7 WATER

7.1 Introduction

7.1.1 Background & Objectives

Hydro-Environmental Services (HES) was engaged by McCarthy Keville O'Sullivan (MKO), on behalf of Arlum Ltd, to carry out an assessment of the potential impacts of a proposed housing development at Moneyduff, Oranmore Co. Galway on water aspects (hydrology and hydrogeology) of the receiving environment.

The objectives of the assessment are:

- Produce a baseline study of the existing water environment (surface water and groundwater including connectivity with local designated sites) in the area of the proposed development site;
- Identify likely negative impacts of the Proposed Development on surface water and groundwater during construction, operational and decommissioning phases of the development;
- Identify mitigation measures to avoid, remediate or reduce significant negative impacts; and,
- Assess significant residual impacts and cumulative impacts of the Proposed Development along with other local residential and infrastructural developments.

7.1.2 Statement of Authority

Hydro-Environmental Services (HES) are a specialist hydrological, hydrogeological and environmental practice which delivers a range of water and environmental management consultancy services to the private and public sectors across Ireland and Northern Ireland. HES was established in 2005, and our office is located in Dungarvan, County Waterford.

Our core areas of expertise and experience include upland hydrology and windfarm drainage design. We routinely complete impact assessments for hydrology and hydrogeology for a large variety of project types.

This chapter of the EIAR was prepared by Michael Gill.

Michael Gill (BA, BAI, Dip Geol., MSc, MIEI) is an Environmental Engineer with over 17 years' environmental consultancy experience in Ireland. Michael has completed numerous hydrological and hydrogeological impact assessments of residential and infrastructure developments in Ireland. In addition, he has substantial experience in surface water drainage design and SUDs design, and surface water/groundwater interactions.

7.1.3 Relevant Legislation

The EIAR is carried out in accordance with the follow Irish legislation:

- S.I. No. 349 of 1989: European Communities (Environmental Impact Assessment) Regulations, and subsequent Amendments (S.I. No. 84 of 1995, S.I. No. 352 of 1998, S.I. No. 93 of 1999, S.I. No. 450 of 2000 and S.I. No. 538 of 2001), S.I. No. 30 of 2000, the Planning and Development Act, and S.I. 600 of 2001 Planning and Development Regulations and subsequent Amendments. These instruments implement EU Directive 85/373/EEC and subsequent amendments, on the assessment of the effects of certain public and private projects on the environment;
- Directives 2011/92/EU and 2014/52/EU on the assessment of the effects of certain public and private projects on the environment, including Circular Letter PL 1/2017: Implementation of Directive 2014/52/EU on the effects of certain public and private projects on the environment (EIA Directive);
- Planning and Development Act, 2000, as amended;
- S.I. No. 94 of 1997: European Communities (Natural Habitats) Regulations, resulting from EU Directives 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (the Habitats Directive) and 79/409/EEC on the conservation of wild birds (the Birds Directive);
- S.I. No. 293 of 1988: Quality of Salmon Water Regulations, resulting from EU Directive 78/659/EEC on the Quality of Fresh Waters Needing Protection or Improvement in order to Support Fish Life;
- S.I. No. 272 of 2009: European Communities Environmental Objectives (Surface Waters) Regulations 2009 and S.I. No. 722 of 2003 European Communities (Water Policy) Regulations which implement EU Water Framework Directive (2000/60/EC) and provide for implementation of 'daughter' Groundwater Directive (2006/118/EC). Since 2000 water management in the EU has been directed by the Water Framework Directive (WFD). The key objectives of the WFD are that all water bodies in member states achieve (or retain) at least 'good' status by 2015. Water bodies comprise both surface and groundwater bodies, and the achievement of 'Good' status for these depends also on the achievement of 'good' status by dependent ecosystems. Phases of characterisation, risk assessment, monitoring and the design of programmes of measures to achieve the objectives of the WFD have either been completed or are ongoing. In 2015 it will fully replace a number of existing water related directives, which are successively being repealed, while implementation of other Directives (such as the Habitats Directive 92/43/EEC) will form part of the achievement of implementation of the objectives of the WFD;
- S.I. No. 41 of 1999: Protection of Groundwater Regulations, resulting from EU Directive 80/68/EEC on the protection of groundwater against pollution caused by certain dangerous substances (the Groundwater Directive);
- S.I. No. 249 of 1989: Quality of Surface Water Intended for Abstraction (Drinking Water), resulting from EU Directive 75/440/EEC concerning the quality required of surface water intended for the abstraction of drinking water in the Member States (repealed by 2000/60/EC in 2007);
- S.I. No. 439 of 2000: Quality of Water intended for Human Consumption Regulations and S.I. No. 278 of 2007 European Communities (Drinking Water No. 2) Regulations, arising from EU Directive 98/83/EC on the quality of water intended for human consumption (the Drinking Water Directive) and WFD 2000/60/EC (the Water Framework Directive);

- S.I. No. 272 of 2009: European Communities Environmental Objectives (Surface Waters) Regulations 2009;
- S.I. No. 9 of 2010: European Communities Environmental Objectives (Groundwater) Regulations 2010; and,
- S.I. No. 296 of 2009: European Communities Environmental Objectives (Freshwater Pearl Mussel) Regulations 2009.

7.1.4 Relevant Guidance

The water section of the EIAR is carried out in accordance with guidance contained in the following:

- Guidance on the preparation of the EIA Report (Directive 2011/92/EU as amended by 2014/52/EU);
- Environmental Protection Agency (2017): Draft Guidelines on the Information to be Contained in Environmental Impact Assessment Reports;
- Environmental Protection Agency (September 2015): Draft - Advice Notes on Current Practice (in the preparation on Environmental Impact Statements);
- Environmental Protection Agency (September 2015): Draft – Revised Guidelines on the Information to be Contained in Environmental Impact Statements;
- Environmental Protection Agency (2003): Advice Notes on Current Practice (in the preparation on Environmental Impact Statements);
- Environmental Protection Agency (2002): Guidelines on the Information to be Contained in Environmental Impact Statements;
- Institute of Geologists Ireland (2013): Guidelines for Preparation of Soils, Geology & Hydrogeology Chapters in Environmental Impact Statements;
- National Roads Authority (2005): Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes;
- Eastern Regional Fisheries Board (not dated): Requirements for the Protection of Fisheries Habitat during Construction and Development Works at River Sites;
- PPG1 - General Guide to Prevention of Pollution (UK Guidance Note);
- PPG5 – Works or Maintenance in or Near Watercourses (UK Guidance Note);
- CIRIA (Construction Industry Research and Information Association) 2006: Guidance on 'Control of Water Pollution from Linear Construction Projects' (CIRIA Report No. C648, 2006); and,
- CIRIA 2006: Control of Water Pollution from Construction Sites - Guidance for Consultants and Contractors. CIRIA C532. London, 2006.

7.2 Methodology

7.2.1 Desk Study

A desk study of the Proposed Development study area was largely completed prior to the undertaking of field mapping and walkover assessments. The desk study involved collecting all relevant geological, hydrological, hydrogeological and meteorological data for the area. This included consultation with the following:

- Environmental Protection Agency database (www.epa.ie);
- Environmental Protection Agency River Catchment Mapper (www.catchments.ie);
- Geological Survey of Ireland - Groundwater Database (www.gsi.ie);
- Met Eireann Meteorological Databases (www.met.ie);
- National Parks & Wildlife Services Public Map Viewer (www.npws.ie);
- Water Framework Directive Map Viewer (www.catchments.ie);
- Bedrock Geology 1:100,000 Scale Map Series, Sheet 14 (Geology of Galway Bay). Geological Survey of Ireland (GSI, 2004);
- Geological Survey of Ireland - Groundwater Body Characterisation Reports;
- OPW Indicative Flood Maps (www.floodinfo.ie);
- Environmental Protection Agency – "Hydrotool" Map Viewer (www.epa.ie);
- CFRAM Preliminary Flood Risk Assessment (PFRA) maps (www.cfram.ie); and,
- Department of Environment, Community and Local Government on-line mapping viewer (www.myplan.ie).

