9 SOILS, GEOLOGY AND HYDROGEOLOGY

9.1 Introduction

This chapter provides an assessment of the potential effects that may arise from the proposed development at Hollywood Great, Nag's Head, Naul, Co. Dublin with respect to soils, geology and hydrogeology.

The chapter provides a description of the site and its immediate environs in terms of soils, geology and hydrogeology in light of the comprehensive ground investigation and monitoring data gathered for the site in recent years. It is against this robust baseline evidence base those potential future effects are assessed.

The local soils, geology and hydrogeology is inter-related with the local hydrology, drainage and biodiversity for the site. Further details on these topics can be found in **Chapter 8** (Biodiversity) and **Chapter 10** (Water) of this EIAR.

This chapter of the EIAR should be read in conjunction with the supporting documentation provided in **Volume IV** of this EIAR. In particular the following documents are included in this volume:

- A Hydrogeological Assessment report which addresses the hydrological concern and uncertainty identified in the EPA's 2016 decision notice to refuse permission for the licence application. The report supports this chapter of the EIAR and presents the detailed hydrogeological investigations that have been undertaken at the site to present an updated conceptual site model of the site for the proposed development. The report presents a clear evidence base that the proposed development at the Hollywood site will not have an adverse impact on hydrogeology in the area.
- A LandSim Report on the application of the LandSim model, an interactive programme used to model new and existing landfills. LandSim is used to track leachate production, chemistry, migration and leakage through structures assessing the potential of leachate migration to the underlying aquifer. The LandSim model uses the site-specific input parameters at the Hollywood facility to assess the impact of the proposed development.

All other supporting information on soils, geology and hydrogeology are included in **Volume IV** of the EIAR.

9.2 Legislative and Policy Framework

The principal legislation relevant to the chapter is set out in the following primary European legislation:

- Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy (Water Framework Directive);
- Directive 2006/118/EC of the European Parliament and of the Council of 12 December 2006 on the protection of groundwater against pollution and deterioration (daughter to 2000/60/EC) (Groundwater Daughter Directive); and
- Directive 2013/39/EU of the European Parliament and of the Council of 12 August 2013, amending Directives 2000/60/EC and 2008/105/EC as regards priority substances in the field of water policy.

The implementation of the Water Framework Directive (WFD) has resulted in the repeal and/or replacement of other European legislation of relevance to consideration of the water environment. Most notably, this includes the following:

- The Groundwater Directive (80/68/EEC), repealed in 2013; and
- The Dangerous Substances Directive (76/464/EEC), repealed in 2013.

A brief summary of the relevant guidance and legislation is provided in this section.

9.2.1 Water Framework Directive 2000/60/EC

The EU Water Framework Directive 2000/60/EC (WFD) came into force in December 2000 and its primary objective is for all waters to achieve ‘good’ ecological status by 2015. The WFD also promotes the sustainable use of water resources, defines a management and reporting system based on River Basin Districts (RBDs) and sets environmental objectives which take account of the full range of pressures on the aquatic environment (including pollution, abstraction, flow regulation, habitat impact, etc.).

9.2.2 Groundwater Directives 80/68/EEC and 2006/118/EC

The Groundwater Directive 2006/118/EC establishes a regime which sets groundwater quality standards and introduces measures to prevent or limit inputs of pollutants into groundwater. The Directive establishes quality criteria that takes account local characteristics and allows for further improvements to be made based on monitoring data and new scientific knowledge. The Directive thus represents a proportionate and scientifically sound response to the requirements of the WFD as it relates to assessments on chemical status of groundwater and the identification and reversal of significant and sustained upward trends in pollutant concentrations.

The Groundwater Directive complements the WFD and requires:

- Groundwater quality standards to be established by the end of 2008;
- Pollution trend studies to be carried out by using existing data and data which is mandatory by the WFD (referred to as ‘baseline level’ data obtained in 2007-2008);
- Pollution trends to be reversed so that environmental objectives are achieved by 2015 by using the measures set out in the WFD;
- Measures to prevent or limit inputs of pollutants into groundwater to be operational so that WFD environmental objectives can be achieved by 2015;
- Reviews of technical provisions of the directive to be carried out in 2013 and every six years thereafter; and
- Compliance with good chemical status criteria (based on EU standards of nitrates and pesticides and on threshold values established by Member States).

The Directive 80/68/EEC on the protection of groundwater against pollution caused by certain dangerous substances has provided a groundwater protection framework before the Directive 2006/118/EC. It was required to prevent the (direct or indirect) introduction of high priority pollutants into groundwater and to limit the introduction into groundwater of other pollutants so as to avoid pollution of groundwater by these substances. This Directive was repealed in 2013.

Annexes I and II of the Groundwater Directive 2006/118/EC were reviewed in 2013 and are reflected under the Commission Directive 2014/80/EU in June 2014.

9.2.3 Landfill Directive 1999/31/EC

The Landfill Directive (Directive 1999/31/EC on the landfill of waste) sets out detailed rules on waste landfills, including non-hazardous and inert landfills. Article 6 details the waste to be accepted in the different classes of landfill and the relevant classes. Council Decision (2003/33/EC) establishes criteria and procedures for the acceptance of waste at landfills pursuant to Article 16 of, and Annex II to, the Landfill Directive.

9.2.4 European Communities Environmental Objectives (Groundwater) Regulations 2009 (S.I. No. 9 of 2010)

The purpose of the European Communities Environmental Objectives (Groundwater) Regulations is to transpose the requirements of the WFD and Groundwater Directive 2006/118/EC into National legislation and provide for transitional arrangements from the old Groundwater Directive (80/68/EEC). These regulations have been transposed into national legislation through the Environmental Objectives (Groundwater) Regulations 2010 (S.I. No. 9 of 2010) and Environmental Objectives (Groundwater) Amendment) Regulations 2016 (S.I. No. 366 of 2016). These Regulations aim to:

- Establish a new strengthened regime for the protection of groundwater in line with the requirements of the Water Framework Directive (2000/60/EC) and by the Groundwater Directive (2006/118/EC);
- Establish clear Environmental Objectives, Groundwater Quality Standards and Threshold Values for the classification of groundwater and the protection against pollution and deterioration; and
- The Regulations also introduce the legal basis for a more flexible, proportionate and risk-based approach to implementing the legal obligation to prevent or limit inputs of pollutants into groundwater which already exists under the old Groundwater Directive (80/69/EEC).

9.2.5 Relevant Guidance

This chapter has had due regard to relevant guidelines that include the following:

- Environmental Protection Agency (EPA, 2011). Guidance on the Authorisation of Discharges to Groundwater;
- Environmental Protection Agency (EPA, 2006). EPA Landfill Manuals. Manual on site selection, draft for consultation;
- Geological Survey of Ireland (GSI, 1999). Groundwater Protection Responses for Landfills;
- Institute of Geologists of Ireland (September 2002). 'Geology in Environmental Impact Statements – a Guide';
- National Roads Authority (NRA, 2008). 'Environmental Impact Assessment of National Road Schemes – A Practical Guide';
- National Roads Authority (NRA, 2009). 'Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes';
- Environmental Protection Agency (EPA, 2010). Classification of Hazardous and Non-Hazardous Substances in Groundwater;
- Environmental Protection Agency (EPA, 2013). Guidance on the Management of Contaminated Land and Groundwater at EPA Licensed Sites; and
- The Model Procedures for the Management of Land Contamination (CLR 11).

The Department of the Environment & Local Government (DoELG), EPA and GSI published general guidance regarding the determination of site suitability for non-hazardous wastes (DoELG, EPA and GSI, 1999) to assist the statutory authorities to meet their responsibility to protect groundwater. This guidance document provides a methodology for the preparation of groundwater protection schemes to assist the statutory authorities and others to meet their responsibility to protect groundwater. It incorporates land surface zoning and groundwater protection responses, including the siting or selection of landfills.

9.3 Methodology

The general approach adopted within this impact assessment is as follows:

- Define the appropriate study area required to allow consideration of potential effects;
- Characterise baseline conditions within the study area relevant to the consideration of soils, geology and hydrogeology;
- Consultation; and
- Assessment of significance of effects.

9.3.1 Study Area / Spatial Scope

The potential effect that the proposed development may have on the hydrogeological regime of the site represents the principal consideration for this chapter. To understand the nature of the hydrogeological regime relevant to the Hollywood site, the spatial scope of the study area must be sufficiently large to enable the general hydrogeological setting and associated conceptual hydrogeological model (CSM) to be defined. As such, the study area relevant to consideration of soil, geology and hydrogeology extends outside of the proposed development boundaries, to include the groundwater catchment area in which the site is located. The study area in relation to the hydrogeology is shown in **Figure 9-1** and has been extended to include the Bog of the Ring public water supply situated c. 3km to the northeast of the Hollywood site owing to its general sensitivity.

9.3.2 Baseline Characterisation

The baseline conditions on the Hollywood site and within the study area is characterised with respect to soils, geology and hydrogeology. The baseline has been fully characterised in recent years and therefore includes active landfilling operations authorised on the site through Waste Licence Reg. W0129-02. Baseline conditions relevant to the Hollywood facility have been investigated through multiple phases of work undertaken on the site in the support of this application. The baseline characterisation presented herein has placed reliance on the data gathered in those investigations but interpreted as a whole for this specifically for this application.

To inform baseline characterisation, publicly available information data sources were reviewed to define the regulatory framework pertaining to soils, geology and hydrogeology and this review involved:

- Review of information on the GSI spatial resources website; and
- Review of consultation responses from key stakeholders most notably the Geological Survey of Ireland (GSI).

The following publicly available documents have been reviewed and inform the CSM developed for the site and baseline characterisation of the study area:

- EPA online resources that include Hydronet (EPA Hydronet) and Hydrotool (EPA HydroTool);
- Geological Survey of Ireland publicly available geological and hydrogeological datasets (GSI Public Data Viewer Series);
- Groundwater monitoring of the Bog of the Ring. Final hydrogeological Assessment Report (Fingal County Council, 2006);
- Bog of the Ring: Source Protection Zones (Geological Survey of Ireland, 2005);
- Geological Survey of Ireland National Draft Bedrock Aquifer map (GSI Generalised Bedrock Map);
- GSI Bedrock 3D Model of Dublin (accessible from GSI's website);
- Geological Survey of Ireland (1999). 1:100,000 scale Bedrock Series geology Map Sheet 13;
- Geological Survey of Ireland (19th Century). 1:10,560 scale Bedrock Series geology Map Sheet Dublin 14/2;
- Geological Survey of Ireland (1901). 1:63,360 scale Bedrock Series geology Map Sheet 102 (1901); and
- An Foras Taluntais. Ireland, General Soils Map, Second Edition, Published by the National Soil Survey.

The following site-specific investigation work and associated reporting has informed conceptualisation and baseline characterisation of the study area:

- Arup (2013): MEHL Integrated Waste Facility - Assessment of Hydrogeological Isolation (Bog of the Ring and the MEHL Site);
- Arup (2010): MEHL Integrated Waste Facility - Hydrogeological Quantitative Risk Assessment;
- Jones, G.Ll (2010). Conodate Micropalaeontology report on sample MEHL – 18, 15.2-15.8 m, The Naul, Co. Fingal;
- APEX (2010). Report on the Geophysical Survey at the MEHL Integrated Waste Facility Site in Naul, Co. Dublin;
- Site investigation report: IGSL (2010) Ground Investigation Factual report on MEHL Integrated Waste Management Facility;

- Patel Tonra (2010). Historic groundwater level and quality monitoring data;
- Minerex (2010) Well survey report;
- Jones, G.Ll. (2009). Conodate Report on the geology of the landfill site Hollywood, Naul, Co. Fingal; and
- Borehole logs and well records for monitoring wells drilled as part of the current EPA waste licence.

Condition 6 and Schedule C of Waste License Reg. W0129-02 define the scope of environmental monitoring delivered by the site operator to demonstrate that effect that current operations have upon the local environment. The following monitoring schedules are of relevance to this chapter:

- Groundwater (quality and level);
- Leachate (quality and level) within infilled cells; and
- Surface water including discharges (quality).

The monitoring dataset gathered to date has been reviewed with a view to ensuring the original assumptions that underpin the engineering design of landfill cells and restoration strategy remain appropriate considering the additional data gathered. This includes a consideration of:

- Formation levels of basal liner relevant to relative to groundwater level (Condition 3.5.5);
- Leachate management and control (Condition 3.19); and
- Restoration design and phasing as defined in the Closure, Restoration and Aftercare Management Plan (CRAMP) (Condition 10).

The following investigation works have also been undertaken on the site:

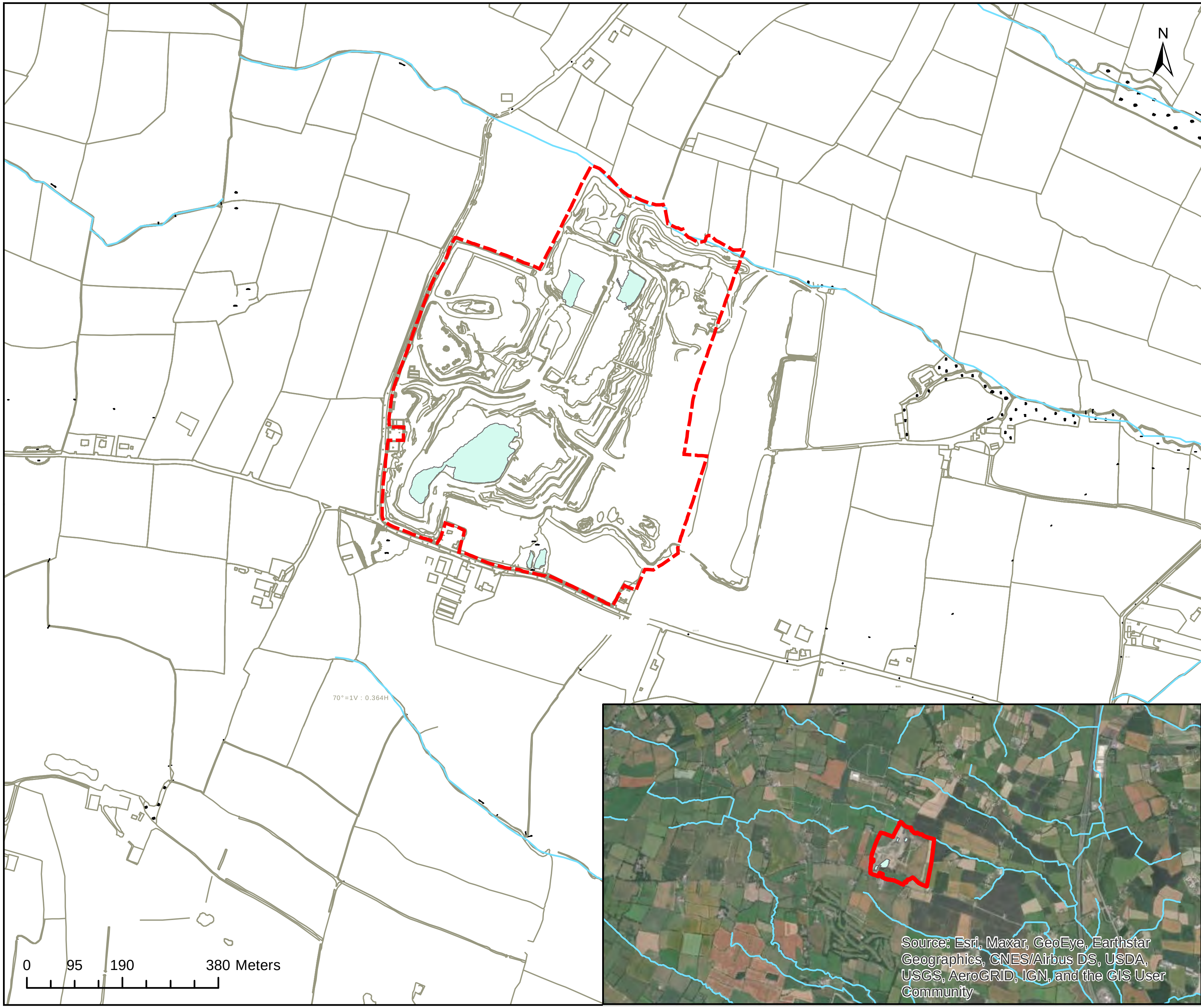
- New borehole installation and pumping tests undertaken in December 2018 / January 2019; and
- The collection of an extended groundwater level monitoring dataset since 2017.

