low | 40% |
| Swales | High | High | High | Low - High | High | 40% |
| Oil /petrol Interceptor | Low – Moderate | Moderate-High | No Data | Low | N/A | 50% |

Table 6.9: Potential Pollutant Removal Efficiencies, Peak Flow Attenuation and Spillage Risk Reduction of SUDS treatment options (Sources: CIRIA C697 (2007); DMRB HD 45/09 (Highways Agency et al., 2009)

As outlined in Table 6.8, different elements of the drainage design have individual advantages in the removal of pollutants from road runoff at different stages of the ‘treatment train’. In addition, the risk of pollution to the Un-named turlough, resulting from a spillage on the road, would be further reduced as highlighted in Table 6.9. Therefore, a combination of these drainage measures has been incorporated into the drainage design.

As a further mitigation measure, the rate of runoff to the Un-named turlough has been designed to be attenuated to the greenfield runoff rate, i.e. the pre-development conditions that would exist in the absence of the N60 road, to prevent an increase in flood risk. An increase in impermeable area can increase the peak and total volume of water reaching a discharge point, resulting in a ‘flashier’ response of the catchment compared to a natural rural catchment, where more water would be lost to infiltration. As discussed in Section 6.3.2, the runoff rates with the existing N60 scheme in place are considered to be very similar to the greenfield runoff rate (prior to any road). This is because the existing over-the-edge drainage system would act to attenuate the flow, compared to a drainage system consisting of pipes and gulleys, for example, where runoff would be rapidly conveyed to a discharge point.

The estimated percentage changes in peak flows arising from the proposed development were compared to the greenfield/existing N60 design peak flows, for the 1 year and 50 year return periods. These are summarised in Table 6.10.
### Table 6.10: Estimated design peak flows for the scheme compared to the pre-development situation

<table>
<thead>
<tr>
<th>Development Stage</th>
<th>Turlough Catchment Area (ha)</th>
<th>% Difference to Greenfield/existing Catchment Area</th>
<th>Return Period Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>1 year (l/s)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(% change)</td>
</tr>
<tr>
<td>Greenfield/Existing N60</td>
<td>94.38</td>
<td>n/a</td>
<td>306</td>
</tr>
<tr>
<td>Proposed Development</td>
<td>92.88 (reduced area as parts of the drainage system discharge to soakaways)</td>
<td>-1.59%</td>
<td>294</td>
</tr>
</tbody>
</table>

The runoff rates in Table 6.10, demonstrate a slight reduction in the runoff rates with the proposed development compared to the existing situation (i.e. 603 l/s compared to 613 l/s for a 1 in 50 return period flow). This also coincides with a slight reduction of the catchment area draining to the Un-named turlough as some of the existing drainage would be discharged to soakaways. As a result, the impact on potential flood risk is considered to be of ‘negligible’ magnitude, resulting in an impact significance of ‘imperceptible’ on the Un-named turlough.

A long term maintenance regime of the drainage system will be undertaken and at an agreed frequency, in consultation with the Local Authority or maintenance contractor, to avoid flooding (ponding) on the road surface, as a result of blockage or sediment accumulation, and to reduce the impacts of the runoff on the receiving water environment.

### 6.6 Residual Impacts

Identical to the potential impacts discussed in Section 6.4, residual impacts are assessed during both the construction and operational phases of the scheme. The Un-named turlough and Balla Turlough cSAC/pNHA are assumed to be hydrologically-linked by surface and/or groundwater pathways. Residual impacts on surface water feature attributes are considered to be identical.

Following implementation of the mitigation outlined in Section 6.5, the potential for impacts on the surface water attributes, ‘Conveyance of Flow’ and ‘Water Quality and Biodiversity’, during construction would be reduced to ‘negligible’ magnitude, resulting in an impact significance of ‘imperceptible’ on both turloughs.

During operation, the proposed development would result in beneficial impacts due to the higher standard of drainage design. In terms of the attributes ‘Water Quality and Biodiversity’, these impacts are considered to be of ‘minor beneficial’ magnitude, resulting in an impact significance of ‘significant/moderate beneficial’ and ‘significant beneficial’ on the Un-named turlough and Balla Turlough cSAC/pNHA, respectively. The scheme drainage has also been designed to the greenfield runoff rate, and therefore in terms of the attributes ‘Water quality and Biodiversity’, the impact is considered to be of ‘negligible’ magnitude, resulting in an impact significance of ‘imperceptible’ on the Un-named turlough.
A summary of the residual impacts on surface water attributes, during the construction and operational phases of the proposed development, is provided in Tables 6.11 and 6.12, respectively.

Limitations to Assessment

In assessing the existing water quality within both Balla Tulough cSAC and the Un-named Turlough, assumptions were made on the baseline condition of these surface water features based on surrounding land use and professional judgement.