7.2.2 Site Investigations

A walkover survey, including detailed drainage mapping, was undertaken by HES on 05th January 2018.

The hydrological walkover survey involved:

- Walkover survey and hydrological mapping of the proposed site the surrounding area were undertaken whereby water flow directions and drainage patterns were recorded; and,
- A flood risk assessment for the proposed development footprint area.

7.2.3 Impact Assessment Methodology

Please refer to Chapter 1 of the EIAR for details on the impact assessment methodology (EPA, 2002, 2003, 2015 and 2017). In addition to the above methodology, the sensitivity of the water environment receptors was assessed on completion of the desk study and baseline study. Levels of sensitivity which are defined in Table 7.1 are then used to assess the potential effect that the Proposed Development may have on them.

Table 7.1 Receptor Sensitivity Criteria (Adapted from www.sepa.org.uk)

Sensitivity of Receptor	
Not sensitive	Receptor is of low environmental importance (*e.g.* surface water quality classified by EPA as A3 waters or seriously polluted), fish sporadically present or restricted). Heavily engineered or artificially modified and may dry up during summer months. Environmental equilibrium is stable and is resilient to changes which are considerably greater than natural fluctuations, without detriment to its present character. No abstractions for public or private water supplies. GSI groundwater vulnerability "Low" – "Medium" classification and "Poor" aquifer importance.
Sensitive	Receptor is of medium environmental importance or of regional value. Surface water quality classified by EPA as A2. Salmonid species may be present and may be locally important for fisheries. Abstractions for private water supplies. Environmental equilibrium copes well with all natural fluctuations but cannot absorb some changes greater than this without altering part of its present character. GSI groundwater vulnerability "High" classification and "Locally" important aquifer.
Very sensitive	Receptor is of high environmental importance or of national or international value *i.e.* NHA or SAC. Surface water quality classified by EPA as A1 and salmonid spawning grounds present. Abstractions for public drinking water supply. GSI groundwater vulnerability "Extreme" classification and "Regionally" important aquifer

7.3 Receiving Environment

7.3.1 Site Description & Topography

The Proposed Development site is located in the townland of Moneyduff in Oranmore, Co. Galway. The total study area is approximately 8.642ha (~0.09km^2) in area.

The proposed site is used for rough grazing of horses and contains a number of areas where stone material has grassed over in the past.

The elevation of the site ranges between approximately 3.4 and 12.8m OD (metres above Ordnance Datum). The overall local topography generally slopes from east to west with stone mounds creating artificial high points around the site. The dominant land use on the bordering land is residential housing to the north, an environmental reserve to the west and an empty site and further residential uses to the south and greenfield site to the east.

The Proposed Development site does not contain field drains or natural watercourses and it is likely that much of the rainfall that falls on the site drains through the soils. The Millplot Stream drains the land immediately to the west of the site.

7.3.2 Water Balance

Long term rainfall and evaporation data was sourced from Met Éireann. The 30-year annual average rainfall (1981 - 2010) recorded at Athenry station, located northeast of the Proposed Development site, are presented in Table 7.2 below. This is the closest station to the proposed development site.

(*Please note that these rainfall data are used for baseline characterisation purposes only and are not used for assessing runoff volumes pre/post development or for drainage design*).

Table 7.2 Local Average long-term Rainfall Data (mm) at Athenry

Station		X-Coord		Y-Coord		Ht (MAOD)		Opened		Closed		
Athenry		08°47'08" W		53°17'21" N		40		1945		N/A		
Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec	Total
117	88	95	72	75	80	87	108	100	129	120	123	1,193

The closest synoptic station where the average potential evapotranspiration (PE) is recorded is at Claremorris station, approximately 51km north of the site. The long-term average PE for this station is 408mm/yr. This value is used as a best estimate of the site PE. Actual Evaporation (AE) at the site is estimated as 388mm/yr (which is 0.95 × PE).

The effective rainfall (ER) represents the water available for runoff and groundwater recharge. The ER for the site is calculated as follows:

Effective rainfall (ER) = AAR – AE
= 1,193mm/yr – 388mm/yr
ER = 805mm/yr

Based on groundwater recharge coefficient estimates (85%) from the GSI (www.gsi.ie) an estimate of 684mm/year average annual recharge is given for the study area. This means that the hydrology of the study area is characterised by low surface water runoff rates and high groundwater recharge rates. The site is also relatively close to the coast, and all drainage from the site will ultimately end up in Oranmore Bay Galway Bay.

Therefore, annual recharge and runoff rates for the site are estimated to be 684mm/yr and 121mm/yr respectively. The large coverage of well-draining mineral soils and relatively flat ground means recharge rates are likely to be towards the higher end of the GSI range.

7.3.3 Regional & Local Hydrology

On a regional scale, the site is located within Hydrometric Area 29. The site is located in the Galway Bay South East catchment and Carrowmoneash (Oranmore)_SC_010 sub-catchment under the Water Framework Directive (WFD). A regional hydrology map is shown as Figure 7.1.

The Millplot Stream flows west from the land to the west of the proposed site, and continues west, discharging into Oranmore Bay ~340 downstream. The Proposed Development site does not contain any mapped watercourses.

A local hydrology map is shown as Figure 7.2.