These data sources have been reviewed and included in the baseline characterisation presented herein where it is relevant to the assessment and/or where it alters the historical conceptualisation presented for the site.

9.3.3 Consultation

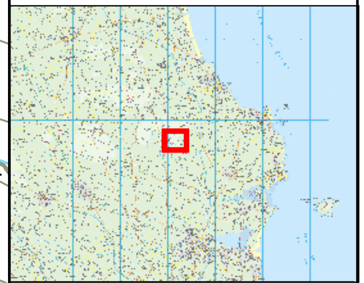
A process of stakeholder consultation was undertaken as described in **Chapter 1** of the EIAR and the following points relevant to this chapter were raised by GSI in consultation:

- The proposed site is a County Geological Site (CGS);
- In December 2019, GSI carried out fieldwork within Nag's Head Quarry to record and document the geology prior to infilling;
- With the current plan, there are no further envisaged impacts on the integrity of current CGSs by the proposed development;
- The Groundwater Data Viewer indicates an aquifer classed as a 'Locally Important Aquifer - Bedrock which is Generally Moderately Productive' underlies the proposed development;
- The Groundwater Vulnerability map indicates the range of groundwater vulnerabilities within the area covered is variable. Recommend use of the Groundwater Viewer to identify areas of High to Extreme Vulnerability and 'Rock at or near surface' in the assessments, as any groundwater-surface water interactions that might occur would be greatest in these areas; and
- Geological Survey Ireland maintains online datasets of bedrock and subsoils geological mapping that are reliable and accessible.



Legend

- Waste Licence Boundary
- Rivers
- Site Ponds



Client

Integrated Materials Solutions (IMS) Limited Partnership

IMS Hollywood 2022 Update

Title

Figure 9-1: General Site Setting

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Issue Details

File Identifier: MDR1492A-RPS-00-XX-DR-Z-AG-0032

Status: S0	**Rev:** P01	**Model File Identifier:**
Drawn: MV		**Date:** 21/09/2022
Checked: SA		**Scale:** 1:10,000 @A4
Approved: PC		**Projection:** ITM

NOTE:

9.4 Assessment Criteria

The general methodology adopted to assess the significance of a potential effect is based on the consideration of the sensitivity of the receptor affected (i.e. in term of the intrinsic value or importance of its attributes) and the magnitude of the anticipated effect thereon. Criteria outlined in the 'Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes' (NRA, 2009) have been used for this assessment and are described in the following sections with examples relevant to this chapter.

9.4.1 Receptor Sensitivity

The importance of the attributes of a receptor are dependent upon the significance of the receptor at a European, national or local scale, its rarity and its potential for substitution. The importance of receptor attributes used in this assessment are based on the criteria summarised in **Table 9-1** (NRA, 2009).

Table 9-1 Criteria for Defining Importance Receptor Attribute Importance (NRA, 2009)

Importance	Criteria Descriptor	Example
Extremely High	Attribute has a high quality or value on an international scale	**Groundwater** Groundwater supports river, wetland or surface water body ecosystem protected by EU legislation e.g. SAC or SPA status. **Geology & Soils** None Defined. **Surface Water** Described in Chapter 10.
Very High	Attribute has a high quality, significance or value on a regional or national scale Degree or extent of soil contamination is significant on a national or regional scale	**Groundwater** Regionally Important Aquifer with multiple wellfields. Groundwater supports river, wetland or surface water body ecosystem protected by national legislation – NHA status. Regionally important potable water source supplying >2500 homes. Inner source protection area for regionally important water source. **Geology & Soils** Geological feature rare on a regional or national scale (NHA). Large existing quarry or pit. Proven economically extractable mineral resource. **Surface Water** Described in Chapter 10.
High	Attribute has a high quality, significance or value on a local scale Degree or extent of soil contamination is significant on a local scale	**Groundwater** Regionally Important Aquifer. Groundwater provides large proportion of baseflow to local rivers. Locally important potable water source supplying >1000 homes. Outer source protection area for regionally important water source. Inner source protection area for locally important water source. **Geology & Soil** Contaminated soil on site with previous heavy industrial usage. Large recent landfill site for mixed wastes. Geological feature of high value on a local scale (County Geological Site). Well drained and/or highly fertility soils. Moderately sized existing quarry or pit. Marginally economic extractable mineral resource. **Surface Water** Described in Chapter 10.

Importance	Criteria Descriptor	Example
Medium	Attribute has a medium quality, significance or value on a local scale Degree or extent of soil contamination is moderate on a local scale	**Groundwater** Locally Important Aquifer. Potable water source supplying >50 homes. Outer source protection area for locally important water source**.** **Geology & Soils** Contaminated soil on site with previous light industrial usage. Small recent landfill site for mixed wastes. Moderately drained and/or moderate fertility soils. Small existing quarry or pit. Sub-economic extractable mineral resource. **Surface Water** Described in Chapter 10.
Low	Attribute has a low quality, significance or value on a local scale Degree or extent of soil contamination is minor on a local scale	**Groundwater** Poor Bedrock Aquifer. Potable water source supplying <50 homes. **Geology & Soils** Large historical and/or recent site for construction and demolition wastes. Small historical and/or recent landfill site for construction and demolition wastes. Poorly drained and/or low fertility soils. Uneconomically extractable mineral resource. **Surface Water** Described in Chapter 10.

9.4.2 Magnitude of Effect

The magnitude of a predicted effect is dependent on its size (i.e. scale and extent), duration, timing (e.g. seasonality) and frequency (e.g. permanent or seasonal). The magnitude of predicted effects is defined using the criteria presented in **Table 9-2**.

Table 9-2 Criteria for Defining Magnitude of Effects (NRA, 2009)

Magnitude	Criteria Descriptor	Example
Large Adverse	Results in loss of attribute	**Groundwater** Removal of large proportion of aquifer. Changes to aquifer or unsaturated zone resulting in extensive change to existing water supply springs and wells, river baseflow or ecosystems. Potential high risk of pollution to groundwater from routine run-off. Calculated risk of serious pollution incident >2% annually. **Geology & Soils** Loss of high proportion of future quarry or pit reserves. Irreversible loss of high proportion of local high fertility soils. Removal of entirety of geological heritage feature. Requirement to excavate / remediate entire waste site. **Surface Water** Described in Chapter 10.
Moderate Adverse	Results in impact on integrity of attribute or loss of part of attribute	**Groundwater** Removal of moderate proportion of aquifer. Changes to aquifer or unsaturated zone resulting in moderate change to existing water supply springs and wells, river baseflow or ecosystems. Potential medium risk of pollution to groundwater from routine run-off.

Magnitude	Criteria Descriptor	Example
		Calculated risk of serious pollution incident >1% annually. **Geology & Soils** Loss of moderate proportion of future quarry or pit reserves. Removal of part of geological heritage feature Irreversible loss of moderate proportion of local high fertility soils. Requirement to excavate / remediate significant proportion of waste site. **Surface Water** Described in Chapter 10.
Small Adverse	Results in minor impact on integrity of attribute or loss of small part of attribute	**Groundwater** Removal of small proportion of aquifer. Changes to aquifer or unsaturated zone resulting in minor change to water supply springs and wells, river baseflow or ecosystems. Potential low risk of pollution to groundwater from routine run-off. Calculated risk of serious pollution incident >0.5% annually. **Geology & Soils** Loss of small proportion of future quarry or pit reserves. Removal of small part of geological heritage feature. Irreversible loss of small proportion of local high fertility soils and/or high proportion of local low fertility soils. Requirement to excavate / remediate small proportion of waste site. Requirement to excavate and replace small proportion of peat, organic soils and/or soft mineral soils beneath alignment. **Surface Water** Described in Chapter 10.
Negligible	Results in an impact on attribute but of insufficient magnitude to affect either use or integrity	**Groundwater** Calculated risk of serious pollution incident <0.5% annually. **Geology & Soils** No measurable changes in attributes.
Minor Beneficial	Results in minor improvement of attribute quality	**Geology & Soils** Minor enhancement of geological heritage feature.
Moderate Beneficial	Results in moderate improvement of attribute quality	**Geology & Soils** Moderate enhancement of geological heritage feature.
Major Beneficial	Results in major improvement of attribute quality	**Geology & Soils** Major enhancement of geological heritage feature.

9.4.3 Significance of Effect

The significance of a predicted effect is determined from the designated receptor sensitivity and effect magnitude using the qualitative matrix provided in **Table 9-3** (NRA, 2009). For the purpose of this assessment a significance of slight is considered acceptable in terms of EIA.

Table 9-3 Significance Matrix

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

9.5 Baseline Conditions

This section assesses the regional and site-specific baseline conditions at the Hollywood site. Additional baseline condition information regarding soils, geology and hydrogeology are reviewed in the Hydrogeological Assessment (**Volume IV** of this EIAR).

9.5.1 Topography, Hydrology and Drainage

The facility is situated immediately east of topographic high ground that extends from Nag's Head, near the existing entrance to the site (at c. 150mAOD) to Knockbrack Hill (at c. 176mAOD) to the north. This high ground forms a hydrological divide, with the site situated within the headwaters of the eastern catchment area of the Bedaragh/Walshestown Stream. The Bedaragh/Walshestown Stream forms the northern boundary of the site, flowing eastwards into Ballough Stream and Ballyboghil River. These watercourses ultimately discharge to the Rogerstown Estuary located c. 9 km to the east-southeast. The area around the site is generally hilly with elevations falling steeply towards the coast where the area becomes more even.

Knockbrack Hill is located approximately 1km north of the site and represents the highest point on the pronounced topographic divide that separates the site from the Bog of the Ring wellfield and associated watercourses. That high ground extends circa 5km westward from Walshestown to Cabinhall then southwest to Mallahow. The gradient decreases broadly radially away from the Nags Head – Knockbrack high ground, but particularly in an easterly direction, towards the coast that is situated circa 7km from the Hollywood facility at its closest point. The local topography surrounding the site is therefore dominated by an easterly decline along the valley of the northern boundary stream towards the coastline in that direction.

The general site setting and topographic elevation across the current extent of the study area are shown in **Figure 9-2**. The elevation of the Bedaragh/Walshestown Stream declines along the northern site boundary from c. 115mAOD in the northwest to below 90mAOD in the east. Topography generally declines from the southwestern corner of the site (at c. 140mAOD) to the northeast, towards the Bedaragh/Walshestown Stream. The deepest excavations within the Hollywood site have a basal elevation of c. 100 to 105mAOD around the former areas of standing water in the southeast corner of the site (now infilled) and central part of the northern site boundary.

The regional and site hydrology and drainage baseline conditions are available in **Chapter 10 Water**. Surface water bodies present on the site include a former quarry pond in the southwest of the site (now infilled) and a number of smaller ponds used as part of the surface water management for the former quarry. The hydrology of the study area is dominated by a south-easterly flowing stream that drains away from the Nag's Head – Knockbrack high ground to discharge to the Rogerstown Estuary located c. 9km to the east-southeast of the site. Four watercourses are of principal relevance to the study area and are identified and include three headwater streams of the Ballough Stream (EPA Waterbody code IE_EA_08B031500) and the Matt River.

On-site drainage shown in **Figure 10-1** is described in **Section 10.4** and includes the following elements:

- Silt settlement tank and oil interceptor in the northwest of the site for managing runoff generated in areas of hardstanding area around entrance yard, weighbridge and site offices. Discharging to point SWD1;

- Former surface water discharge points SWD2 to SWD7 associated with surface water pumping from the associated with quarrying activities. Any flow at these points is currently derived from surface water run-off from non-landfill areas;
- Former pond in the southwest corner which has been infilled in late 2019 which formerly had a surface elevation of c. 100mAOD and depth of c. 10m. The former water level in that pond represents the groundwater table in the underlying aquifer;
- Two silt settlement ponds along the northern part of the site that regulate discharge to the water course on the northern boundary of the site; and
- Water collecting in active engineered cells is pumped out as required and disposed of at a licensed facility. Leachate building up in cells is recirculated back over the existing capped landfill cells.

9.5.2 Land Use

9.5.2.1 On-site Land-use

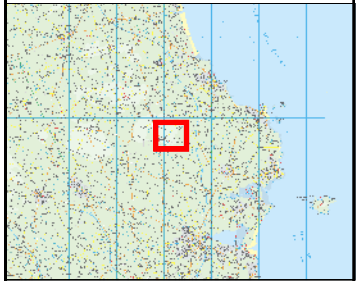
The former quarry on the current site operated from the 1940s up to 2007 extracting shale and limestone from a deep quarry pit. Permission for the infilling and restoration of the former quarry using inert waste was first granted in 1988.

The primary activity currently carried out on site is the recovery of the former quarry via deposition of wastes into engineered landfill cells. Only waste which meets the criteria for inert landfill as set out in the Landfill Directive (Directive 1999/31/EC) may be accepted and is subject to strict Waste Acceptance Procedures approved by the EPA and contained in the site's Environmental Management System under the terms of the Waste Licence (Register No. W0129-02). The existing site layout is shown in **Figure 9-2**.

9.5.2.2 Off-Site Land-Use

The key land-uses identified within the study area include the following:

- The land-use in the area surrounding the site is predominantly agricultural with surrounding fields used mainly for pasture and tillage uses;
- A small number of commercial operations are located within the area, including a potato processing plant approximately 700m to the north of the facility;
- The rural surrounding the site includes some low density, most notably residential properties along the local roads;
- The Bog of the Ring public water abstraction and wetland site approximately 3km to the northeast of the site; and
- Approximately 1.4km to the east of the site, at Nevitt, Fingal County Council has received planning permission and an EPA licence for a municipal waste landfill site but this project hsa not commenced and FCC have clarified that it is not intended to proveed with this project.



Client

Integrated Materials Solutions (IMS) Limited Partnership

IMS Hollywood 2022 Update

Title

Figure 9-2: Current Site Layout

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Issue Details

File Identifier: MDR1492A-RPS-00-XX-DR-Z-AG-0008

Status: S0 **Rev:** P01	**Model File Identifier:**
Drawn: MV	**Date:** 15/09/2022
Checked: SA	**Scale:** N.T.S. @A4
Approved: PC	**Projection:** ITM

NOTE:

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9.5.3 Current Waste Deposition

Current operations on the Hollywood site are authorised and regulated through Waste License Reg. W0129-02. The following conditions and schedules on the Waste Licence are of relevance to the consideration of effects within this chapter of the EIAR:

- Condition 3.5 regarding landfill lining of inert cells that includes:
  - Condition 3.5.2: base and side walls shall comprise of a mineral layer of minimum thickness 1m with a hydraulic conductivity less than or equal to 1.0 x 10^{-7} m/s; and
  - Condition 3.5.5: Formation level of basal liner prior to emplacement of compacted clay shall be constructed at least 1m above the water table and no lower than 104.5mAOD Malin. Any excavations deeper than formation level shall only be backfilled with granular materials quarried from the facility.
- Condition 5.6 regarding groundwater management that includes:
  - There shall be no direct emissions of polluting matter to groundwater;
  - Effective groundwater management infrastructure to be maintained on the facility;
- Condition 8 and Schedule A.2 define the Acceptable Waste types for the inert landfill site;
- Condition 8 and Schedule A.3 and A.4 define the Acceptance Criteria, verification requirements and the ‘Limit Values for Pollutant Content of Inert Waste’;
- Condition 2 and Schedule C define the monitoring requirements for the site, most notably leachate, groundwater and surface water;
- Condition 3.19 regarding leachate monitoring frequencies and design;
- Condition 5.6 regarding groundwater management that includes:
  - There shall be no direct emissions of polluting matter to groundwater;
  - Effective groundwater management infrastructure to be maintained on the facility:
- Condition 3.9 regarding Waste Inspection and Quarantine Areas;
- Condition 3.16 regarding Silt Traps and Oil Separators on the site;
- Condition 3.11 regarding the design and operation of waste water treatment plants on the facility; and
- Condition 3.4 regarding the tank, container and drum storage areas.

The status of inert waste cell engineering, deposition and restoration on the site in 2022 is shown on the working plans provided in **Figure 9-2**.