A water quality routine runoff assessment is most applicable to roads with a direct drainage outfall to a watercourse and with an annual average daily traffic (AADT) flow greater than 10,000 vehicles. As highlighted in Section 6.2.4, it was considered that a routine runoff assessment would not be applicable to this scheme due to:

- Lack of watercourses in the area; there is no point source drainage outfall proposed to a watercourse. Due to the environmental sensitivity of the Balla Turlough cSAC/pNHA and the underlying groundwater/geological conditions, the scheme drainage design only includes discharges to soakaways, with the exception of one drainage run (Run C), which utilises a swale prior to discharge to the Un-named turlough (Jacobs, 2013).

- The AADT in 2010 for this section of the N60 was 5,523 vehicles (NRA website). The proposed road has an estimated maximum capacity of 8,600 vehicles (NRA TD 9/12, Table 6/1, 2012), which is still below the AADT threshold of 10,000 vehicles for DMRB methods A and B.

As highlighted in Section 6.2.6, a flood risk assessment has not been undertaken due to the lack of watercourses in the area and therefore no requirements for watercourse culverts beneath the carriageway. In addition to the minor increase of the impermeable ‘footprint’ of the scheme within the Moy River Catchment, it was considered that a flood risk assessment would not be applicable to this scheme. The scheme drainage design would include adequate storage capacity to attenuate and contain runoff from the scheme up to the required return period flood event, as specified by the NRA and EPA.

6.7 Assessment Conclusions

The assessment indicates that any potential impacts to the hydrological attributes of the turloughs, ‘Conveyance of Flow’ and ‘Water Quality and Biodiversity’ during construction would be of ‘negligible’ magnitude and ‘imperceptible’ significance, after implementation of the proposed mitigation measures.

No significant impacts have been identified on the turloughs as a result of disturbance of contaminated land or dewatering as a result of groundwater interception.

During operation, the proposed development would result in beneficial impacts due to the higher standard of drainage design and improvements to the quality of runoff reaching the turloughs. Flows would be attenuated to the peak greenfield flow rate and a maintenance regime will be implemented, thereby reducing the risk of flooding and maintaining the efficiency of the SUDS features during the operation of the proposed development.
6.8 References


Environmental Protection Agency website [www.epa.ie](http://www.epa.ie) [last accessed 13 February 2013]


National Roads Authority (NRA) website [http://www.nra.ie](http://www.nra.ie) [last accessed 13 February 2013]


Appendix 6.1 – Hydrology and Drainage

WATER QUALITY SPILLAGE RISK ASSESSMENT CALCULATION SHEET

The spillage risk calculation spreadsheet below was used to determine the risk of an accidental spillage to the Un-named turlough, which would indirectly receive the polluted runoff from the scheme. The results of these calculations have been used to inform the surface water assessment.

<table>
<thead>
<tr>
<th>Assessment of Priority Outfalls</th>
<th>Method D - assessment of risk from accidental spillage</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1 Water body type</td>
<td>A (main road)</td>
</tr>
<tr>
<td>D2 Length of road draining to outfall (m)</td>
<td>950</td>
</tr>
<tr>
<td>D3 Road Type (A-road or Motorway)</td>
<td>A</td>
</tr>
<tr>
<td>D4 If A road, is site urban or rural?</td>
<td>Rural</td>
</tr>
<tr>
<td>D5 Junction type</td>
<td>No junction</td>
</tr>
<tr>
<td>D6 Location</td>
<td>&lt; 1 hour</td>
</tr>
<tr>
<td>D7 Traffic flow (AADT two way)</td>
<td>8,600</td>
</tr>
<tr>
<td>D8 % HGV</td>
<td>5.1</td>
</tr>
<tr>
<td>D9 Spillage factor (no/10^6 HGVkm/year)</td>
<td>0.29</td>
</tr>
<tr>
<td>D10 Probability factor</td>
<td>0.60</td>
</tr>
<tr>
<td>D11 Risk of pollution incident</td>
<td>0.00003</td>
</tr>
<tr>
<td>D12 Is risk greater than 0.01?</td>
<td>No</td>
</tr>
<tr>
<td>D13 Return period without pollution reduction measures</td>
<td>0.00003</td>
</tr>
<tr>
<td>D14 Existing measures factor</td>
<td>1</td>
</tr>
<tr>
<td>D15 Return period with existing pollution reduction measures</td>
<td>0.00003</td>
</tr>
<tr>
<td>D16 Proposed measures factor</td>
<td>1</td>
</tr>
<tr>
<td>D17 Residual with proposed Pollution reduction measures</td>
<td>0.00003</td>
</tr>
</tbody>
</table>

Source: The Highways Agency Water Risk Assessment Tool (HAWRAT) v1.0, DMRB HD 45/09 (Highways Agency et al., 2009).