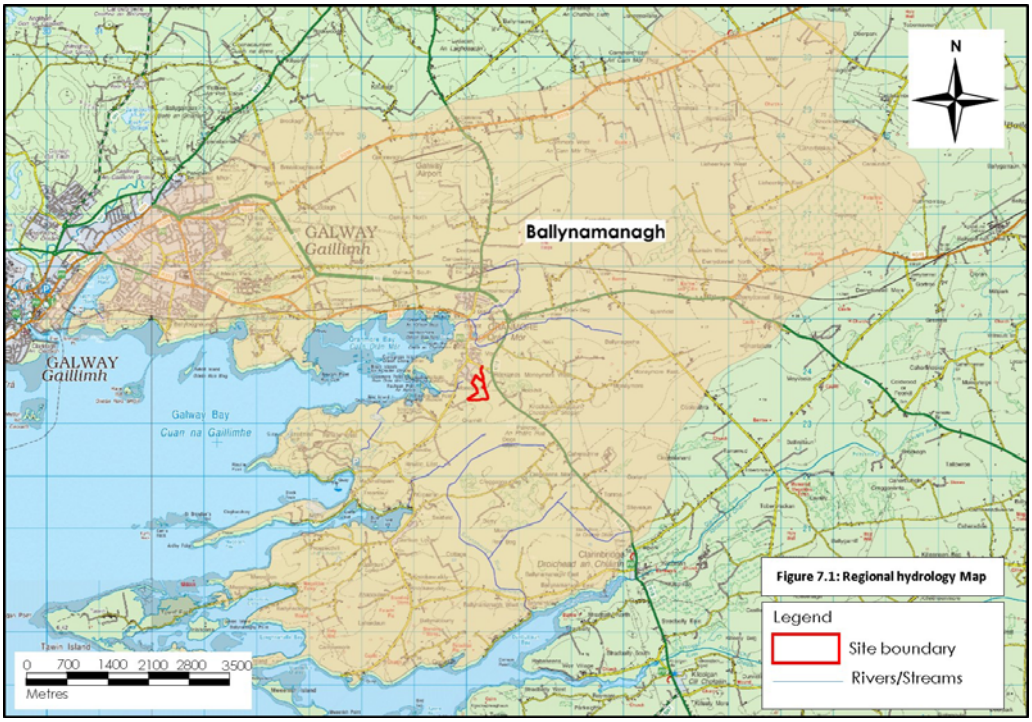


Figure 7.1 Regional Hydrology

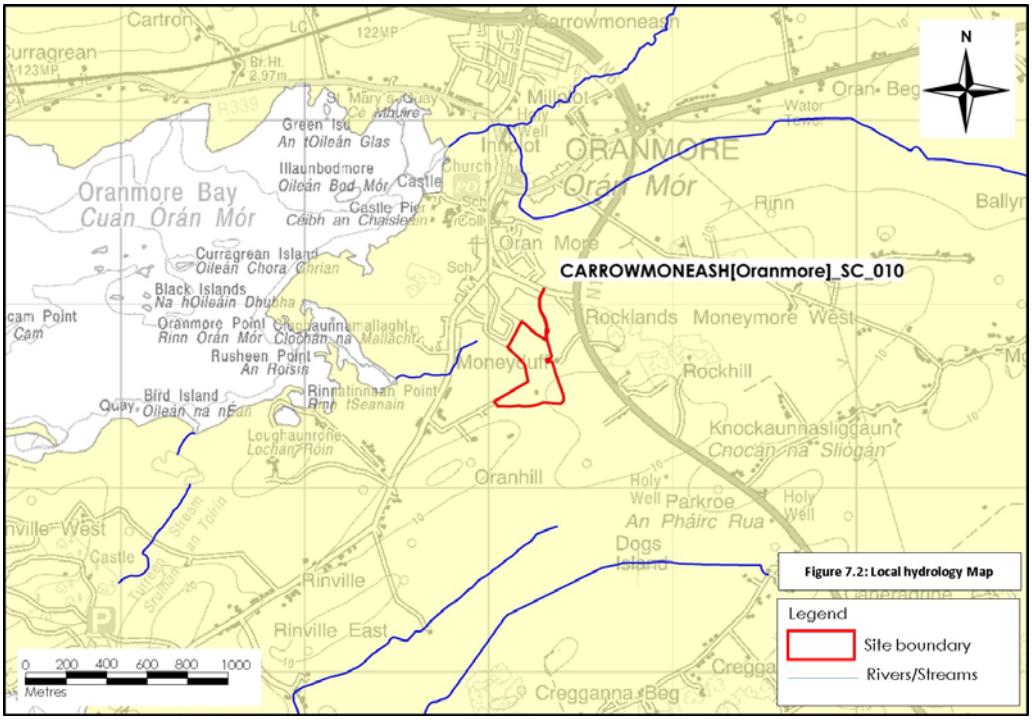


Figure 7.2 Local Hydrology

7.3.4 Site Drainage

In the field to the west of the proposed development site, the soil was poorly drained and wet underfoot. This field is influenced by the Millplot Stream and artificial drainage channels that cross the site. The Millplot Stream and field drains all drain to a single culvert under the road on the site's western boundary. All channel banks showed evidence of scouring from machinery shovels suggesting they are actively maintained. There was evidence of seaweed on the banks of the Millplot Stream and a

nearby field drain indicating a tidal influence on both. High tides occurred in Galway bay area in the days preceding the site inspection (January 2018).

The Millplot Stream enters this area on the northern boundary from a neighbouring construction site. On the day of the site visit, the stream showed adequate capacity to manage flow within its channel. The stream channel is approximately 3m wide and the height varied from 0.7m to 1.2m, with a bank full width of 4-5m.

A possible spring was observed on the northern boundary of this property. This is consistent with the historic 25" OS map that indicates a spring in this part of the site.

The Proposed Development site is separated from the western, flood-affected land by a stone wall. Generally, the fields within the proposed site were better drained and firmer underfoot than the western field, but still contained some waterlogged areas.

Mounds of existing rock-based fill appear to influence the direction of runoff to some degree in this area of the site, with higher land to the east and lower land to the west. Ultimately the natural topography of the land, underlying the existing artificial fill, follows the same slope from east to west.

No field drains or channels were observed in this area and the surrounding residential land on the northern boundary of these fields, and land and road on the southern boundary are significantly higher (~1.3m on northern side and ~2m on southern side) than the proposed development site.

The lowers parts of this area, on the eastern side of the stone wall that separates it from the larger western field, is where ponding was observed.

In the proposed development site, there are no relevant surface water features. In addition, there was no evidence of tidal influences such as the seaweed debris line seen in the western field. As such, the most relevant source of flooding in this section of the site is pluvial/surface runoff.

7.3.5 Flood Risk Identification

To identify those areas as being at risk of flooding OPW's indicative river and coastal flood map (www.floodmaps.ie), CFRAM Preliminary Flood Risk Assessment (PFRA) maps (www.cfram.ie), Department of Environment, Community and Local Government on-line planning mapping (www.myplan.ie) and historical mapping (*i.e.* 6" and 25" base maps) were consulted.

There is no identifiable map text on local available historical 6" or 25" mapping for the study area that identify lands that are "prone to flooding".

There are no recurring flood incidents within the study area boundary according to the OPW's flood mapping. There are no areas within the study area mapped as "Benefiting Lands". Benefiting lands are defined as a dataset prepared by the Office of Public Works identifying land that might benefit from the implementation of Arterial (Major) Drainage Schemes (under the Arterial Drainage Act 1945) and indicating areas of land subject to flooding or poor drainage.

The OPW PFRA map for the area, Map no. 210 (www.cfram.ie/pfra/interactive-mapping/), indicates that there are areas of the proposed site, on the western boundary, within the indicative 200-year coastal flood zone (i.e. Flood Zone A) and 1000-year coastal flood zone (i.e. Flood Zone B). Land to the west of the proposed site

is located within the indicative Flood Zone A. The PFRA mapping reflects the close proximity of the site to Oranmore Bay and the fact that the topography of the land between Oranmore Bay and the proposed development site is relatively flat.

No areas within the proposed site are located in the indicative 100-year fluvial or pluvial flood zones (Flood Zone A) or the 1000-year fluvial or pluvial flood zone (Flood Zone B).

Where complete the Catchment Flood Risk Assessment and Management (CFRAM) OPW Flood Risk Assessment Maps are now the primary reference for flood risk planning in Ireland and supersede the PFRA maps. CFRAM mapping has been completed for the area of the proposed site.

The CFRAM mapping shows that the proposed development site is outside the 10-year Tidal Flood Extent. Large sections of the land to the west of the proposed development site are located within the 10-year Tidal Flood Extent but owing to higher land within the development site, the flood extent does not encompass this land to the east. Furthermore, no areas within the proposed development site are located in the 200-year flood level (Flood Zone A) or the 1000-year flood level (Flood Zone B). As such, the entire proposed development site is located in Flood Zone C.

Refer to attached Appendix 7-1 which includes a Stage 2 Flood Risk Assessment for the proposed development site.

7.3.6 Surface Water Hydrochemistry

Q-rating status data is not available for the Millplot Stream as no EPA monitoring points exist on this watercourse. No watercourses or field drains exist within the Proposed Development site to determine surface water hydrochemistry.

7.3.7 Hydrogeology

Dinantian Pure Bedded Limestones (DPBL), which are mapped to underlie the Proposed Development site are classified by the GSI (www.gsi.ie) as a Regionally Important Aquifer – Karstified (conduit). A bedrock aquifer map is shown as Figure 7.3.

This bedrock type has typically high transmissivity and low storativity with lower gradients closer to the coast.

Groundwater flow occurs along fissures, faults, joints and bedding planes. Rapid groundwater flow velocities indicate a large proportion of groundwater flow occurs in enlarged conduit systems (GSI, 2004).

Groundwater flow directions are generally to the west but as flow pathways are often determined by discrete conduits, actual flow directions will not necessarily be perpendicular to the assumed water table contours (GSI, 2004).

There is a high degree of interaction between surface water and groundwater. Prior to drainage, streams sank underground via the sinks within turloughs, approximately 5-15 km from the coast, before being discharged as springs on the coast (GSI, 2004).