The records submitted to the EPA as part of annual reporting for the Waste Licence have demonstrated that the materials deposited in the landfill cells have met criteria required by the Waste Licence and that inert waste cells have been engineered, infilled and restored meet the requirements of the EPA having been undertaken in compliance with conditions in the Waste Licence.

Leachate quality in the restored landfill phases is monitored on a six-monthly basis in the seven leachate monitoring wells shown in **Figure 9-3**. Leachate quality has been monitored for the following parameters:

- Physical Parameters: Leachate Level, Electrical Conductivity and pH;
- Indicator Parameters: Chemical Oxygen Demand, Dissolved Organic and Total Organic Carbon;
- Nutrients: Ammoniacal Nitrogen and Total Oxidised Nitrogen;
- Inorganic Parameters: Chloride, Potassium, Sodium and Sulphate; and
- Organic Parameters: Total Phenols, List I & II Substances (Screening of organic compounds by GC-MS including VOCs and SVOCs).

The leachate quality dataset available for the point of Baseline Characterisation (up to 2021) is provided in **Volume IV** along with time series charts for selected quality parameters. To evaluate the leachate quality at each monitoring well, the observed leachate quality dataset is compared to relevant water quality assessment criteria that include:

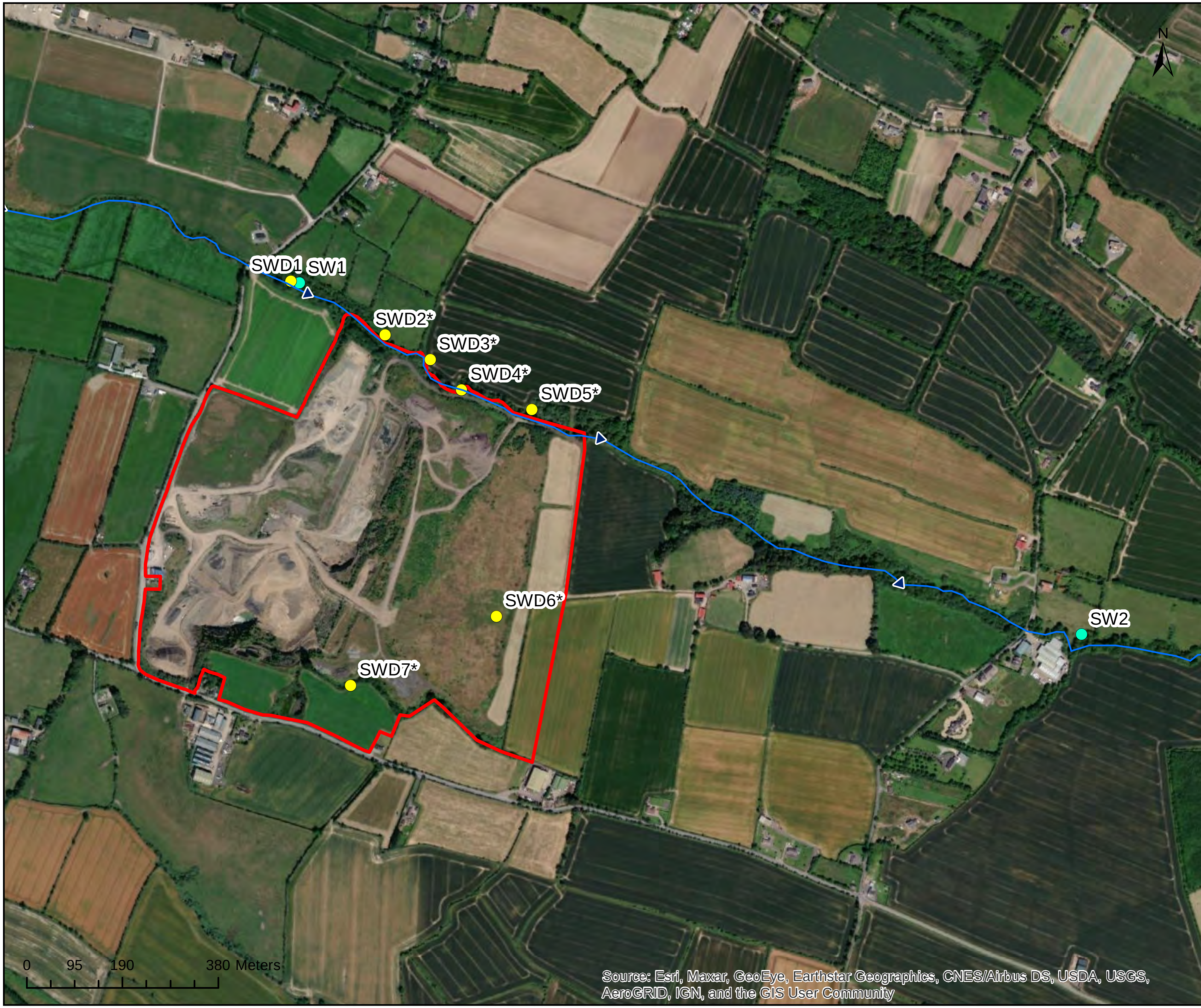
- The list of substance classified by the EPA as being hazardous substances or non-hazardous pollutants (formerly List I or List II substances) (Classification of Hazardous and Non-hazardous Substances in Groundwater (EPA, 2010));
- Schedule 5 Groundwater Threshold Values for chemical status test as presented in EU Environmental Objectives (Groundwater) (Amendment) Regulations 2016 (S.I. No. 366 of 2016);
- Drinking water standards defined in Table A, B and C of the EU (Drinking Water) Regulations 2014, as amended; and
- Interim Guideline Values for a suite of parameters determined by EPA (Towards setting Guideline Values for the Protection of Groundwater in Ireland, Interim Report (EPA, 2003).

The key observations with respect to the leachate dataset presented in **Volume IV** includes the following:

- Typically, a mildly alkaline pH;
- General absence of hazardous and non-hazardous organic substances consistent with the inert waste mass;
- Often elevated inorganic parameters (most commonly sulphate, sodium, chloride and potassium) which do exceed certain respective water criteria on occasions but is consistent with the composition of the waste mass that includes a component of crushed concrete; and
- Ammoniacal nitrogen concentrations typically below 10 mg/l.

The time series charts for leachate quality typically show concentration reductions or stability over the period for which data is available. No trends of concern are present in the dataset.

The leachate quality dataset therefore describes a water quality consistent with the inert waste deposited in the landfill, confirming the generally low risk that the deposition of inert waste represents to groundwater in light of the mitigations implemented on the site through conditions on Waste Licence W0129-02. Some inorganic parameters (most notably sulphate) are elevated relative water quality standards owing to the materials included within the waste mass, but there is general absence of organic contaminants and hazardous substances.



Legend

- Ballough River
- River monitoring station
- Drain monitoring station

Data Sources:
http://www.epa.ie/licsearchdownload/CombinedFileView.aspx?regno=W0129-02&classification=Enforcement

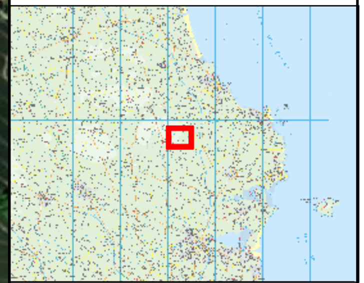


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Figure 9-3: Monitoring Locations

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9.5.4 Soils & Ground Conditions

Soils in the vicinity of the site are dominated by the Gley group, except for Knockbrack Hill/ Nags Head area and the Palmerstown townland area where the soils are of the Brown Earth Group. A small isolated area of peat occurs around the Bog of the Ring Commons area.

The site is located in the Knockbrack Hill/ Nags Head area and is therefore characterised by the Brown Earth Group soils that comprise generally well drained mature mineral soil. The soils of this group are generally good arable soils although sometimes low in nutrients. These have good drainage and structure characteristics with medium textures.

The area of currently undeveloped land situated within the facility boundary to the east of the main quarry void is largely covered by a veneer of site-won excavation spoil. This depth of this reworked material upon natural bedrock is uncertain and is now grassed / overgrown. Although not used as part of current operations on the site, this land has historically been used for temporary material storage during the lifespan of the quarry.

Access roadways, hardstanding, permanent structures and operational areas are shown in the current working plan for the facility in **Figure 9-2**. This includes those areas of the landfill that are characterised by an absence of soils and/or presence of Made Ground fill in the areas of exiting development around the site entrance.

Naturally occurring soils within the former quarry have been stripped and stockpiled. All stored soils, quarry stone and scalpings will be reused in the construction of future inert waste cells and the final restoration of completed inert waste cells. All restored cells have been completed with cap and grassed surface using soils retained on the site.

9.5.5 Geology

9.5.5.1 Regional Geological Setting

The regional geological sequence within the study area is shown in **Figure 9-4**. The regional geology has been determined from the Geological Survey of Ireland online Spatial Data and Resources (GSI Spatial Data) and is summarised in **Table 9-4**.

Table 9-4 Regional Geological Sequence

Age		Name	Lithological Description*	Maximum Thickness (m)
Quaternary		Alluvium	Post-glacial deposit comprising gravel, sand, silt or clay in a variety of mixes, usually includes a high percentage of organic carbon	-
		Glacial Till (TNSSs) - derived from Namurian sandstones and shales	‘Clayey’ till dominating the area around the site. Defined as ‘CLAY’ using BS5930 in most samples.	-
		Glacial Till (IrSTLPSsS) - Irish Sea Till derived from Lower Palaeozoic sandstones and shales.	Dominating the area to north of the site, Clayey in texture. Classified as a ‘CLAY’ or ‘SILT/CLAY’ in majority of samples, using BS 5390.	-
		Glacial Till (TLs) - Till derived from limestones	-	-
Carboniferous	Upper / Namurian	Walsheston Formation (WL)	Shales, thin sandstones / siltstones, occasional thin limestones	> 200
	Upper / Namurian	Balrickard Formation (BC)	Micaceous sandstone with shale interbeds.	75-100

Age		Name	Lithological Description*	Maximum Thickness (m)
	(Visean / Namurian)	Donore Formation (DR)	Transitional unit between the Balrickard and Loughshinny Formations.	-
	Lower / Visean	Loughshinny Formation (LO)	Layered dark grey micrite and calcarenite (fine-coarse grained limestone) and shale	100-150
	Lower / Visean	Naul Formation (NA)	Calcarenite and calsilitite (coarse-medium grained limestone) with minor chert and thin shales.	100
	Lower/ Visean	Luan Formation (LU)	Dark grey well bedded cherty, graded limestones and calcareous shales	210

* Description taken from Bog of the Ring, Groundwater Source Protection Zones (GSI, 2005)

Bedrock Geology

The bedrock geology in the vicinity of site and to the south thereof is dominated by predominately limestone formations of the Lower Carboniferous (Visean). This includes the Lucan Formation, the Naul Formation and the Loughshinny Formation. GSI regional geological data indicates that the site is partially situated on limestone bedrock of the Loughshinny Formation. The dominant lithologies of the Naul Formation are calcarenite and, with minor chert and occasional thin shales which is similar to the Loughshinny Formation, but the limestones are paler, less argillaceous with less shale. The Lucan Formation situated further to the south comprises dark-grey to black, fine-grained, argillaceous/shaley, occasionally cherty, micritic limestones that weather paler, usually to pale grey. The Naul Formation is estimated to be 100m thick, the Lucan Formation is estimated to be 201m thick and the Loughhshinny Formation is estimated to be 100-150m thick.

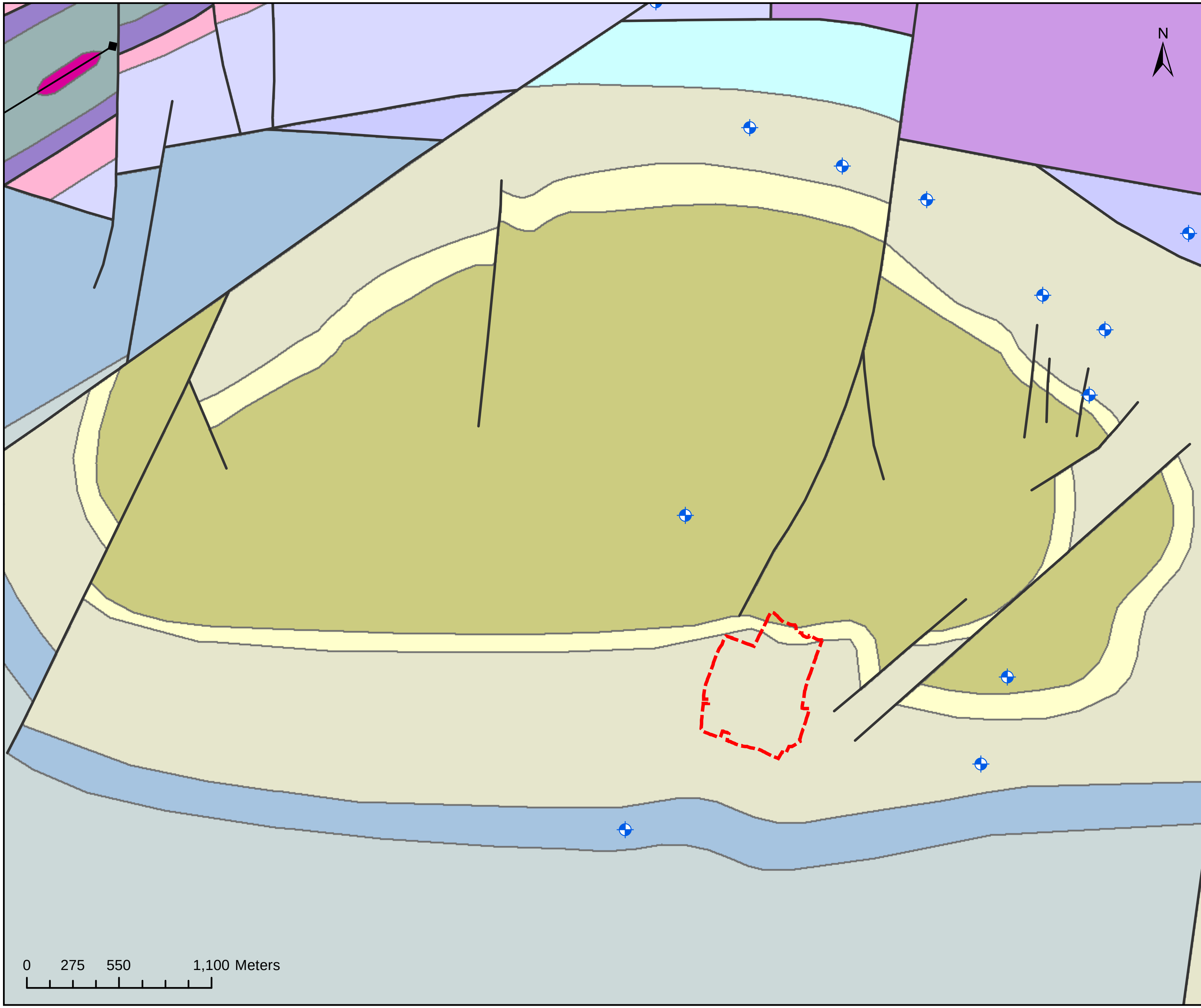
Regional geological structure is dominated by a large syncline with its axis running approximately west-northwest to east-southeast, beneath the Knockbrack Hill ridge, approximately 1km to the northeast of the site. The limestone bedrock of the Loughshinny Formation identified on the site is situated on the southern limb of the syncline, with younger Namurian bedrock present at the surface immediately to the north and beneath the Knockbrack Hill ridge. Bedrock near the site therefore dips northwards, at c. 5° to 40°, exposing the outlier of younger Namurian bedrock in the core of syncline in that direction. The Lower Carboniferous limestone outcrops once again on the northern limb of the syncline, on the opposite side of the Knockbrack Hill, in the vicinity of Bog of the Ring, Hazardstown and Naul.

The Namurian bedrock comprises shales interbedded with sandstone and siltstone units, with subordinate calcareous mudstones and/or argillaceous limestones. Namurian bedrock within the syncline is dominated by the Walshestown Formation which consists predominantly of black shales, with subordinate siltstones, fine sandstones bands with rippled lenses, calcareous mudstone and occasional limestones (biosparite). The Balrickard Formation is also present and consists of metre thick feldspathic micaceous sandstone with shale and argillaceous fossiliferous micrite interbeds. Sandstones are medium-grey, well sorted, coarse to very coarse grained, feldspathic sub-litharenites (Mc Connell *et al*., 2001). The Donore Formation is generally considered a transitional unit between the Loughshinny Formation and Balrickard Formation.

The Carboniferous bedrock within the syncline in the study area is also faulted, typically with a north-south or northeast-southwest orientation. As shown in **Figure 9-4** several normal/ strike slip major faults / fault sets extend from close to the site to the north or northeast.

Superficial Deposits

Superficial deposits overlying the bedrock in the vicinity of the site are dominated by Quaternary glacial till. The GSI Spatial Data suggests that these are mixed, unconsolidated deposits that are predominately clay rich in nature and variously derived from either Namurian bedrock (Shales and sandstones) or Limestone bedrock.



Legend

- Waste Licence Boundary

Bedrock Stratigraphy

- Belcamp Formation
- Herbertstown Formation
- Holmpatrick Formation
- Loughshinny Formation
- Lucan Formation
- Naul Formation
- Clashford House Formation
- Balrickard Formation
- Walshestown Formation
- Fourknocks Formation
- Diorite
- Mudbank Limestone
- Snowtown Formation
- Anticlinal Axis
- Fault

Data Sources: Geological Survey Ireland (GSI)

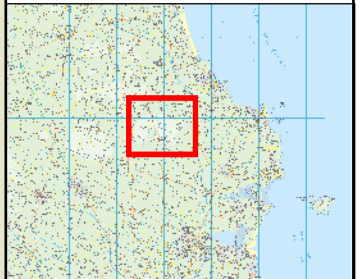


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Figure 9-4: Regional Geological Setting

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NOTE:

9.5.5.2 Site Specific Geology

The site has been subject to multiple phases of geological investigation principally in support earlier applications for waste disposal operations on the site. The detailed understanding of site-specific geology is therefore based on data obtained from the information sources:

- Report on the '*Geology of the Landfill Site, Hollywood Naul, Co. Fingal*' (Conodate, 2009): Geological field study undertaken in November 2009 to understand rock types present on the former quarry and their structural relationship. This included an analysis of micropalaeontology and palynology of samples from the site;
- Geophysical Survey (Apex, 2010): Geophysical survey to locate significant faults present on the site and provide information regarding the deep bedrock; and
- Geological logs for boreholes installed on the site:
  - Original monitoring infrastructure installed between 1998 and 2008 to fulfil the requirements of EPA waste licence for the site (namely BH4a, BH5, BH6, BH8, BH9, BH10a, BH11a, BH12, and BH13);
  - Geological and hydrogeological investigation boreholes installed in support of planning applications by the previous site operator (MEHL). Boreholes installed under the supervision of Arup in 2010 (namely BH15, BH15a, BH16, BH17 (Pumping Well 1), BH18, BH19 and BH20); and
  - Additional boreholes drilled in 2018 that include borehole BH24 to borehole BH30, the 'New Pumping Well' and the 'New Off-site Monitoring Well' BH31.

The geophysics and geological field report referred to above are provided in **Volume IV** of this EIAR along with a summary of borehole data. With the exception of new boreholes installed in 2018, the above data sources have been previously provided to regulator in support of previous planning applications, most notably Chapter 14 of Environmental Impact Statement for MEHL Waste Management Facility at Hollywood Great, Nag's Head, Naul, Co. Dublin (Arup, 2010).

The sites-specific geological data confirms the general succession expected on the site that comprises (from oldest to youngest):

- Loughsinny Formation typically interbedded light-coloured limestone and darker shales;
- Donore Formation shales, limestones and sandstones that are thought to be transitional between the Loughshinny Formation and the Balrickard Formation;
- Balrickard Formation that comprises thinly bedded, intensely fractured and jointed sandstone, shale and rare limestones; and
- Walshestown Formation that comprises thinly bedded, intensely fractured and jointed black shales, with subordinate siltstones, fine sandstones bands with rippled lenses, calcareous mudstone and occasional limestones.

Photographs of the geological formations exposed within the former quarry taken in 2009 and presented support of Chapter 14 of Environmental Impact Statement for MEHL Waste Management Facility at Hollywood Great, Nag's Head, Naul, Co. Dublin (Arup, 2010) are provided in **Volume IV o**f this EIAR.

Site-specific data demonstrates that the geology of the site is dominated by younger Namurian bedrock, with the limestones of the Loughshinny Formation restricted to the southwestern section of the site. Bedrock generally dips to the north, typically at less than 20° (Conodate, 2009), exposing progressively younger units, in accordance with the regional structure mapped by the GSI in this area. The Namurian bedrock of the Walshestown Formation, Balrickard Formation and Donore Formation on the site is characterised by its dark colour relative to underlying limestone and it's intensely fractured and jointed nature. All geological formations present on the site are subject to a variable degree of folding.

A new off-site monitoring well, BH31, was installed in 2018 approximately 0.7km to the north-northeast of the landfill in the approximate direction of the Bog of the Ring public water supply wellfield. That borehole confirms the regional synclinal structure, with 126m of Namurian bedrock (comprising interbedded mudstone, siltstone and sandstone units) proven to the base of the borehole at an elevation of c. 0mAOD.

A fault that bisects the site was identified visually within the former quarry (Conodate, 2009). The presence of this fault was supported by the results of the geophysical investigations undertaken in 2010 (Apex, 2010) and the variable elevation of contact between the Loughshinny Formation and overlying Namurian bedrock determined through borehole drilling (refer **Table 9-7**). Consistent with the regional structure mapped by the GSI, these results indicate that the site is located in a significant fault zone orientated approximately southwest northeast (with a strike of 034°).

The geophysics has been interpreted as being consistent with geological downthrow to the east and north of the two discrete faults identified on the site. However, the contact elevation data (between the Loughshinny Formation and Namurian) across the site is also consistent with a general decline in elevation to the north, with the lowest elevation of the contact approximately following the north-northeast orientated fault bisecting the former quarry.

Figure 9-6 provides the revised geological map has been developed for the site on the basis of the site-specific geological dataset, with the elevation of the contact between Namurian bedrock and underlying Loughshinny Formation shown in **Table 9-7.** The geology of the site is dominated by the presence of Namurian bedrock, which extends further to the south than that shown on the GSI mapping.

9.5.5.3 Geological Sites of National and/or Local Importance

Geological Heritage sites are defined by the GSI on the basis of an audit undertaken by County Geological Sites (CGS). Geological Heritage sites there represent sites considered to be of national importance. Three Geological Heritage Sites are located within the study area within Co. Fingal:

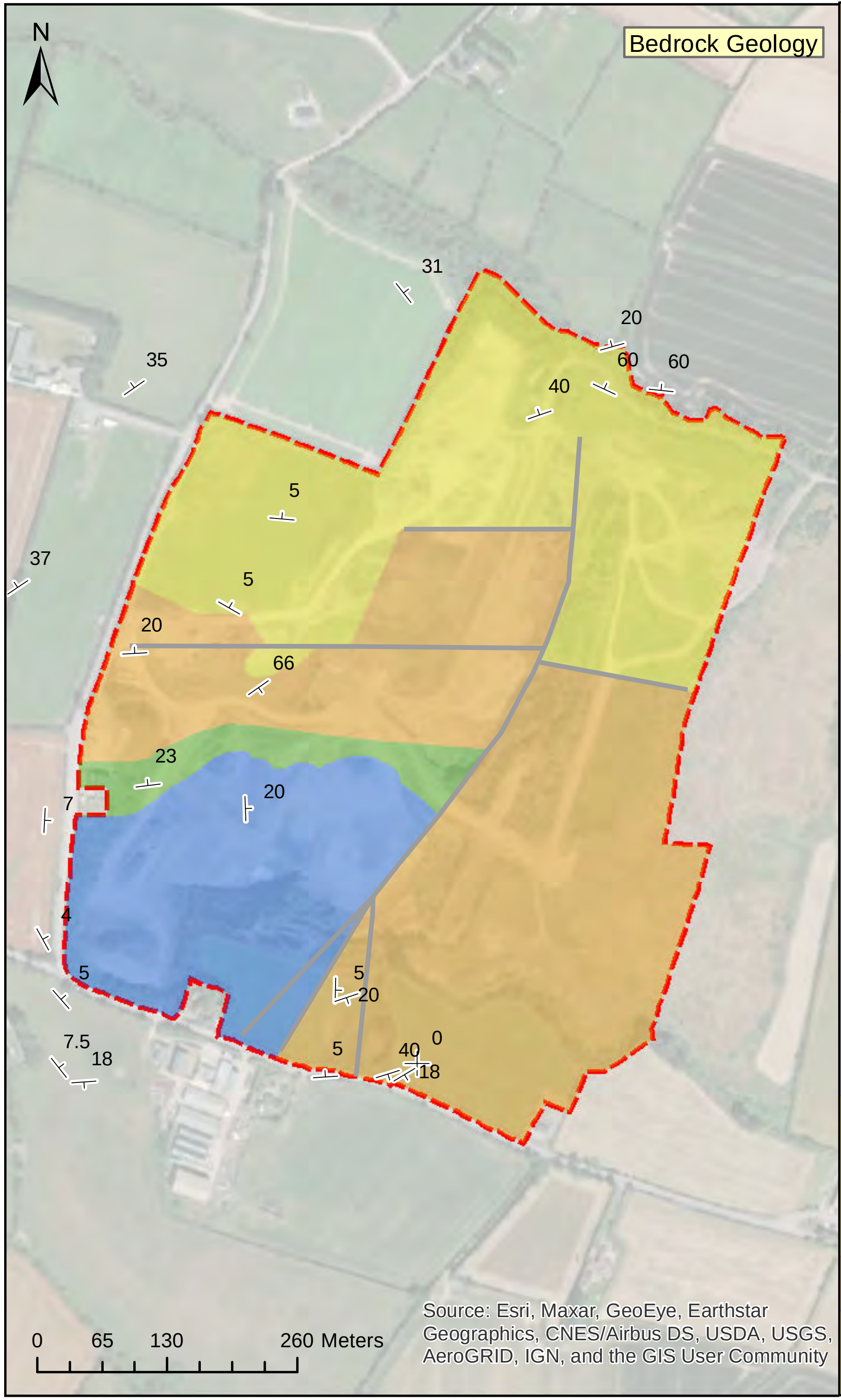
- Nags Head Quarry – Lower Carboniferous (Visean) limestone, shale and sandstone;
- Balrickard Quarry – Upper Carboniferous (Namurian) sandstone and shale of the Balrickard Formations; and
- Walshestown Stream Section – Upper Carboniferous (Namurian) shale, sandstone and limestones of the Walshestown and Balrickard Formations.

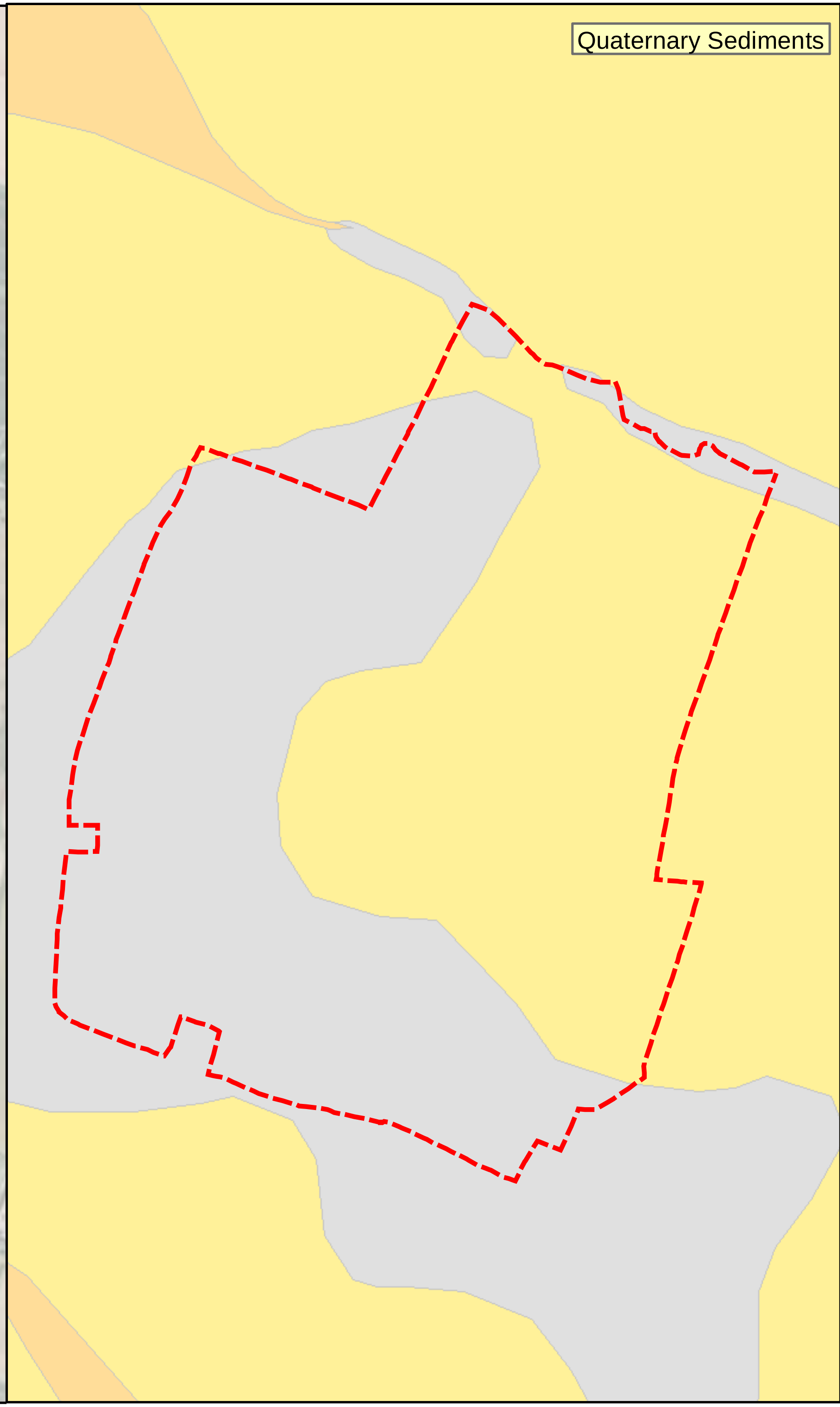
The Nags Head Quarry Geological Heritage Site covers the footprint of the former quarry now occupied by the landfill. The site is designated on the basis of the exposed faces of thin to medium bedded limestone, shale and sandstone that display large scale structural deformation features, most notably chevron folds.

In response to consultation (refer **Table 1-2**), the GSI state that the proposed development will not result in any impact on the integrity of this nationally important geological site, although features may potentially be covered during restoration.

9.5.6 Climatic Data

Updated climatic and rainfall data for the site has been obtained and is described in **Section 10.4.1**. This includes rainfall and evapotranspiration data for Dublin Airport. Additional site-specific rainfall data has been periodically gathered, most recently for the pumping test undertaken in 2018.