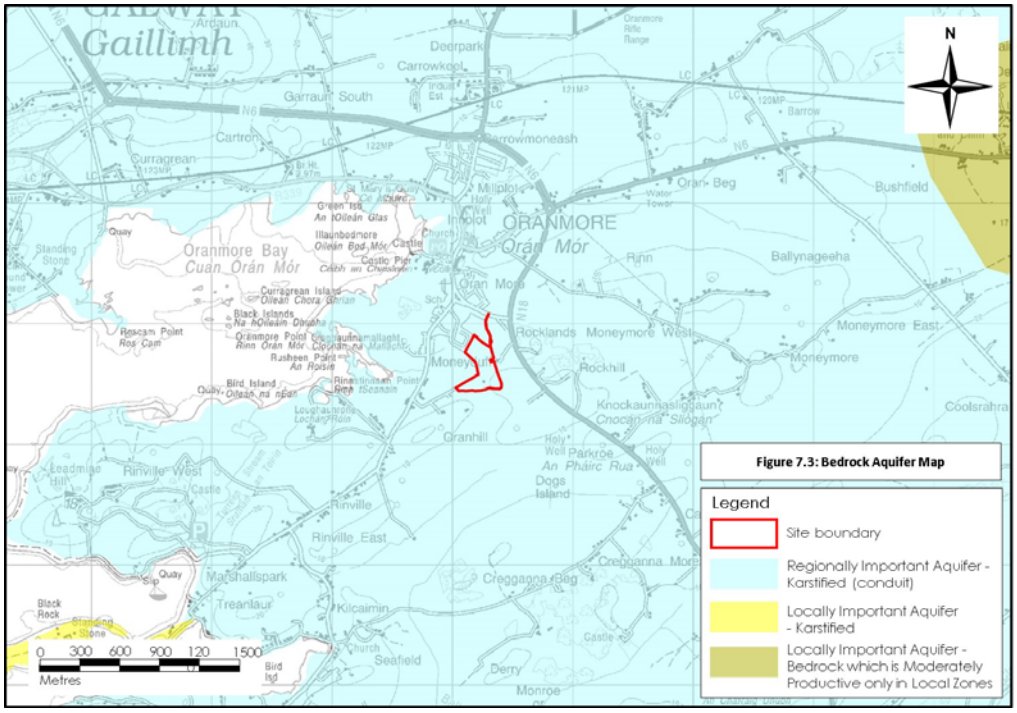


Figure 7.3 Bedrock Aquifer Map

7.3.8 Groundwater Vulnerability

The vulnerability rating of the aquifer within the overall site is classified as "Extreme (X –rock at/near surface)".

Due to the relatively high permeability nature of the bedded limestone bedrock aquifer underlying the site and the highly karstified nature of the bedrock, there is a higher potential for groundwater dispersion and movement within the aquifer and aquifer vulnerability should be considered in the mitigation measures for the site.

7.3.9 Groundwater Hydrochemistry

There are no groundwater quality data for the proposed development site and groundwater sampling would generally not be undertaken for this type of development in terms of EIAR reporting as groundwater quality impacts would not be anticipated. There are also no proposed discharges to ground. The WFD status for the local groundwater body in terms of water quality is Good and therefore this is assumed to be the baseline condition for groundwater in the area of the proposed development.

Based on data from GSI publication Calcareous/Non calcareous classification of bedrock in the Republic of Ireland (WFD,2004), alkalinity for this bedrock type generally ranges from 9.6 – 990mg/L while electrical conductivity and hardness were reported to have mean values of 691µS/cm and 339mg/L respectively.

7.3.10 Water Framework Directive Water Body Status & Objectives

Local Groundwater Body and Surface Water Body status and risk result are available from (www.catchments.ie).

The proposed development site predominately drains to the underlying subsoil and aquifer. The Millplot stream drains the land immediately to the west of the site.

The River Water Quality Status (2010 – 2015) for the Millplot Stream is rated as "Unassigned" and has a risk result of "Review".

7.3.11 Groundwater Body Status

Local Groundwater Body (GWB) status information are available (www.catchments.ie). Refer to Figure 7.4 for the location and extent of local groundwater body.

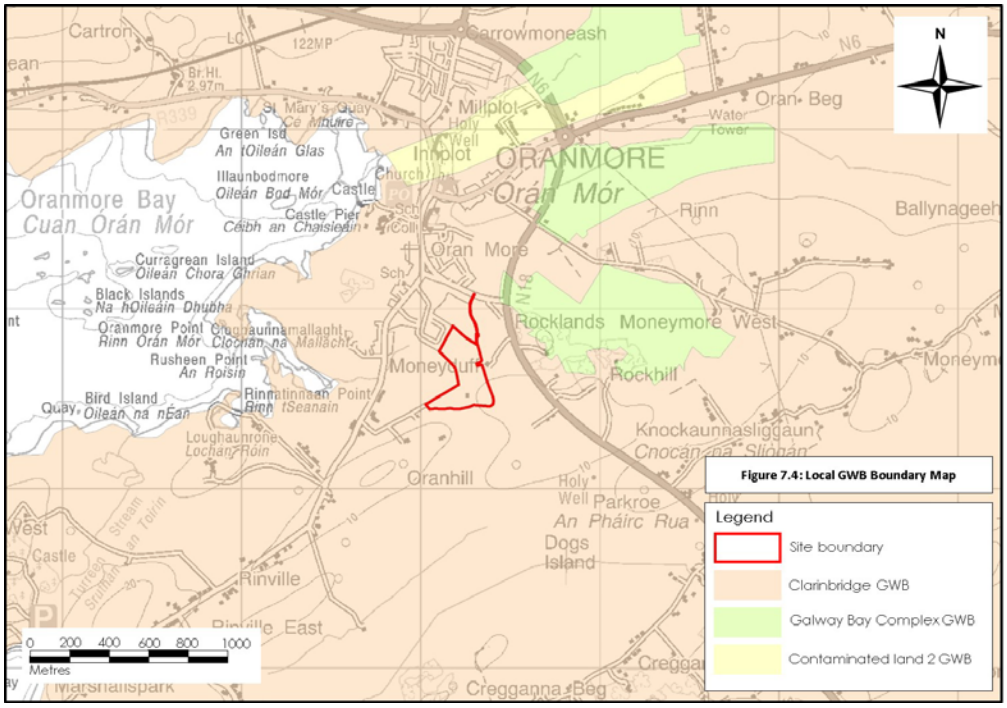


Figure 7.4 Groundwater Bodies

The Clarinbridge GWB (IE_WE_G_0008) which underlies the Proposed Development site is assigned an 'At Risk' status based on the quantitative status and chemical status of the GWB.

7.3.12 Designated Sites & Habitats

Designated sites include National Heritage Areas (NHAs), Proposed National Heritage Areas (pNHAs), Special Areas of Conservation (SACs), candidate Special Areas of Conservation (cSAC) and Special Protection Areas (SPAs).

Immediately to the west of the proposed site is the Galway Bay Complex SAC (Code: 000268), and three additional isolated pockets of the Galway Bay Complex SAC also exists to the east of the proposed development site, on the eastern side of the N18. The Millplot Stream which flows through the land to the west of the site, enters the Inner Galway Bay SPA (Code: 004031) approximately 340m downstream of the proposed site. The Cregganna Marsh SPA/NHA is located south of the proposed Development site. A designated sites map is attached as Figure 7.5.