Legend

- Waste Licence Boundary
- Landownership Boundary

Quaternary Sediments

- Alluvium
- Bedrock outcrop or subcrop
- Till derived from Namurian sandstones and shales

Structures

- Potential Fault

Bedrock Geology

- Balrickard Formation
- Walshestown Formation
- Donore Formation
- Loughshinny Formation (L)

Data Sources: Geological Survey Ireland (GSI)

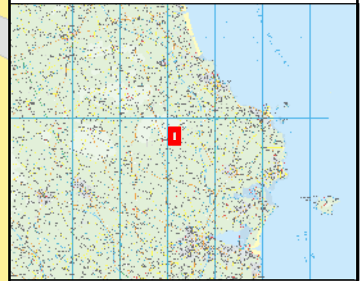


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Figure 9-5: Site Specific Geology

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NOTE:

9.5.7 Hydrogeology

9.5.7.1 Hydrogeological Classification

Aquifer Classification

The GSI provide a general hydrogeological classification based on the geological setting. The GSI aquifer categories are intended to describe both resource potential (Regionally or Locally Important, or Poor) and groundwater flow type and attenuation potential (through fissures, karst conduits or intergranular). The aquifer classification for the key geological units within the study area are summarised in **Table 9-5.**

Table 9-5 GSI Aquifer Classification for Key Geological Units within the Study Area

Geological Unit	Age	Lithology	GSI Aquifer Classification
Walshestown Formation (WL)	Namurian	Shales, thin sandstones / siltstones, occasional thin limestones	PI Poor Aquifer – Bedrock which is generally unproductive except for local zones.
Balrickard Formation (BC)	Namurian	Coarse micaceous sandstone with shale interbeds.	
Donore Formation (DR)	Namurian	Transitional between Balrickard and Loughshinny Formations	
Loughshinny Formation (LO)	Visean	Layered dark grey micrite and calcarenite (fine-coarse grained limestone) and shale	Lm Locally Important Aquifer – Bedrock which is generally moderately productive

On the base of the general GSI classification the Loughshinny Formation represents the most important aquifer unit underlying the landfill. The Namurian shales that overly the Loughshinny Formation is considered a Poor Aquifer (PI).

The GSI provide general characteristics for each aquifer classification. A PI aquifer is described as an aquifer with a limited and poorly connected network of fractures, fissures and joints with limited zones of high permeability. A Lm aquifer is described as an aquifer which the network of fractures, fissures and joints, through which groundwater flows, is reasonably well connected and dispersed throughout the rock, giving a moderate permeability and groundwater throughput. Aquifer storage is moderate and groundwater flow paths can be up to several kilometres in length.

Water Framework Directive Groundwater Body (GWB)

Groundwater Bodies (GWB) have been designated for the purpose of the Water Framework Directive (WFD). GWBs are subdivisions of large geographical areas of aquifers that allow more effective management to protect the groundwater and linked surface water or groundwater dependent features. The two groundwater bodies defined in the vicinity of the landfill are shown in **Figure 9-6** and include:

- Lusk-Bog of the Ring (IE_EA_G_014) - FI (Productive fissured bedrock); and
- Hynestown (IE_EA_G_033) - PP (Poorly productive bedrock).

The full GSI summary of the characteristics of these GWB is provided in **Volume IV** of this EIAR and summarised below.

The Lusk-Bog of the Ring GWB is composed of moderate permeable limestone, which in some places is karstified. The GWB is associated with the Loughshinny Formation in the vicinity of the site and exposed around the inlier of Namurian bedrock that characterises the regional syncline structure shown in **Figure 9-4**. Groundwater flow is typically along fractures and in places solution enhanced karstic conduits. Aquifers are typically unconfined but may be locally confined where overlain by Namurian strata. Recharge typically diffuse through subsoils and via outcrop.

The Hynestown GWB underlies the hill to the northeast of the site that forms the syncline in regional geological structure. The GWB comprises the undifferentiated Namurian bedrock (shale and Sandstone) that form the core of the syncline. The Namurian strata comprise low permeability rocks with localised regions of enhanced permeability and form aquifers that are typically unconfined. Recharge occurs diffusely through subsoils and outcrop.

The designation of the hydrogeological characteristics of each GWB generally reflects the aquifer classification of the dominant bedrock geology for each GWB, as summarised in **Table 9-5**.

The WFD requires 'Good Water Status' for all European waters by 2015 or at the latest by 2027, to be achieved through a system of river basin management planning and extensive monitoring. 'Good status' means both 'Good Ecological Status' and 'Good Chemical Status'. The overall objective of the river basin management plans is to restore the status to 'Good' by 2021.

The Water Framework Directive (WFD) status 2013 to 2018 of the Lusk-Bog of the Ring Groundwater Body (GWB) (IE_EA_G_014) is currently under review and classified as 'Not at Risk'. The WFD status 2013 to 2018 of the Hynestown (IE_EA_G_033) is 'Good' and the risk is currently under review.

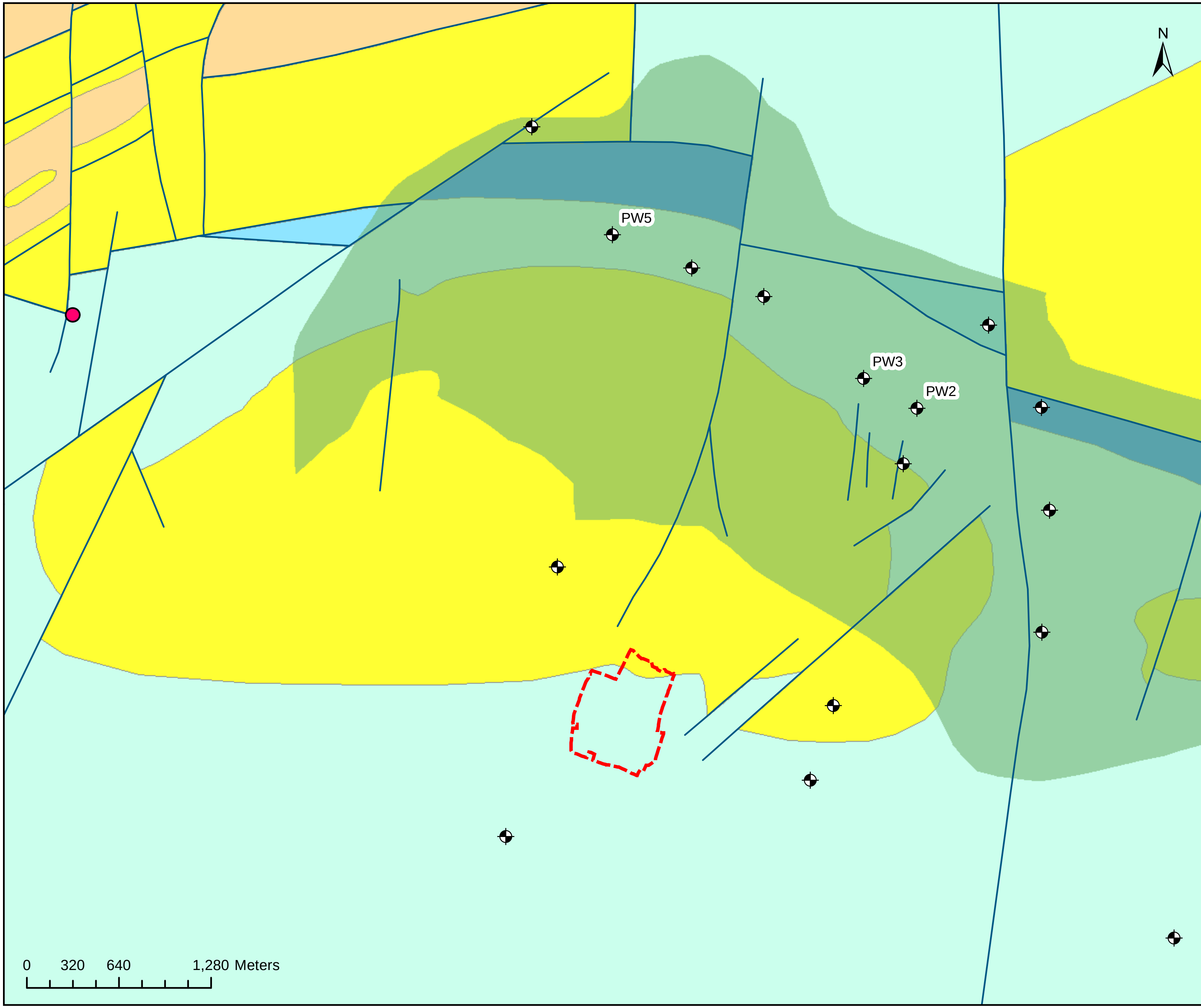
9.5.7.2 Groundwater Vulnerability

Groundwater vulnerability defines the natural ground characteristics that determine the ease with which groundwater may be contaminated by human activities. A vulnerability category is assigned to a site or area based on the relative ease that infiltrating water and potential contaminants may reach groundwater in a vertical or sub-vertical direction. Groundwater vulnerability classes designated by the EPA are as follows:

- Extreme 'X' Groundwater Vulnerability;
- Extreme 'E' Groundwater Vulnerability;
- High 'H' Groundwater Vulnerability;
- Moderate 'M' Groundwater Vulnerability; and
- Low 'L' Groundwater Vulnerability.

Groundwater vulnerability designation in the vicinity of the site is shown in **Figure 9-7** and is typically *Extreme* with rocks commonly at or near the ground surface. This includes areas outside of the current operational areas and/or the former quarry footprint, most notably to the east of the quarry void.

Groundwater vulnerability within the Waste Licence boundary is now affected by the historical quarrying and infilling activities undertaken thereon. The removal of soils and quaternary superficial deposits, allied with a reduction in the thickness of the unsaturated zone has increased groundwater vulnerability across the former quarry void, with the exception of areas of restored inert cells, areas of material stockpiling and/or areas concealed beneath structures / hardstanding. Current land-use on the site is shown in **Figure 9-2**.



Legend

- Waste Licence Boundary
- Source Protection Areas (SPAs)

Groundwater Bodies - Aquifer Designations

- Locally Important Aquifer - Bedrock which is Generally Moderately Productive
- Locally Important Aquifer - Bedrock which is Moderately Productive only in Local Zones
- Locally Important Aquifer - Karstified
- Poor Aquifer - Bedrock which is Generally Unproductive except for Local Zones
- Poor Aquifer - Bedrock which is Generally Unproductive
- Regionally Important Aquifer - Karstified (diffuse)
- Unclas

Significant Geologic Structures

- Faults

Boreholes & Wells

- Borehole
- Dug well

Data Sources: Geological Survey Ireland (GSI)

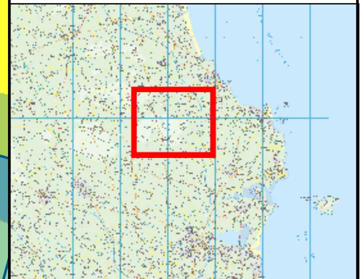


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Figure 9-6: Hydrogeological Setting

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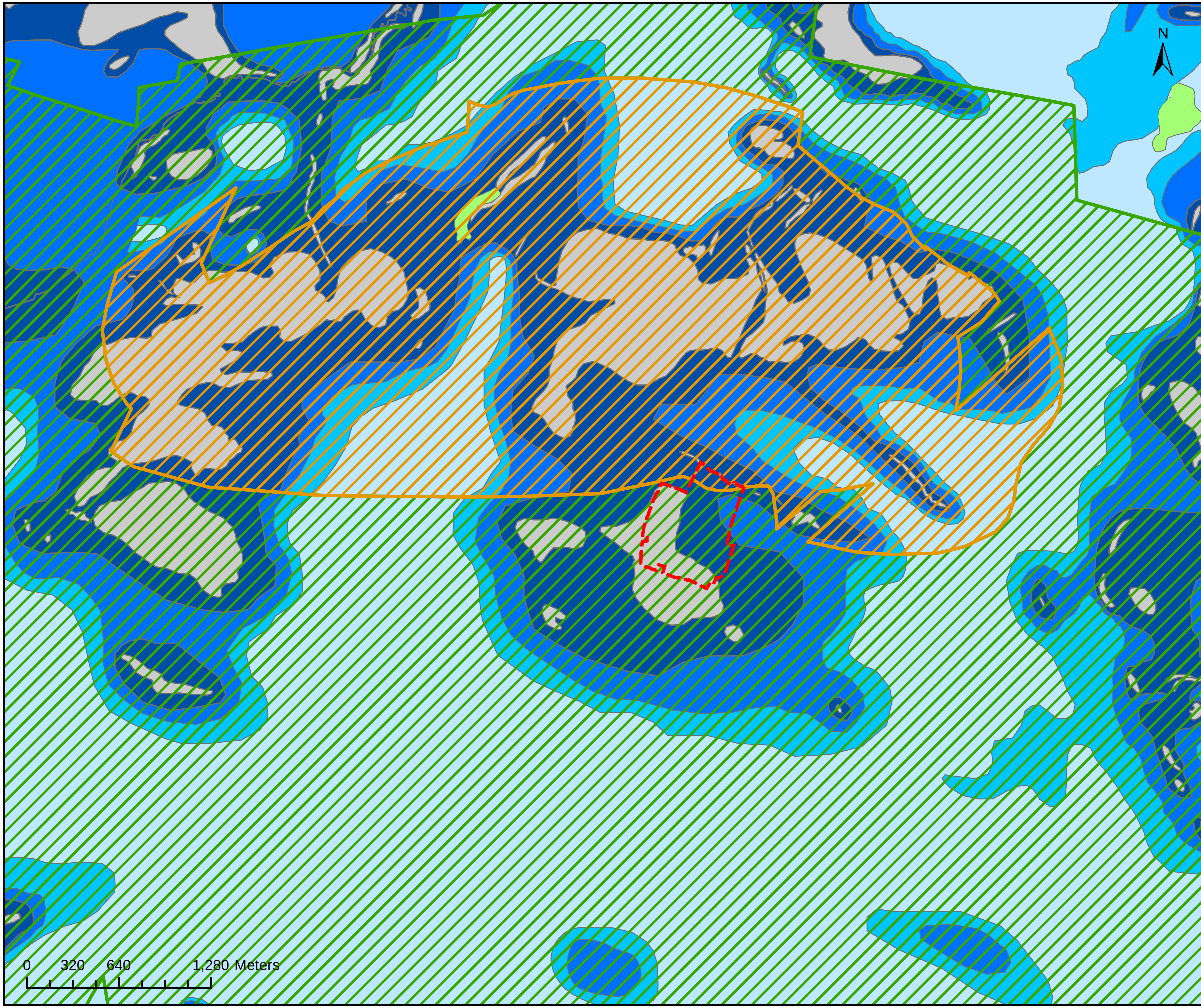

Legend

Waste Licence Boundary

Groundwater Vulnerability

- Extreme
- High
- Moderate
- Low
- Rock at or near Surface or Karst
- Surface water

WFD Groundwater Water Bodies

- Hynestown
- Lusk-Bog of the Ring

Data Sources: Geological Survey Ireland (GSI)

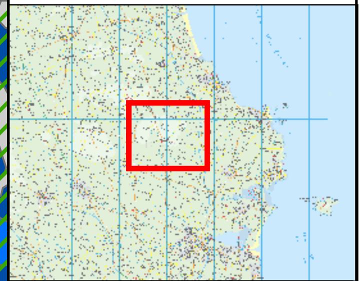

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Figure 9-7: Groundwater Vulnerability

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NOTE:

9.5.7.3 Groundwater Levels and Flow Directions

Regional Groundwater Flow System

Regional groundwater levels are available from the GSI Spatial Data, where they are presented as a contour surface at a 20m interval.

A schematic regional groundwater contour plot has been produced for the study area, by synthesizing the recent groundwater monitoring data collected with historical data collected for the Fingal Landfill Project. The resulting groundwater contour plot for the regional groundwater flow is presented in **Figure 9-8**.

Figure 9-8 demonstrates that the south-easterly flow direction characteristic natural groundwater within the Loughshinny Formation on the site is consistent with the south-easterly flow direction also identified around the proposed Fingal Landfill. This south-easterly flow direction is consistent with flow within the Loughshinny Formation that is orientated towards the upper reaches of the Ballough Stream.

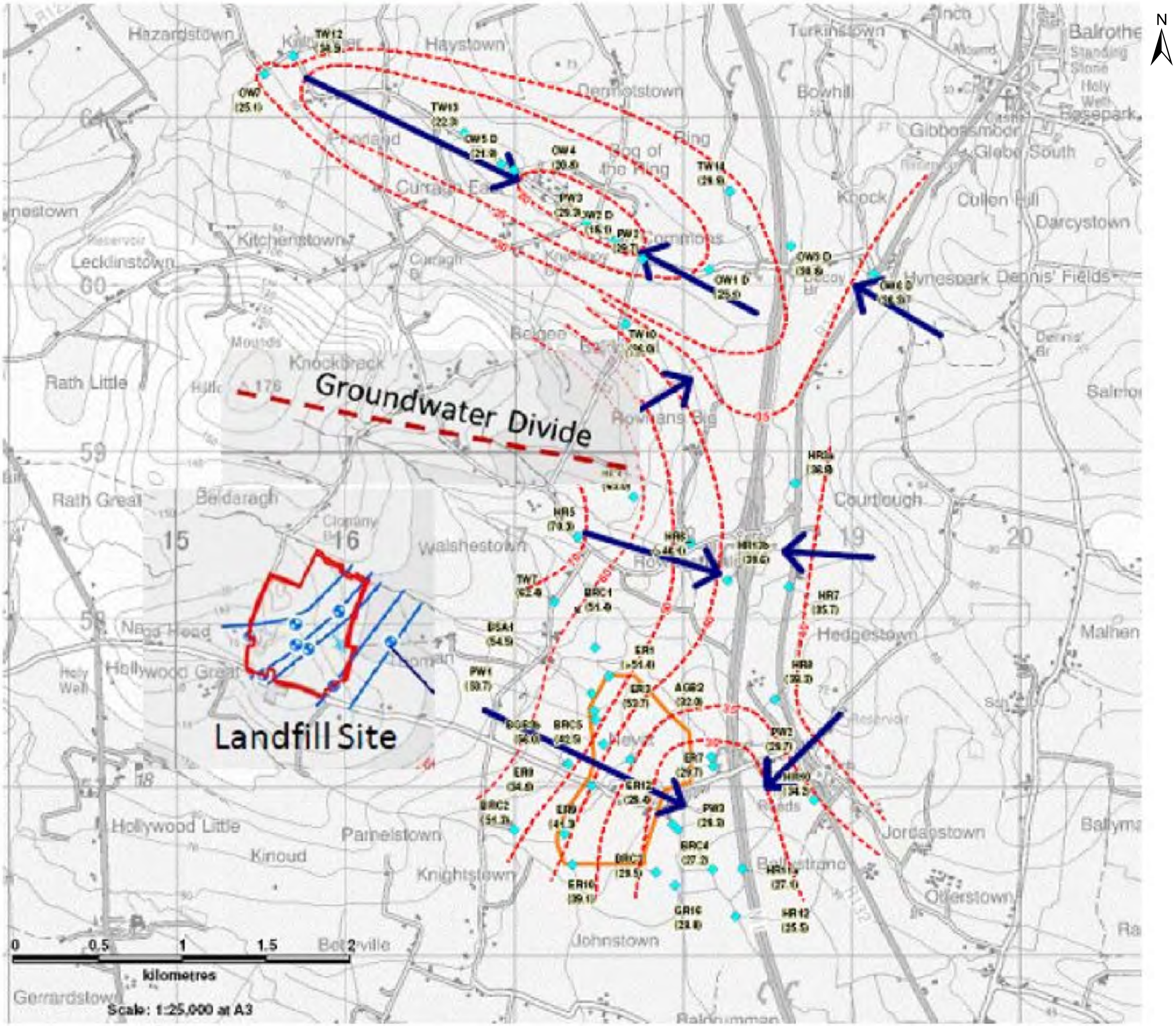
The groundwater contour surfaces in the vicinity of the site are shown in **Figure 9-8**. The contour surface reflects surface topography, with high groundwater levels inferred between the high ground to the west and northwest of the site that decline to the east and southeast towards the valley of the principal watercourses in that direction.

In general terms, conceptual groundwater flow directions are expected to be orientated towards the principal groundwater receptors, most notably large groundwater resurgences at springs (most notably Bog of the Ring) and at times of high groundwater levels the local surface watercourses. The groundwater contours shown in **Figure 9-9** do not however account for the potential influence that geological structure (most notably regional faulting of bedrock) and/or large public water abstractions may have on groundwater levels and the groundwater flow regime.

Site-specific Groundwater Levels and Flow

Groundwater levels have been recorded at monitoring boreholes installed in compliance with Condition 6 of Waste Licence Reg. W0129-02. In addition, groundwater levels have been monitored at extensive number of boreholes since January 2017, as part of the most recent hydrogeological investigations undertaken on the site.

The location of all monitoring boreholes constructed on or near the Hollywood site and the units monitored are summarised in **Figure 9-3**. A summary of the key monitoring boreholes for which monitoring data exists is provided in **Table 9-6**. The location of all on-site monitoring borehole identified in **Table 9-6** is shown in **Figure 9-3.** Geological logs for all boreholes are provided in **Volume IV** of this EIAR.



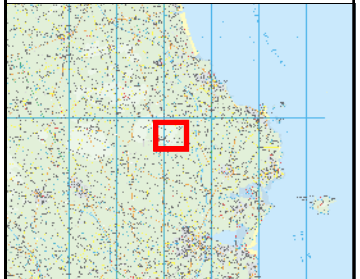


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Figure 9-8: Interpreted Regional Groundwater Flow Directions

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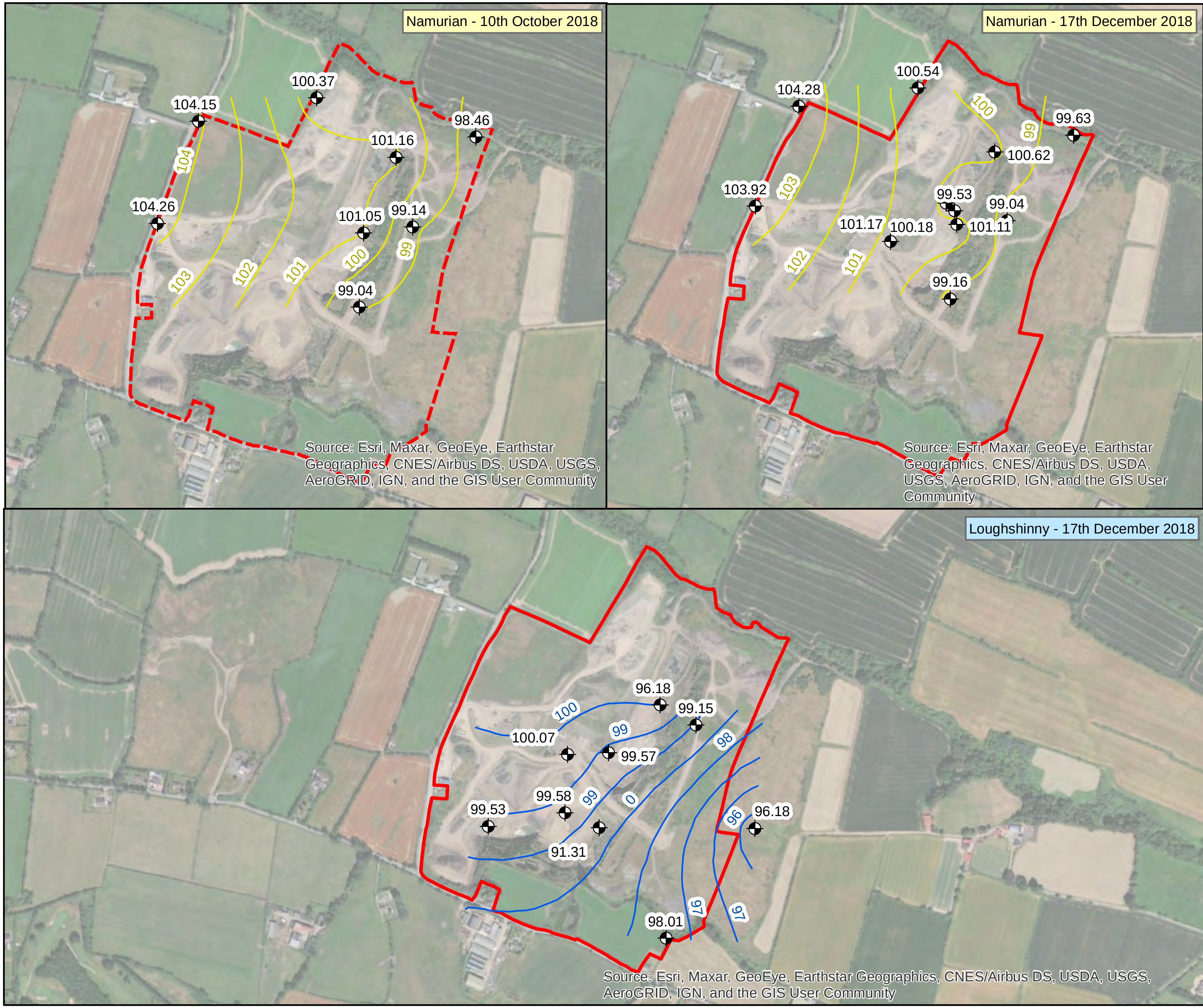

Legend
- Waste Licence Boundary
- Groundwater Contour - Namurian
- Groundwater Contour - Loughshinny
- Groundwater Monitoring Borehole

Data Sources: Geological Survey Ireland (GSI)

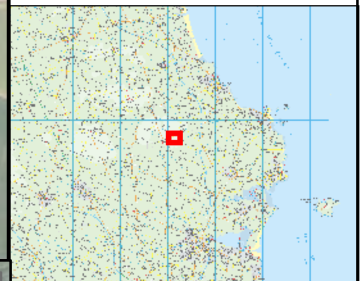

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Figure 9-9: Groundwater Contours

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NOTE:

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Table 9-6 Summary of Groundwater Monitoring Locations

Borehole Reference	Response Zone / Unit	Date Installed	Accessible in 2018/2019	Waste Licence Monitoring Borehole?	Elevation of Interface Between Loughshinny Formation and Namurian (mAOD)
BH4A	Loughshinny Formation	Nov-2018	No	Y	-
BH10A		Mar-2007	Y	Y	116.14
BH12		May-2007	No	Y	100.99
BH15A		Apr-2010	Y		81.89
BH18		Apr-2010	Y	-	95.30
BH25		Apr-2010	Y	-	-
BH30		Apr-2010	Y		c.55.7
BH32		2018	Y	--	60.03
TW10 (existing offsite BOTR)		2018	Y	-	-
BH08	Loughshinny Formation & Namurian	Aug-2001	Y	-	-
BH14		Mar-2007	Y	Y	95.06
BH17		Apr-2010	Y	-	72.41
BH05	Namurian Bedrock	Sep-1998	Y	Y	Not Proven (NP)
BH06		Sep-1998	No	Y	NP
BH08A		Aug-2001	Y	Y	NP
BH09		Aug-2001	Y	Y	NP
BH11A		May-2007	Y	Y	NP
BH13		Apr-2007	No	Y	100.92
BH19		Apr-2010	Y	-	NP
BH20		Apr-2010	Y	-	61.84
BH24		-	Y	-	NP
BH26		-	Y	-	NP
BH27		-	Y	-	NP
BH28		-	Y	-	NP
BH29		-	Y	-	-
BH31		2018	Y	-	32.36
TW07 (existing offsite BOTR)		2018	Y	-	NP
BH16		Apr-2010	N0	-	46.79

Of the 28 monitoring boreholes identified in **Table 9-6**, nine have response zones completed in the limestones of the Loughshinny Formation, sixteen have response zones within the overlying Namurian deposits (shale, mudstone, sandstone and siltstone), with the remaining four locations completed across both the Loughshinny and Namurian bedrock. **Table 9-6** also provides the elevation of the interface between the principal hydrogeological units of interest, namely the limestones of the Loughshinny Formation (Locally Important Aquifer) and overlying mudstones, sandstones and shales of Namurian bedrock (Poor Aquifer).

Time series groundwater level charts for all monitoring boreholes are provided **Volume IV** of this EIAR. Although the long-term trends in groundwater level observed in several monitoring locations were apparently unique to the borehole and difficult to interpret, many boreholes did exhibit similar long-term groundwater variability. The most notable features of those boreholes showing similar long-term variability is as follows:

- A minimum groundwater level, often below 95mAOD, is observed in 2006 or 2007, followed by a subsequent rise in groundwater level that attains are relatively high groundwater level in 2010 that remained high over the period between 2015 to 2018;
- Similar groundwater levels and trends in groundwater are evident in monitoring boreholes completed in the Loughshinny Formation, Namurian strata and boreholes crossing both units;
- The annual range of groundwater levels is typically small in comparison with the long-term variability observed over the entire monitoring period; and
- Boreholes BH04A, BH06 and BH11A exhibit artesian groundwater conditions on occasions. These boreholes are all generally boreholes are constructed in areas with a low ground level and /or near the Bedaragh / Walshestown Stream on the northern site boundary.

Site-specific groundwater level contour maps for the landfill are provided in **Figure 9-8**. Separate contour maps have been provided for the groundwater levels observed within the Loughshinny Formation and the groundwater levels observed in the overlying Namurian strata. The groundwater contour plans confirm the easterly or south-easterly flow direction in these groundwater bearing units on the site, placing the western and eastern site boundary in an up-hydraulic gradient and down-hydraulic gradient position respectively.

The groundwater elevation observed in BH31, the 'offsite monitoring well' drilled in 2018 c. 700m to the north of the site, is higher than observed on the landfill and at the Bog of the Ring public water supply wellfield. This confirms the presence of a groundwater divide between the landfill and the Bog of the Ring and supports the regional easterly hydraulic gradient observed thereon.

The contour plans provided in **Figure 9-8** suggest that despite its small size / low flow, the Ballough Stream that flows from west to east along the northern site boundary is likely to constitute a groundwater receptor at times of high groundwater level. This may not be the case at times of low groundwater level (e.g. 2006) when on-site groundwater levels in both the Loughshinny and Namurian Strata are commonly fall below 95 mAOD. Furthermore, as shown in **Figure 9-1**, there are two additional west-east flowing watercourses present between the landfill and the Bog of the Ring for which it is reasonable to assume that these are likely to exhibit similar groundwater-surface water interrelationship.

The contour plots provide in **Figure 9-8** confirm that although groundwater levels variations were commonly similar in the central and northern parts of the site, a small downward hydraulic gradient is maintained from the saturated Namurian strata to the underlying saturated Loughshinny Formation aquifer was consistently observed. This confirms the site is located in zone of diffuse aquifer recharge. is maintained from the saturated Namurian strata to the underlying saturated Loughshinny Formation aquifer was consistently observed. This confirms the site is located in zone of diffuse aquifer recharge.

The pumping test undertaken in July 2018 demonstrated that the former pond in the southwest corner of the site, which is excavated c. 10m into the limestone of the Loughshinny Formation, represents the elevation of the unconfined groundwater level in that aquifer unit and exerts control on groundwater levels in the southern half of the landfill. The pumping test also demonstrated a strong drawdown response in both the Loughshinny Formation and Namurian strata in boreholes constructed in central and northern parts of the site, suggesting a significant hydraulic continuity between these two units (refer **Volume IV** for further details).

9.5.7.4 Aquifer Productivity & Flow Characteristics

The general the productivity of Lower Carboniferous (Dinantian) Locally Important Aquifers is summarised in the description for the Lusk and Bog of the Ring GWB provided in **Volume IV** of this EIAR. This confirms a generally high transmissivity for Bog of the Ring area, in the region of 580m^2/day, although lower transmissivities of 60-130m^2/day are considered indicative of the regional flow system. The nature of groundwater flow is determined by the degree of fracturing, solution enhanced fissuring, karstification and purity of limestone units. In most areas' groundwater flow is expected to be unconfined, except where it is locally confirmed by glacial till or Namurian strata (depending on the degree of faulting and fracturing thereof) overlie the limestone as seen in the northern parts of the site.

Similarly, the general productivity of Namurian shale and sandstone bedrock is summarised in the description for Hynestown GWB, also provided in **Volume IV**. The permeability of these units is expected to be low and imparted by faulting and jointing enhanced by deformation through folding of these units. Transmissivity and storativity are therefore expected to be low although it is accepted that quantitative data is largely absent. The results of the most recent pumping tests undertaken on the landfill in 2018 demonstrated a strong drawdown response in both the Loughshinny Formation and Namurian strata in boreholes constructed in central and northern parts of the site. This suggests the Namurian strata present on the landfill are characterised by locally enhanced permeability potentially associated with the fault zone characteristic of the site-specific and local geological structure.

9.5.7.5 Groundwater Quality

Site-specific groundwater quality data is collected on a quarterly basis in compliance with Condition 6 of the Waste Licence and reported to the EPA annually. Groundwater quality was monitored in the nine boreholes shown in **Figure 9-4** that include BH4A, BH5, BH6, BH9, BH10A, BH11A, BH12, BH13 and BH14. The groundwater quality monitoring suite is defined in Schedule C.2.2 of the Waste Licence and includes the monitoring of the following parameters on a quarterly basis.