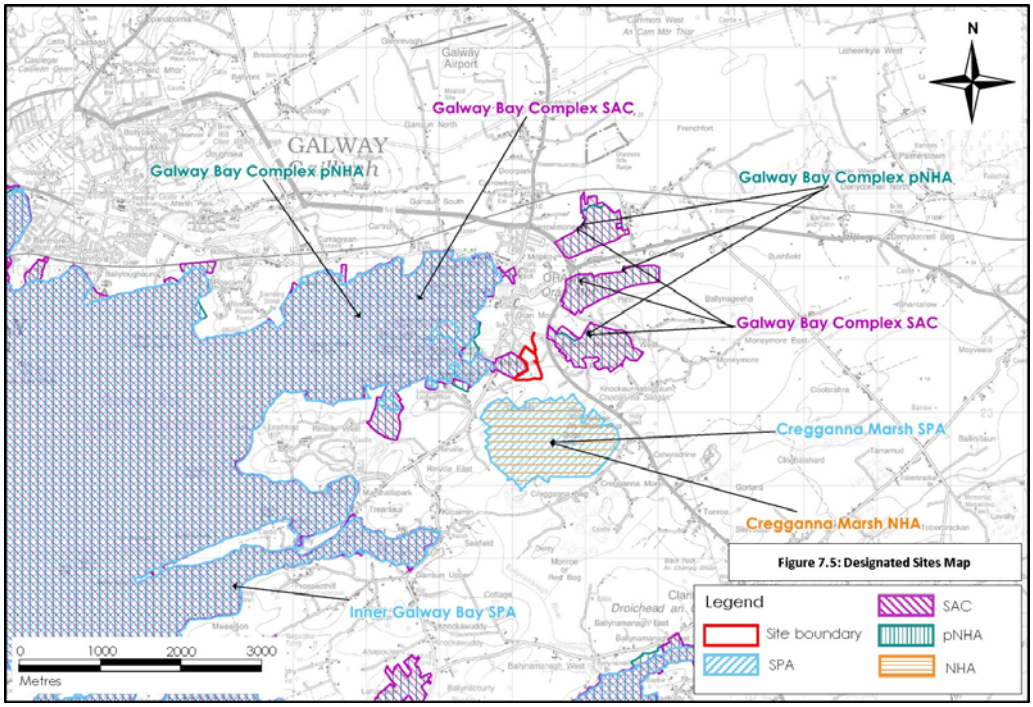


Figure 7.5 Designated Sites

7.3.13 Water Resources

There are no groundwater protection zones mapped within the proposed development site or study area. There are no mapped private well locations (GSI database to accuracy of <50m) within 2km, which were obtained from the GSI well database (www.gsi.ie).

No groundwater wells would be expected in the area, given the proximity to the sea. Notwithstanding this, an assessment of groundwater resources relative to the proposed development is completed below.

7.3.14 Receptor Sensitivity

Due to the nature of residential developments, being near surface construction activities, impacts on groundwater are generally negligible and surface water is generally the main sensitive receptor assessed during impact assessments. The primary risk to groundwater at the site would be from cementitious materials, hydrocarbon spillage and leakages. No interruption of existing groundwater drainage pathways below the site are anticipated due to the shallow nature of excavations within the development. The above are common potential impacts on all construction sites (such as road works and industrial sites). All potential contamination sources are to be carefully managed at the site during the construction and operational phases of the development and mitigation measures are proposed below to deal with these potential minor impacts.

Based on criteria set out in Table 7.1 above, the Regionally Important Karstified Aquifer (*i.e.* Limestone) at the site can be classed as Sensitive to pollution. Also, any contaminants which may be accidently released on-site may also discharge to local surface water drainage and the Millplot stream, and then on into Galway Bay.

The lands to the west of the proposed site are located within the Galway Bay Complex SAC (Code: 000268) and the Millplot Stream flows into the Inner Galway Bay SPA

(Code: 004031) approximately 340m downstream of the proposed site. Three isolated pockets of the Galway Bay SAC also exist to the east of the site, east of the N18.

Comprehensive surface water mitigation and controls are outlined below to ensure protection of all downstream receiving waters during construction and operational phases of the development. Mitigation measures will ensure that surface runoff from the developed areas of the site will be of a high quality and will therefore not impact on the quality of downstream surface water bodies. Any introduced drainage works at the development site will mimic the existing hydrological regime, and discharge will be to ground via soakaways, thereby avoiding changes to surface water flow volumes leaving the site.

7.3.15 Proposed Site infrastructure and Drainage Management

It is proposed that the development will drain via gravity to 5 no. soakaways proposed on site. Water draining to soakaways will pass through silt traps and hydrocarbon interceptors prior to reaching each soakaway. No surface water from roofs or paved surfaces will be discharge from the site, other than via the soakaways to ground.

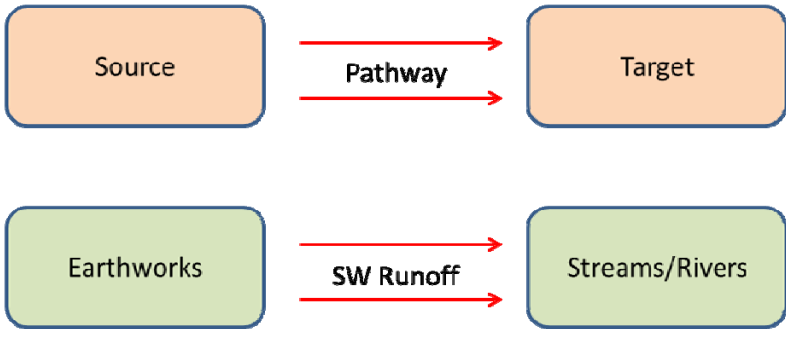
Water supply to the site will be via connection to the adjacent public (Irish Water) watermain.

The proposed on-site foul sewers will discharge by gravity to a pumping station to the west of the site, and the foul waste will discharge from this pumping station via pumped rising main to the adjacent public (Irish Water) foul sewer network.

7.4 Potential Impacts and Mitigation Measures

7.4.1 Overview of Impact Assessment Process

The conventional source-pathway-target model (see below, top) was applied to assess potential impacts on downstream environmental receptors (see below, bottom as an example) as a result of the proposed housing development.



Where potential impacts are identified, the classification of impacts in the assessment follows the descriptors provided in the Glossary of Impacts contained in the following guidance documents produced by the Environmental Protection Agency (EPA):

- Draft Guidelines on the Information to be Contained in Environmental Impact Assessment Reports (EPA, 2017);
- Advice Notes on Current Practice in the Preparation of Environmental Impact Statements (EPA, 2003);
- Guidelines on the Information to be contained in Environmental Impact Statements (EPA, 2002).

The description process clearly and consistently identifies the key aspects of any potential impact source, namely its character, magnitude, duration, likelihood and whether it is of a direct or indirect nature.

In order to provide an understanding of the stepwise impact assessment process applied below (Section 7.4.2 and 7.4.3), we have firstly presented below a summary guide that defines the steps (1 to 7) taken in each element of the impact assessment process. The guide also provides definitions and descriptions of the assessment process and shows how the source-pathway-target model and the EPA impact descriptors are combined.

Using this defined approach, this impact assessment process is then applied to the development construction and operational activities which have the potential to generate a source of significant adverse impact on the geological and hydrological/ hydrogeological (including water quality) environments.

Step 1	Identification and Description of Potential Impact Source This section presents and describes the activity that brings about the potential impact or the potential source of pollution. The significance of effects is briefly described.	
Step 2	**Pathway / Mechanism:**	The route by which a potential source of impact can transfer or migrate to an identified receptor. In terms of housing developments, surface water and groundwater flows are the primary pathways, or for example, excavation or soil erosion are physical mechanisms by which a potential impact is generated.
Step 3	**Receptor:**	A receptor is a part of the natural environment which could potentially be impacted upon, *e.g.* human health, plant / animal species, aquatic habitats, soils/geology, water resources, water sources. The potential impact can only arise as a result of a source and pathway being present.
Step 4	**Pre-mitigation Impact:**	Impact descriptors which describe the magnitude, likelihood, duration and direct or indirect nature of the potential impact before mitigation is put in place.
Step 5	**Proposed Mitigation Measures:**	Control measures that will be put in place to prevent or reduce all identified significant adverse impacts. In relation to housing developments, these measures are generally provided in two types: (1) mitigation by avoidance, and (2) mitigation by engineering design.
Step 6	**Post Mitigation Residual Impact:**	Impact descriptors which describe the magnitude, likelihood, duration and direct or indirect nature of the potential impacts after mitigation is put in place.
Step 7	**Significance of Effects:**	Describes the likely significant post mitigation effects of the identified potential impact source on the receiving environment.