Quarterly Groundwater Suite (denotes Non-Hazardous and # denotes Hazardous Substance)*

- Physical Parameters: Dissolved Oxygen, Odour, Electrical Conductivity, pH, Temperature and Groundwater Level;
- Metals: Iron and Manganese
- Nutrients: Ammoniacal Nitrogen*^{ammonia} and Total Oxidised Nitrogen;
- Inorganic Parameters: Calcium, Chloride, Potassium, Sodium and Sulphate;
- Indicator Parameters: Total Organic Carbon; and
- Organic Parameters: Total Phenols*^{phenol}.

Annual Groundwater Suite (denotes Non-Hazardous and # denotes Hazardous Substance)*

- Metals: Cadmium$^{\#}$, Chromium (Total)*^{CrVI}, Copper, Cyanide (total), Lead*, Magnesium, Mercury$^{\#}$ and Zinc*;
- Nutrients: Total Phosphorous as orthophosphate*;
- Other Inorganic Parameters: Boron* and Fluoride*;
- List I / II Organic Parameters* $^{and\ \#}$; and
- Biological Parameters: Faecal Coliforms, total coliforms.

The groundwater quality monitoring suite, principally for annual monitoring, includes a number of hazardous and non-hazardous substances as defined most recently in Classification of Hazardous and Non-hazardous Substances in Groundwater (EPA, 2010). To aid understanding of groundwater quality the observed on the landfill has been compared to the following:

- Schedule 5 Groundwater Threshold Values for chemical status test as presented in EU Environmental Objectives (Groundwater) (Amendment) Regulations 2016 (S.I. No. 366 of 2016);
- Drinking water standards defined in Table A, B and C of the EU (Drinking Water) Regulations 2014, as amended; and
- Interim Guideline Values (IGVs) for a suite of parameters determined by EPA (Towards setting Guideline Values for the Protection of Groundwater in Ireland, Interim Report (EPA, 2003).

The groundwater quality dataset available at the time of writing is provided in **Volume IV** and typically extends back to 2014. Time series charts showing groundwater quality for selected boreholes are provided in **Volume IV**. The key observations with respect to the groundwater dataset include:

- Generally low and compliant concentrations of principal inorganic parameters (e.g. sulphate, sodium and chloride). Notable exception is non-compliant sulphate concentrations at location BH10A with a mean concentration of 260 mg/l. In the absence of any infilling operations within this area of the former quarry, the elevated concentrations are attributed to natural sulphate concentrations associated within bedrock and processes within the pond in the southwest of the site.

- Typically low and compliant concentrations of ammoniacal nitrogen typically (below 1mg/l) with occasional occurrence of more elevated, non-compliant, concentrations up to 2mg/l. Borehole BH4A is characterised by more consistently elevated concentrations between 0 and 5.3mg/l although this does not appear attributable to waste deposition activities within the facility considering the position of the borehole a significant distance down hydraulic gradient from other monitoring boreholes located in closer proximity to areas of historical or current infilling.
- The concentrations of metals are typically low and below water quality assessment criteria.

Although there are occasional occurrences of certain parameters above water quality assessment criteria the groundwater quality is typically good.

9.5.8 Groundwater Abstraction

9.5.8.1 Public Water Supply Abstractions and Source Protection Areas

Fingal County Council has developed a well field in the Loughshinny formation at the Bog of the Ring (BOTR) that supplies up to 4,000 m^3/day to Balbriggan and surrounding area. The BOTR public water supply is located approximately 3km northeast of the landfill (**Figure 9-6**), on the opposite side of the Namurian bedrock that forms part of the regional synclinal geological structure in this area. Assuming an average daily domestic consumption of 250L/d/household the abstraction rate could supply well in excess up to 10,000 domestic households.

The GSI has defined a Source Protection Area for the BOTR public water supply composed of an Inner Protection Area and Outer Protection Area. As shown in **Figure 9-6** the Hollywood site is located 1km outside of the Outer Source Protection Zone.

9.5.8.2 Private Groundwater Users

A well survey was undertaken by Minerex Environmental Limited (MEL) in August 2010 for MEHL. The well survey involved MEL staff visiting all residential properties situated within a 1km down-gradient and 0.5km up-gradient radius and commercial / business within 2km down-gradient and 1 km up-gradient. The three properties shown in **Figure 9-6** were identified with groundwater abstraction wells, of which only one is located down hydraulic gradient from the site (i.e. to the east thereof) at a distance of c. 0.7km.

9.5.9 Environmental Receptors

The environmental receptors considered relevant to the assessments presented in this chapter and their respective sensitivity is summarised in **Table 9-7**.

Although soils situated in currently undeveloped areas within the ownership boundary, principally to the east of the quarry void, are considered to be of medium importance, there is the potential for localised contamination of these soils in relation to undocumented historical activities in these areas.

The Bog of the Ring is known as an important wetland and wildlife area. The area is proposed as a National Heritage Area (NHA) and this site is considered further in **Chapter 8 Biodiversity**.

Table 9-7 Environmental Receptors

Receptor	Key Receptor Attributes	Distance from Site Boundary (km)	Receptor Importance
Bog of the Ring	Groundwater provides locally important potable water source to > 1000 homes (< 2500 homes)	c. 3km to northeast	Very High
	Groundwater dependent wetland.		
Off-site Private Groundwater Users	Active groundwater abstraction situated down-hydraulic gradient from the site.	Nearest well situated c. 0.7km to east	Medium

Receptor	Key Receptor Attributes	Distance from Site Boundary (km)	Receptor Importance
Groundwater: Loughshinny Formation (LO) Aquifer	Locally Important Aquifer (Lm) Site not located in Source Protection Zone	-	Medium
Groundwater: Walsheston Formation (WL) Aquifer	Poor Bedrock Aquifer (Pl) Potable water source supplying less< 50 homes	-	Low
Groundwater: Balrickard Formation (BC) Aquifer	Poor Aquifer (Pl) Potable water source supplying less< 50 homes	-	Low
Groundwater: Donore Formation (DR) Aquifer	Poor Aquifer (Pl) Potable water source supplying less< 50 homes	-	Low
Soils on undeveloped areas within the land ownership boundary, principally to the east of the quarry void.	Moderately drained and/or moderate fertility soils overlying sub-economically extractable mineral resources (i.e. quarry spoil, above Namurian which is no longer commercially quarried at the site)	-	Medium
Geological Site (Nags Head Quarry Geological Heritage Site).	County Geological Site (Fingal CC, IGH 8 Lower Carboniferous) but does not have National Heritage Areas (NHA) status. Geological site of regional / high local importance.	-	High

9.6 Impact Assessment

The proposed development involves landfilling a mixture of non-hazardous and inert wastes at a rate of 500,000 tonnes per annum as per the existing operation in engineered landfill cells for a 25-year lifetime of operation. An extensive description of the proposed development is available in **Section 5.6**.

A hydrogeological assessment of the landfill was prepared to support the EIAR for the planning and licencing applications and to specifically address the hydrogeological concerns raised by the EPA in 2016 for a similar application at the site. In addition, a LandSim model of the proposed development has also been prepared. Both the hydrogeological assessment and LandSim report are presented in **Volume IV** of this EIAR and provide a conceptual site model for the proposed development.

9.6.1 'Do-Nothing' Impact

The 'Do-Nothing' scenario refers to a scenario whereby the facility would continue the existing permitted operations at the site including the landfilling of inert wastes and the processing of aggregates and concrete.

Under such a scenario the baseline status outlined above would remain largely unchanged. Current operations are having minimal impact and the continuation of operations would continue this impact in the medium term. Waste Licence monitoring of leachate and groundwater would continue until the licence was successfully surrendered with the EPA after which point the monitoring and regulation of these factors would cease.

9.6.2 Construction Phase

The key civil engineering works which will have potential temporary impact on the soils, geology and hydrogeology during construction are summarised below:

- Construction of the attenuation pond and the leachate tanks and area; and
- Other construction activities will include site storage of cement and concrete materials, oils, fuels and other construction chemicals.

The construction phase does have the potential to affect soils, geology and hydrogeology and effects considered for this chapter include:

- Accidental emissions and release of potentially hazardous substances during construction that may affect the quality of groundwater and/or soils, most notably associated with cement, concrete materials, temporary oils and fuel particularly where ground excavations are required;
- Short-term effects on groundwater quality through the infiltration of surface run-off within or adjacent to construction areas; and
- Loss of soil reserves through the construction of hardstanding and structures on the site.

The potential impacts of the operational phase in relation to soil, geology and hydrogeology are described in the following sections and summarised in **Table 9-8**.

Land quality in proposed construction areas (including the hardstanding leachate area and the pond) have the potential to affect human health (site users and construction workers), groundwater and/or surface waters during both the construction and operational phase. The construction areas are largely situated in undeveloped areas of the site that lie outside the quarry void to the east of the site. These areas are currently grassed or vegetated and underlain by quarry excavation spoil historically deposited in these areas during the operation of the active quarry.

Although the new construction areas are currently unused, there is the potential that soils in the areas could have been affected by undocumented historical activities in these areas. The risk associated with land quality in these areas is considered to be low on the basis of discussions with site management team, observations from site walkovers and in the absence of any unacceptable impacts observed on surface waters or groundwater. These risks will therefore be manged through standard measures operational during the construction phase most notably the development of Discovery Strategy for inclusion in the Environmental Management System (EMS) which is currently employed at the site.

Owing to the location of the majority of construction activities outside of the quarry void and the shallow nature, the proposed construction activities are considered unlikely to have the potential to have an effect on the geology / geological features associated with the site, most notably the Nags Head Quarry Geological Heritage Site. Furthermore, it is not anticipated that any of the construction activities will directly intercept groundwater in the aquifer units identified on the site, thereby having a direct effect on the groundwater flow regime in the aquifer units underlying the site.

Table 9-8 Potential Impacts during the Construction Phase

Potential Impact	Attribute	Character of Potential Impact	Importance of Receptor	Magnitude of Potential Effect	Significance of Effect
Accidental emission / release of potentially hazardous substances	Soils	Accidental spillages of fuels, chemicals or other contaminants during construction may result in localised contamination of soils and groundwater underlying the site if materials are not stored and used in an environmentally safe manner. Concrete (cement component) is highly alkaline and any spillage which migrates to groundwater could be detrimental to water quality.	Medium	Small Adverse	Slight Adverse
	Locally Important Aquifer (Lm) (LO)		Medium	Small Adverse	Slight Adverse
	Poor Aquifer (Pl) (DR, BC, WL)		Low	Small Adverse	Imperceptible
	Off-site Private Groundwater Users		Low	Negligible	Imperceptible
	Bog of the Ring PWS & Wetland		Very High	Negligible	Imperceptible
Infiltration of surface runoff	Soils	Silt-laden water can arise from exposed ground and soil stockpiles during construction. Surface water run-off containing large amounts of silt could migrate into the groundwater which can cause significant pollution of water through the generation of suspended solids.	Medium	Small Adverse	Slight Adverse
	Groundwater: Locally Important Aquifer (Lm) (LO)		Medium	Small Adverse	Slight Adverse
	Groundwater: Poor Aquifer (Pl) (DR, BC, WL)		Low	Small Adverse	Imperceptible
	Off-site Private Groundwater Units		Low	Negligible	Imperceptible
	Bog of the Ring PWS & Wetland		Very High	Negligible	Imperceptible
Loss of soil reserves through excavation and/or concealment by structures / hardstanding.	Soils	Soil reserves will be loss through the construction of hardstanding and structures on site in areas of construction and / or areas of hardstanding.	Medium	Small Adverse	Slight Adverse

9.6.3 Operational Phase

The operational phase of the proposed development involves the diversification of infilling and restoration of the former quarry with non-hazardous and inert waste at a rate not exceeding 500,000 tonnes per annum. As an active non-hazardous and inert landfill, the operations effects considered in this chapter are those effects that may result from this planning proposal in relation to the extension and diversification of waste acceptance at the landfill.

The potential impacts of the operational phase in relation to soil, geology and hydrogeology are described in the following sections and summarised in **Table 9-9**. It should be noted that a number of potential impacts have been identified early in the design stage and, as such, have been subject to mitigation inherent in the design as described in **Chapter 5**. In this regard, for these pathways there is no predicated significant adverse impact and no further mitigation is proposed.

The proposed mitigation measures include the construction of cell liners and caps in conjunction with EU legislation, meeting the minimum requirements of the Landfill Directive (Directive 1999/31/EC). The significant mitigation and control measures in the current waste licence will be retained and supplemented in the new IE licence with additional control measures added for the proposed acceptance of non-hazardous and inert waste.

The proposed working plan for the site is described in **Chapter 5** and displayed in **Figure 9-3** and includes:

- The restoration of Cells 4 and 5;
- The continued infill of inert Cell 6 and eventual restoration;
- The construction, infill of inert waste and restoration of Cells 7 and 8;
- The construction, infill of non-hazardous waste and restoration of Cells 9 to 13; and
- Monitoring of all restored cells.

The current inert waste operations undertaken on the facility are considered acceptable from a regulatory perspective and conform to conditions on the Waste Licence. The proposed operations of infilling cells with non-hazardous and other inert wastes do have the potential to effect soils, geology and hydrogeology and these possible effects include:

- Impact on groundwater quality during active infilling through the infiltration of runoff and/or leachate collecting within the waste mass within active cells as a consequence of the time duration extension of active filling. This could result in an increased risk to groundwater dependent receptors (e.g. groundwater users, wetlands or surface water bodies) as compared to existing licensed operations;
- Groundwater abstraction to supplement the water supply to the aggregate processing unit; and
- Increase duration in risk of localised effect compared to the current licensed operation on the quality of soil and potentially groundwater through the accidental release of hazardous materials, most notably fuels, and oils associated with areas of parking, vehicular movements around the site and/or refuelling activities.

The assessment of impacts is summarised in **Table 9-9**.

The proposed surface water drainage system is designed to collect, and transport run off from the landfill and surrounding area to drains at the periphery of the landfill for attenuation and discharge. The collection system will be a network of perimeter drains at the boundary of the landfill footprint. The drains will be designed to minimise run off entering the waste body for active cells and capture the run off from the drainage layers of the capped cells.

9.6.3.1 Potential for Leachate from the Landfill

The mitigation for the potential impact resulting from leachate from the landfill will be mitigated in the design of the proposed development. Cells will be capped and lined in conjunction with the minimum requirements of the Landfill Directive (Directive 1999/31/EC). Leachate will be collected and managed in accordance with the IE Licence conditions. Therefore, there is no predicted significant impacts to the underlying aquifers and off-site private groundwater users.

The Bog of the Ring (BOTR) public water supply (PWS) supplies up to 4,000 m^3/day to Balbriggan and surrounding area. Assuming an average daily domestic consumption of 250L/d/household the abstraction rate could supply well in excess up to 10,000 domestic households. Any potential for ground contamination at the site presents a potential risk to human health through drinking water contamination for these homes.

The hydraulic connectivity to the BOTR PWS and wetland is assessed in the hydrogeological assessment (**Volume IV**). The assessment found that the Hollywood landfill is situated in a different groundwater catchment area than the BOTR wellfield. Notwithstanding this physical separation, sufficient hydrogeological evidence has been gathered to strongly support the conclusion that the two sites are also hydraulically separated.

This evidence includes the observations of the BOTR monitoring boreholes having no response to the one-week Constant Rate Test (CRT) conducted at the site and similarly the absence of response within the landfill monitoring boreholes to very large groundwater drawdown and recovery signals observed within the BOTR wellfield as a consequence of pumping outages and a long period of drought between June and August 2018. Therefore, there is not a pathway to the BOTR, breaking the Source-Pathway-Receptor linkage and meaning no potential for adverse impact.

9.6.3.2 Restoration of Landfill Cells

The proposed development includes the filling and restoration of the current quarry void to be consistent with the landscape surrounding the site. The infilling of the quarry void would result in the loss of the existing geological exposure. However, it is a legal requirement to infill the quarry, there is a requirement to comply with planning and the existing Waste Licence to restore the site to natural ground levels.

The restoration of landfill cells will result the loss of the Nag's Head Quarry a County Geological Site (CGS) but as noted by the GSI in consultation, there are no further envisaged impacts on the integrity of the CGS by the proposed development.