7.4.2 Construction Phase Potential Impacts

7.4.2.1 Earthworks (Removal of Vegetation Cover, Excavations and Stock Piling) Resulting in Suspended Solids Entrainment in Surface Waters

Construction phase activities including site levelling, service trench construction, levelling/construction and building foundation excavation will require earthworks resulting in removal of vegetation cover and excavation of any minor local pockets of organic soil/subsoils, and bedrock. Such excavations will be relatively shallow and temporary. The main risk will be from surface water runoff from bare soil and soil storage areas during construction works.

The site is relatively unique in that there are no adjacent natural or man-made watercourses and surface water generally percolates to ground. However, the construction activities can result in the release of suspended solids to local drainage features and could result in an increase in the suspended sediment load, resulting in increased turbidity which in turn could affect the water quality and fish stocks of downstream water bodies, Oranmore Bay/Galway Bay. This potential impact cannot directly or indirectly effect areas of the Galway Bay SAC east of the N18.

Pathways: Drainage and surface water discharge routes.
Receptors: Down-gradient transitional and water dependent ecosystems.

Pre-Mitigation Impact

Indirect, negative, significant, temporary, likely impact.

Proposed Mitigation Measures

Management of surface water runoff and subsequent treatment prior to release off-site will be undertaken during construction work as follows:

- Prior to the commencement of earthwork silt fencing will be placed down-gradient of the construction areas where drains or drainage pathways are present. These will be embedded into the local soils to ensure all site water is captured and filtered;
- As construction advances there may be a small requirement to collect and treat surface water within the site. This will be completed using perimeter swales at low points around the construction areas, and if required water will be pumped from the swales into sediment bags prior to overland discharge allowing water to percolate naturally to ground or disperse by diffuse flow into local drainage ditches;
- Discharge onto ground will be via a silt bag which will filter any remaining sediment from the pumped water. The entire discharge area from silt bags will be enclosed by a perimeter of double silt fencing;
- Any proposed discharge area will avoid potential surface water ponding areas, and will only be located where suitable subsoils are present;
- No pumped construction water will be discharged directly into any local watercourse;
- Daily monitoring and inspections of site drainage during construction will be completed;
- Earthworks will take place during periods of low rainfall to reduce run-off and potential siltation of watercourses;
- Good construction practices such wheel washers and dust suppression on site roads, and regular plant maintenance will ensure minimal risk. The Construction Industry Research and Information Association (CIRIA) provide guidance on the control and management of water pollution from construction sites ('Control of Water Pollution from Construction Sites, guidance for consultants and contractors', CIRIA, 2001), which provides information on these issues. This will ensure that surface water arising during the course of construction activities will contain minimum sediment.

Mitigation by Design:
A summary of surface water controls that can be employed during the earthworks and construction phase are as follows:

- Source controls:
  - Interceptor drains, vee-drains, diversion drains, flume pipes, erosion and velocity control measures such as use of sand bags, oyster bags filled with gravel, filter fabrics, and other similar/equivalent or appropriate systems.
  - Small working areas, covering stockpiles, weathering off stockpiles, cessation of works in certain areas or other similar/equivalent or appropriate measures.
- In-Line controls:
  - Interceptor drains, vee-drains, oversized swales, erosion and velocity control measures such as check dams, sand bags, oyster bags, straw bales, flow limiters, weirs, baffles, silt bags, silt fences, sedimats, filter fabrics, and collection sumps, temporary sumps/attenuation lagoons, sediment traps, pumping systems, settlement ponds, temporary pumping chambers, or other similar/equivalent or appropriates systems.
- Treatment systems:
  - Temporary sumps and attenuation ponds, temporary storage lagoons, sediment traps, and settlement ponds, and proprietary settlement systems such as Siltbuster, and/or other similar/equivalent or appropriate systems.

Silt Fences:
Silt fences will be placed up-gradient of all drains where construction is proposed. Silt fences are effective at removing heavy settleable solids. This will act to prevent entry to watercourses of sand and gravel sized sediment, released from excavation of mineral sub-soils of glacial and glacio-fluvial origin, and entrained in surface water runoff. Inspection and maintenance of these structures during construction phase is critical to their functioning to stated purpose. They will remain in place throughout the entire construction phase.

Silt Bags:
Silt bags will be used where small to medium volumes of water need to be pumped from excavations or swales. As water is pumped through the bag, most of the sediment is retained by the geotextile fabric allowing filtered water to pass through. Silt bags will be used with natural vegetation filters.

Residual Impact

Indirect, negative, slight, temporary, medium probability impact on downstream surface waters.

Significance of Effects

No significant impacts on surface water quality are expected due to site excavation work. There is limited hydraulic connectivity between the site and watercourses and mitigation measures will be employed on a precautionary basis.

7.4.2.2 Potential Surface Water Quality Impacts from Shallow Excavation Dewatering

Some groundwater seepages will likely occur in foundation excavations and especially where more permeable weathered bedrock are encountered. Dewatering will create additional volumes of water to be treated by the runoff management system. Inflows will likely require management and treatment to reduce suspended sediments. No contaminated land was noted at the site and therefore historical pollution sources are not anticipated. Such works will be temporary.

Pathway: Overland flow and site drainage network.
Receptor: Down-gradient surface water bodies.

Pre-Mitigation Impact
Indirect, negative, moderate, temporary, medium probability impact to surface water quality.

Impact Assessment

Management of excavation seepages and subsequent treatment prior to discharge into the site drainage network will be undertaken as follows:

- Appropriate interceptor drainage, to prevent upslope surface runoff from entering excavations will be put in place if required;
- The interceptor drainage will be discharged to the site constructed drainage system or onto natural vegetated surfaces and not directly to surface waters;
- If required, pumping of excavation inflows will prevent build-up of water in the excavation;
- The pumped water volumes will be discharged via volume and sediment attenuation ponds adjacent to excavation areas, or via silt bags;
- There will be no direct discharge to the on-site main drains, and therefore no risk of hydraulic loading or contamination will occur; and,
- Daily monitoring of excavations by a suitably qualified person will occur during the construction phase. If high levels of seepage inflow occur, excavation work should immediately be stopped and a geotechnical assessment undertaken.

The temporary nature of such works (if they are required), and also the limited shallow depth of any such requirement will not affect the local hydrological regime, the level of the water table, nor the throughflow of shallow or deeper groundwater flow below the development site.

Residual Impact

Indirect, negative, slight, temporary, low probability impact on downstream surface waters.
No impact on groundwater levels or groundwater quality.

Significance of Effects

No significant impacts on surface water quality, groundwater levels or groundwater quality are expected due to excavation dewatering.

7.4.2.3 Potential Release of Hydrocarbons during Construction Stage

Accidental spillage during refuelling of construction plant with petroleum hydrocarbons is a significant pollution risk to groundwater, surface water and associated ecosystems, and to terrestrial ecology. The accumulation of small spills of fuels and lubricants during routine plant use can also be a pollution risk.

Hydrocarbon has a high toxicity to humans, and all flora and fauna, including fish, and is persistent in the environment. It is also a nutrient supply for adapted micro-organisms, which can rapidly deplete dissolved oxygen in waters, resulting in death of aquatic organisms.

Pathway: Groundwater flowpaths and site drainage network.
Receptor: Groundwater and surface water.

Pre-Mitigation Impact
Indirect, negative, slight, short term, likely impact to local groundwater quality.
Indirect, negative, significant, short term, unlikely impact to surface water quality.

Proposed Mitigation Measures:

Mitigation by Design:

- On site re-fuelling of machinery will be carried out using a mobile double skinned fuel bowser. The fuel bowser, a double-axel custom-built refuelling trailer will be re-filled off site and will be towed around the site by a 4x4 jeep to where machinery is located. The 4x4 jeep will also carry fuel absorbent material and pads in the event of any accidental spillages. The fuel bowser will be parked on a level area in the construction compound when not in use and only designated trained and competent operatives will be authorised to refuel plant on site. Mobile measures such as drip trays and fuel absorbent mats will be used during all refuelling operations;
- Fuels stored on site will be minimised. Any storage areas will be bunded appropriately for the fuel storage volume for the time period of the construction;
- The plant used should be regularly inspected for leaks and fitness for purpose; and,
- An emergency plan for the construction phase to deal with accidental spillages will be contained within Environmental Management Plan. Spill kits will be available to deal with accidental spillages.

Residual Impact

Indirect, negative, imperceptible, temporary, unlikely impact on groundwater and surface water.

Significance of Effects

No significant effects on surface water or groundwater quality are anticipated.

7.4.2.4 Groundwater and Surface Water Contamination from Wastewater Disposal

Release of effluent from on-site wastewater systems has the potential to impact on groundwater and surface waters.

Pathway: Groundwater flowpaths and site drainage network.
Receptor: Down-gradient well supplies, groundwater quality and surface water quality.

Pre-mitigation Impact
Indirect, negative, significant, temporary, unlikely impact to surface water quality.
Indirect, negative, slight, temporary, unlikely impact to local groundwater.

Proposed Mitigation Measures

Mitigation by Avoidance:

- A self-contained port-a-loo with an integrated waste holding tank will be used at the site compounds, maintained by the providing contractor, and removed from site on completion of the construction works;
- No wastewater will be discharged on-site during either the construction or operational phase.

Residual Impact

No impact.

Significance of Effects

No significant effects on surface water or groundwater quality are anticipated.

7.4.2.5 Release of Cement-Based Products

Concrete and other cement-based products are highly alkaline and corrosive and can have significant negative impacts on water quality. They generate very fine, highly alkaline silt (pH 11.5) that can physically damage fish by burning their skin and blocking their gills. A pH range of ⩾ 6 ⩽ 9 is set in S.I. No. 293 of 1988 Quality of Salmonid Water Regulations, with artificial variations not in excess of ± 0.5 of a pH unit. Entry of cement based products into the site drainage system, into surface water runoff, and hence to surface watercourses or directly into watercourses represents a risk to the aquatic environment.

Pathway: Site drainage network.
Receptor: Surface water and transitional water hydrochemistry.

Pre-Mitigation Impact
Indirect, negative, moderate, short term, likely impact to surface water.

Proposed Mitigation Measures

Mitigation by Avoidance:

- No batching of wet-cement products will occur on site. Ready-mixed supply of wet concrete products and where possible, emplacement of pre-cast elements, will take place;
- No washing out of any plant used in concrete transport or concreting operations will be allowed on-site;
- Where concrete is delivered on site, only the chute need be cleaned, using the smallest volume of water possible. No discharge of cement contaminated waters to the construction phase drainage system or directly to any artificial drain or watercourse will be allowed. Chute cleaning water is to be tanked and removed from the site to a suitable, non-polluting, discharge location;
- Use weather forecasting to plan dry days for pouring concrete; and,
- Ensure pour site is free of standing water and plastic covers will be ready in case of sudden rainfall event.

Residual Impact

Negative, Indirect, imperceptible, short term, likely impact.

Significance of Effects

No significant effects on surface water quality are anticipated.

7.4.2.6 Potential Impacts on Hydrologically Connected Designated Sites

The lands to the west of the proposed site are located within the Galway Bay Complex SAC (Code: 000268) and the Millplot Stream flows into the Inner Galway Bay SPA (Code: 004031) approximately 340m downstream of the proposed site. Three isolated pockets of the Galway Bay SAC are also located to the east of the N18 (refer to Figure 7.5). A hydrogeological conceptual site model (CSM) is presented as Figure 7.6. this shows the interpreted shallow and deep groundwater flowpaths below the development site. This CSM has been used to assess impact on the SAC east and west of the site.

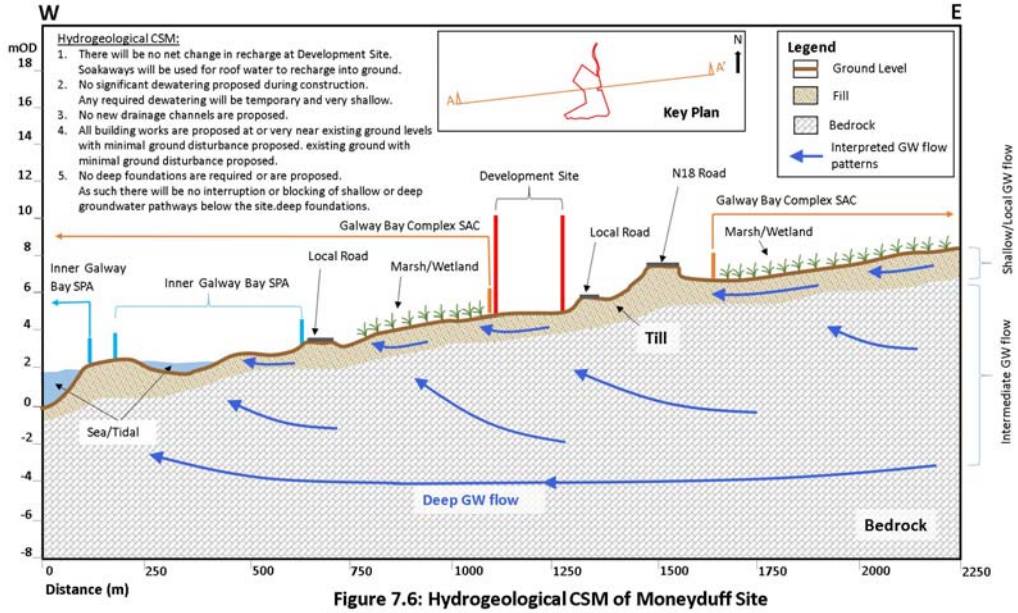


Figure 7.6: Hydrogeological CSM of Moneyduff Site

Figure 7.6 Hydrogeological Conceptual Site Model

Possible effects during the construction phase include water quality impacts which could be significant if mitigation is not put in place.

There will be no impacts on the local hydrological regime during the construction phase for the following reasons:

- There will be no net change in recharge at Development Site. Soakaways will be used for roof water to recharge into ground.
- No significant dewatering is proposed during construction. Any pumping required will be temporary and at a very shallow depth.
- No new drainage channels are proposed.
- All building works are proposed at or very near existing ground levels with minimal ground disturbance proposed.
- No deep foundations are required or are proposed. As such there will be no interruption or blocking of shallow or deep groundwater pathways below the site.

Groundwater flowpaths will be maintained as any excavation proposed will be shallow, and any required dewatering during construction will also be shallow and temporary in nature. Groundwater flowpaths from east to west below the site will be unaltered by the proposed development. There will be no direct or indirect impacts on the existing fens to the east of the N18 (which are part of the Galway Bay SAC).

For similar reasons as outlined above there will be no effect on the hydrological regime, water levels or water quality at the Cregganna Marsh SPA/NHA located to the south of the proposed Development site

Pathway: Surface water and groundwater flowpaths.
Receptor: Down-gradient water quality and hydrological regime of designated sites.

Pre-Mitigation Impact
Indirect, negative, moderate, long term, likely impact to surface water and groundwater quality.
No impacts on groundwater levels or existing hydrological regime or flowpaths.

Proposed Mitigation Measures
The proposed mitigation measures for protection of surface water quality which will include on site drainage control measures (i.e. silt fences, silt bags etc) will ensure that the quality of runoff from proposed development areas will be very high. As outlined above controls will also be put in place to manage risks associated with hydrocarbons/chemicals and cement based products used during construction phase.

All surface water arising on site will drain via soakaways to ground, with no proposed outfall. Groundwater quality risks are reduced during the operational phase by use of hydrocarbon interceptors and silt traps prior to discharge to the soakaways.

Residual Impact

No impacts on water quality or downstream designated sites are anticipated.
No impacts on groundwater levels or existing hydrological regime or groundwater flowpaths relating to the Galway Bay SAC and Cregganna Marsh SPA/NHA.

Significance of Effects

No significant impacts on groundwater or surface water quality and downstream designated sites are anticipated.
No significant impacts on groundwater levels, existing hydrological regime, or groundwater flowpaths relating to upstream or dowmstream areas of the Galway Bay SAC, or Cregganna Marsh SPA/NHA.

7.4.3 Operational Phase Impacts

7.4.3.1 Potential Increased Downstream Flood Risk due to Increased Hardstanding Area

Replacement of the greenfield surface with hardstand surfaces will result in an increased risk of pluvial flooding due to low permeability surfaces which will inhibit any downward percolation of rainwater.

All surface water arising on site will drain via soakaways to ground, with no proposed outfall.

Pathway: Site surface water drainage network.
Receptor: Groundwater aquifer.

Pre-Mitigation Impact
Direct, negative, slight, long term, low probability impact.

Proposed Mitigation Measures

The risk of pluvial flooding is minimised by using soakaways for drainage management.

Water quality risks are reduced by use of hydrocarbon interceptors and silt traps.

Residual Impact

Direct, negative, imperceptible, long term, low probability impact in relation to flood risk.
Direct, negative, imperceptible, long term, low probability impact in relation to groundwater quality.

Significance of Effects

No significant impacts in terms of flooding or water quality are expected due to the proposed development.

7.4.3.2 Potential Impacts on Hydrologically Connected Designated Sites

The lands to the west of the proposed site are located within the Galway Bay Complex SAC (Code: 000268) and the Millplot Stream flows into the Inner Galway Bay SPA (Code: 004031) approximately 340m downstream of the proposed site. Three isolated pockets of the Galway Bay SAC are also located to the east of the N18 (refer to Figure 7.5). A hydrogeological conceptual site model (CSM) is presented as Figure 7.6. this shows the interpreted shallow and deep groundwater flowpaths below the development site. This CSM has been used to assess impact on the SAC east and west of the site.

Possible effects during the operational phase continue to include water quality impacts which could be significant if ongoing mitigation is not put in place.

There will be no impacts on the local hydrological regime during the operational phase of the development for the following reasons:

- There will be no net change in recharge at Development Site. Soakaways will be used for roof water to recharge into ground.
- No dewatering will occur during the operational phase of the development.
- No new drainage channels are proposed.
- All building works will be complete and will have been installed at or very near existing ground levels with minimal ground disturbance having occurred.
- No deep foundations will have been installed. As such there will be no interruption or blocking of shallow or deep groundwater pathways below the site during the operational phase.

Groundwater flowpaths will be maintained during the operational phase as any excavation proposed will be shallow. Groundwater flowpaths during the operational phase from east to west below the site will be unaltered by the proposed development. During the operational phase there will be no direct or indirect impacts on the existing fens to the east of the N18 (which are part of the Galway Bay SAC).

During the operational phase, and for similar reasons as outlined above there will be no effect on the hydrological regime, water levels or water quality at the Cregganna Marsh SPA/NHA located to the south of the proposed Development site

Pathway: Surface water and groundwater flowpaths.

Receptor: Down-gradient water quality and hydrological regime of designated sites.

Pre-Mitigation Impact

Indirect, negative, moderate, long term, likely impact to surface water and groundwater quality.
No impacts on groundwater levels or existing hydrological regime or flowpaths.

Proposed Mitigation Measures

During the operational phase all surface water arising on site will drain via soakaways to ground, with no proposed outfall. Groundwater quality risks are reduced during the operational phase by use of hydrocarbon interceptors and silt traps prior to discharge to the soakaways.

Residual Impact

No impacts on water quality or downstream designated sites are anticipated.
No impacts on groundwater levels or existing hydrological regime or groundwater flowpaths relating to the Galway Bay SAC and Cregganna Marsh SPA/NHA.

Significance of Effects

No significant impacts on groundwater or surface water quality and downstream designated sites are anticipated.
No significant impacts on groundwater levels, existing hydrological regime, or groundwater flowpaths relating to upstream or dowmstream areas of the Galway Bay SAC, or Cregganna Marsh SPA/NHA.

7.4.4 Assessment of Potential Health Effects

Potential health effects are associated with negative impacts on public and private water supplies and potential flooding. There are no mapped public supply group water scheme groundwater protection zones in the area of the proposed housing site.

The proposed site design and mitigation measures outlined in the previous subsections ensures that the potential for impacts on the water environment are not significant

The flood risk assessment for the development has also shown that the risk of the proposed housing development contributing to downstream flooding is also very low, and also that the risk of inundation of the houses within the site post construction is very low due to the proposed design floor levels and site layout.

7.4.5 Do Nothing Scenario

Current land use (grassing/agriculture/scrub) will continue. Surface water drainage and infiltration to ground will continue as is occurring currently with no impact on either surface or groundwater.

7.4.6 Worst Case Scenario

Contamination of surface water streams during the construction and operational phases, which in turn could affect the ecology and quality of the downstream water bodies such as Millplot stream and Galway Bay. Also, potentially localised groundwater contamination may occur. However, measures will be put in place to prevent this from happening.

7.4.7 Cumulative Impacts

There are four other proposed housing developments in the locality[1].

No significant cumulative impacts on the water environment are anticipated during the construction or operation phases as long as mitigation measures outlined are put in place.

7.4.8 Conclusion

The site is naturally separated from any local watercourses, and this setback distance means that there is limited potential for impact on water quality or the downstream designated sites.

Notwithstanding this, during each phase of the proposed housing development at Moneyduff (construction and operation) a number of activities will take place on the proposed development site, some of which will have the potential to affect the hydrological regime or water quality at the site or its vicinity. These potential impacts generally arise from sediment input from runoff and other pollutants such as hydrocarbons and cement based compounds, with the former having the most potential for impact during the construction phase.

Surface water drainage measures, pollution control and other preventative measures have been incorporated into the project design to minimise significant adverse impacts on water quality and downstream designated sites.

The surface water drainage plan will focus on silt management using silt fences, and silt bags, and to control runoff rates. The key surface water control measure is that there will be no direct discharge of development runoff into local watercourses. This will be achieved by avoidance methods and design methods (*i.e.* surface water drainage to soakaways).

Preventative measures during construction include fuel and concrete management and a waste management plan which will all be incorporated into the Construction and Environmental Management Plan (Refer to Appendix 3-2).

Overall the proposal presents no significant impacts to surface water and groundwater quality provided the proposed mitigation measures are implemented.

There will be no net impact on the local hydrological regime, groundwater levels, or groundwater flowpaths during the construction and operational phase of the proposed development. There will be no direct or indirect hydrological impacts on the

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[1] **Residential Development Oranhill – Pl Ref 15/1107 / ABP Ref PL 07.246315**
Thomas Considine, Patrick Sweeney and Ronnie Greene applied to Galway County Council for planning permission for development of 68 two storey houses and associated works. An Bord Pleanála granted permission for the development following a third party appeal on the 25th July 2018 subject to 17 no. conditions. The site adjoins the proposed development to the south.

Residential Development Oranhill – Pl Ref 09/1925/ ABP PL 07.237219
James Cannon applied for permission to Galway County Council for development of a proposed hotel and 161 no. units. The development was granted by An Bord Pleanála. The permission was extended by Roykeel Ltd, Brian and Fidelma Loughran under Pl Ref 15/1334. The site adjoins the proposed development to the east.

Residential Development Moneyduff – Pl Ref 09/2055 / ABP PL 07.237409
Pat and Liam Malone applied to Galway County Council for permission for 38 no. dwelling units and associated works. An Bord Pleanála granted permission following a third party appeal on 22/05/2018 subject to 13 no. conditions. The permission was extended under Pl Ref 17/980. The site is located approximately 130m to the north west of the proposed development.

Residential Development Frenchfort – Pl Ref 17/1268
Ardstone Homes applied to Galway County Council for permission to construct 86 no. units and associated works. Galway County Council issued notification of their decision to grant the development subject to 19 conditions on 7th June 2018. The site is located approximately 1km north of the proposed development.

fens (which form part of the Galway Bay SAC) east of the N18. There will be no direct or indirect hydrological impacts on the Cregganna Marsh SPA/NHA.
No significant cumulative impacts on groundwater or designated sites are anticipated.