Table 9-9 Potential Impacts during the Operational Phase

Potential Impact	Attribute	Character of Potential Impact	Importance of Receptor	Magnitude of Effect	Significance of Effect
Active infilling non-hazardous and inert waste	Locally Important Aquifer (Lm) (LO)	Impact on groundwater quality during active infilling through the infiltration of runoff and/or leachate collecting within the waste mass within active cells as a consequence of the modified waste streams proposed. Leachate will be produced where rain water percolates through the waste (such as an active cell or an uncapped cell), picking up suspended and soluble materials that originate from, or are products of, the degradation of waste.	Medium	Small Adverse	Slight Adverse
	Poor Aquifer (Pl) (DR, BC, WL)		Low	Small Adverse	Imperceptible
	Off-site Private Groundwater Users		Low	Negligible	Imperceptible
	Bog of the Ring PWS & wetland		Very High	Negligible	Imperceptible
Restoration of waste cells	Nags Head Quarry Geological Heritage Site.	The infilling of the quarry void would result in the loss of the existing geological exposure. However, it is a legal requirement to infill the quarry.	High	Moderate Adverse	Significant / Moderate
Increased timeframe of use of vehicles, plant and other equipment as part of existing licensed operational activities. This includes site roadways, parking areas and inert waste processing areas.	Soils	Accidental discharge of hydrocarbons could occur from site traffic, in car parking area or fuel storage and potentially entering the surface water drainage system if not mitigated. These can be mitigated with good working practices.	Medium	Small Adverse	Slight Adverse
	Groundwater: Locally Important Aquifer (Lm) (LO)		Medium	Small Adverse	Slight Adverse
	Groundwater: Poor Aquifer (Pl) (DR, BC, WL)		Low	Small Adverse	Imperceptible
	Off-site Private Groundwater Units		Low	Negligible	Imperceptible
	Bog of the Ring PWS and wetland		Very High	Negligible	Imperceptible
Groundwater abstraction to supplement the water supply to the aggregate processing plant.	Groundwater: Poor Aquifer (Pl) (DR, BC, WL)	A closed loop water treatment system is connected to the plant with minimal need for supplementary water supply. Low demand and periodic requirement for demand will have minimal impact on groundwater levels and no impact on groundwater quality.	Low	Small Adverse	Imperceptible
	Groundwater: Locally Important Aquifer (Lm) (LO)		Medium	Negligible	Imperceptible
	Off-site Private Groundwater Units		Low	Negligible	Imperceptible
	Bog of the Ring PWS and wetland		Very High	Negligible	Imperceptible

9.6.3.3 Accidental Emissions Release

The surface water design for the permitted access road has been designed to collect surface water runoff from the access road and associated hard stand areas within the development. The water will be collected in the proposed attenuation detention basin and then discharged via a Class 1 bypass interceptor and monitoring chamber to a soakaway and allowed to exfiltrate to ground at the appropriate greenfield run off rates. No direct pathway to surface water with limited capacity for adverse impact.

The mitigation measures for the accidental emission release during the operation stage are implemented in the design of the site and are described in **Section 5.6** and in **Chapter 10 Water**. The processing yard will have a dedicated area for the processing operation as well as the parking, refuelling and maintenance of mobile plant (HGVs, front loaders, etc.). This area will be remotely bunded with all drainage in the area directed to twin holding tanks. The contents of these tanks will be cleared on a regular basis and pumped to the leachate holding tank or taken off site to a suitably licensed waste contractor. The integrity of the bund and tanks will be tested every three years in line with conditions set by the EPA in the IE licence.

With these controls incorporated into the project design there is no significant adverse impact predicted.

9.6.3.4 Groundwater Abstraction

It is proposed to install a groundwater abstraction well at the processing yard. This well will be used periodically to supplement the stormwater harvesting system used to capture water supply for the aggregate processing operation. The frequency for this demands is low and the volumes required to supplement the system are very low (less than 100m^3 per day). As such, the localised impact on the groundwater regime underlying the site will be negligible.

The site is situated in a different groundwater catchment area than the Bog of the Ring wellfield. The cessation of pumping at the Bog of the Ring wellfield in September 2018 had no measurable effect on groundwater level or rates of groundwater recession in any monitoring borehole within the site. Additionally, the drawdown pattern observed the same year was not observed on site.

The groundwater levels at the Bog of the Ring wellfield have been shown to be more 80m lower than groundwater levels on the site and 90m lower than groundwater levels at the groundwater divide (as measured at the new offsite monitoring well BH31). Deep and laterally continuous groundwater body in the fractured Namurian bedrock in the core of the syncline that separates the site from the Bog of the Ring well filed as shown in the regional hydrogeological cross section.

As a consequence, the periodic and low volumes of groundwater abstraction required to feed the aggregate processing system will have negligible impact to off-site receptors including the water levels at the Bog of the Ring wellfield.

9.6.3.5 Summary

These potential effects are managed through ‘incorporated mitigation measures’ that form the conditions in existing Waste Licence described below and will be supplemented in the revised IE licence. These measures have provided acceptable protection of the receptors identified in **Section 9.5.9** relevant to this assessment in this chapter and no material change to these operations are proposed. Any soils present on the landfill that must be removed to allow development of infilling will be temporarily stockpiled and re-used in the restoration of the site.

The Hydrological Assessment report (**Volume IV**) assesses the hydrogeological connectivity of the potential receptors. The assessment found that the landfill is located in a separate groundwater catchment to the BOTR, therefore, the public water supply will not be impacted from the proposed development. The mitigation measures that will be implemented in the design of the proposed development results in potential impacts not having a significant impact on the soils, geology and hydrogeology.

9.7 Mitigation Measures

A variety of mitigation measures shall be incorporated in development design to minimise the potential for adverse effects arising during the construction and operational phases of operations at the site.

The design of the proposed development has taken account of the potential impacts on the soils, geology and hydrogeology in the vicinity of the site. Additional measures to mitigate the potential effects on the surrounding soil, geology and hydrogeology during the construction and operation stages are described in further detail in this section.

The proposed development mitigation designs are described in detail in **Chapter 5**. The designs include leachate management through the collection and removal of leachate, removing the source of pollution breaking the Source-Pathway-Receptor linkage. Other mitigation measures included in design include cell lining, capping and restoration in line with EU Legislation and guidance.

Due to the inter-relationship between hydrology, soils, geology and hydrogeology, the following mitigation measures discussed will be considered applicable to all disciplines.

9.7.1 Construction Phase

The construction works shall be undertaken within a framework of environmental protection practices defined and co-ordinated via the site EMS. The EMS provides measures that meet legislative requirements, industry best practice and key regulatory guidance that define good working practices during construction, most notably:

- CIRIA – Guideline Document C532 Control of Water Pollution from Construction Sites (CIRIA, 2001).

The EMS shall be updated to include the following:

- A Pollution Control and Prevention Plan;
- Surface Water Management Plan;
- Emergency Response Procedures; and
- Contamination Discovery Strategy.

The delivery of these plans shall ensure that the risk of contamination of soils, surface waters and groundwater or the discovery thereof will be minimised, avoided and/or managed during the construction phase. All personnel working on the site will be trained in the implementation of the procedures.

All ready-mixed concrete will be brought to site by truck. A suitable risk assessment for wet concreting will be completed prior to works being carried out which will include measures to prevent discharge of alkaline waste waters or contaminated storm water to the underlying subsoil. Wash down and washout of concrete transporting vehicles will take place at an appropriate facility offsite.

During construction, topsoil shall be maintained in good condition and separate from general spoil. Stockpile locations will be kept away from ditches and water-laden channels and excavations will be left open for minimal periods.

Hydrocarbons used during the construction phase will be handled appropriately in accordance with recognised standards. Waste fuels and materials will be stored in designated areas that are isolated from surface water drains. Skips will be closed or covered to prevent materials being blown or washed away and to reduce the likelihood of contaminated water leakage. Hazardous materials including waste oil, solvents and paints, will be stored in sealed containers in bunded areas and kept separate from other waste materials while awaiting collection by a registered waste carrier. Refuelling, lubrication and storage areas and site offices will not be located within 50m of any surface water bodies.

9.7.2 Operational Phase

The current licence conditions listed in **Section 9.5.3** will be retained, updated or amended within the new Industrial Emissions licence where similar conditions will be imposed and updated for the landfilling of a more diverse waste stream (non-hazardous waste and inert waste). The notable additions to the existing waste licence in the new industrial emissions licence includes the following:

- Non-hazardous waste cells shall consist of a mineral layer which has a permeability of $K \leq 1.0 \times 10^{-9}$m/s and thickness ≥1m. As with the inert cells, all non-hazardous cell design, construction and testing will be subject to a set of SEW requirements that will imposed under the IE Licence;
- Wastes to be accepted at the proposed development is provided in **Section 5.6** the new IE licence will include the diversification in waste to accept non-hazardous waste and inert waste, updating the Acceptance Criteria, verification requirements and the 'Limit Values for Pollutant Content of Inert Waste';
- The monitoring requirements including the frequency and locations of groundwater, leachate and surface water set out in the current waste licence will be supplemented in the IE licence with the addition of additional monitoring locations for compliance monitoring; and
- Waste inspection, quarantine areas, silt traps, oil separators and tank, container and drum storage areas will be retained.

All waste arriving at the site for disposal will be subject to the detailed Waste Acceptance Protocols agreed with the EPA. The minimum formation level for actively licensed cells identified in Condition 3.5 shall be reviewed and where necessary modified, for all new cells using the more detailed groundwater level dataset available for the site. As such it can be ensured that all cells operated during the proposed extension period will continue to be constructed above groundwater level within the aquifer units on the site and will not therefore affect the groundwater flow regime therein.

The monitoring schedules outlined in Schedule C of the Waste Licence shall continue to be delivered for all existing and new cells throughout the operational phase. Additional leachate monitoring infrastructure shall be installed in restored cells and monitored in accordance with the existing monitoring schedule outlined in Condition 3.19. The number of monitoring wells will increase for compliance monitoring in the industrial emissions licence.

The leachate management of the proposed development will be in line with the Landfill Directive is described in detail in the **Section 5.6.9**.

9.8 Residual Impact

This section assesses the residual impacts of the proposed development of the potential impacts assessed in **Section 9.6** after the proposed mitigation measures listed in **Section 9.7** are implemented.

9.8.1 Construction Phase

A summary of the potential effects that may occur during the construction phase and the likely significance is provided in **Table 9-10**.

9.8.2 Operational Phase

A summary of the potential effects that may occur during the operational phase and their likely significance is provided in **Table 9-11**. This table include the effect of the incorporated mitigations identified in **Section 9.7.2**.

The principal concern regarding the operational phase is the potential for an adverse effect whereby leachate generated in non-hazardous and inert waste cells may have on groundwater quality in underlying aquifer units and the associated risk with respect to groundwater dependent receptors (most notably private groundwater users and the Bog of the Ring).

The risk to groundwater quality has been mitigated through the condition prescribed on the Waste Licence which will continue as an Industrial Emissions Licence. These measures shall continue during the extended operational phase at the facility and include: All cells to be situated above groundwater with a minimum formation level of 104.5mAOD; the use of an engineered liner and capping; delivery of requisite monitoring; and Waste Acceptance Protocols. The monitoring data collected to date has demonstrated a general absence of impact on groundwater quality on the site.

The Bog of the Ring public water supply wellfield is not considered to be at risk to operational effects, as it is situated in separate groundwater catchment area to the landfill, this is assessed further in the Hydrogeologic Assessment report in **Volume IV**.

Groundwater flooding has historically been identified as a process that could potentially affect the proposed development principally during its operational phase. Groundwater flooding relates to the occasion when groundwater levels are sufficiently high to cause surface waterlogging and/or groundwater emergence at land surface. Groundwater flooding issues are typically related to the natural groundwater level variability potentially exacerbated by operational issues including drainage and/or excavation. A key consideration regarding the risk associated with groundwater flooding are the finished design elevations of the development design.

The formation level for all waste cells is designed to be situated above natural groundwater levels within underlying aquifer units, principally the Loughshinny Formation, across the site. As such groundwater flooding will not have an effect on the proposed development and is not considered further herein. For new waste cells, the formation level shall be reviewed on a cell by cell basis and a finalised formation level agreed in writing with the EPA.

Table 9-10 Summary of Potential Effects during the Construction Phase

Construction Activity	Potential Impact	Receptor Affected	Importance of Receptor	Incorporated Mitigation Measures	Magnitude of Potential Effect	Significance of Effect	Additional Notes
Delivery, storage and use of potentially hazardous substances during construction. This includes oils, fuels, cement and concrete.	Accidental emission / release of potentially hazardous substances resulting in a localised, short-term effect on soil and groundwater quality beneath release area. Localised and short-term effect.	Soils	Medium	Measures delivered principally through the CMP: Pollution Prevention Plan. Emergency Plan. Activities undertaken in designated, bunded areas on hardstanding	Small Adverse	Slight Adverse	-
		Locally Important Aquifer (Lm) (LO)	Medium		Small Adverse	Slight Adverse	Significant attenuation expected in soils and unsaturated zone.
		Poor Aquifer (Pl) (DR, BC, WL)	Low		Small Adverse	Imperceptible	As above.
		Off-site Private Groundwater Users	Low		Negligible	Imperceptible	No impact predicted as: any effect on groundwater beneath release area will be minor; significant further attenuation along long groundwater flow-path.
		Bog of the Ring PWS & Wetland	Very High		Negligible	Imperceptible	No impact predicted as located in different groundwater catchment area at large distance (c. 3km) from the landfill.
Surface water management within construction areas.	Infiltration of surface runoff, resulting localised effects on soil and groundwater quality within areas of infiltration in the construction area.	Soils	Medium	Surface Water Management Plan delivered through the CMP.	Small Adverse	Slight Adverse	Poor water quality with respect to Hazardous Substances &/or non-hazardous pollutants is not expected.
		Groundwater: Locally Important Aquifer (Lm) (LO)	Medium		Small Adverse	Slight Adverse	As above. Attenuation within unsaturated zone expected.
		Groundwater: Poor Aquifer (Pl) (DR, BC, WL)	Low		Small Adverse	Imperceptible	As above. Attenuation within unsaturated zone expected.
		Off-site Private Groundwater Units	Low		Negligible	Imperceptible	As above. Attenuation within unsaturated zone and lateral groundwater flow path (where present) expected.

		Bog of the Ring PWS & Wetland	Very High		Negligible	Imperceptible	As above. Bog of the ring situated c. 3km from site and is not situated down-hydraulic gradient
Construction structures and / or areas of hardstanding / cover.	Loss of soil reserves through excavation and/or concealment by structures / hardstanding.	Soils	Medium	Striping and storing of soils for use in restoration	Small Adverse	Slight Adverse	-

Table 9-11 Summary of Potential Effects during the Operation Phase

Operational Activity	Potential Impact	Receptor Affected	Importance of Receptor	Incorporated Mitigation Measures	Magnitude of Effect	Significance of Effect	Justification / Notes
Extension to duration of active infilling of non-hazardous and inert waste cells	Increase to infiltration of general runoff or leachate that collects in the waste mass contained in active non-hazardous and inert waste cells.	Locally Important Aquifer (Lm) (LO)	Medium	Waste Acceptance Protocols; above groundwater cells; formation level of 104.5 mAOD (subject to review); Cell Engineering; Requisite leachate, groundwater and surface water monitoring.	Small Adverse	Slight Adverse	Supported by water quality dataset for leachate and groundwater collected to date.
		Poor Aquifer (PI) (DR, BC, WL)	Low		Small Adverse	Imperceptible	
		Off-site Private Groundwater Users	Low		Negligible	Imperceptible	Further attenuation will occur along the groundwater flow-path.
		Bog of the Ring PWS & wetland	Very High		Negligible	Imperceptible	No impact predicted as located in different groundwater catchment area at large distance (c. 3km) from the landfill.
Restoration of inert waste cells	Loss of existing geological exposure	Nags Head Quarry Geological Heritage Site.	High	None proposed as infilling a legal requirement.	Moderate Adverse	Significant / Moderate	Requirement to comply with planning and the WL to restore the site to natural ground levels prevents any further mitigation.
Increased timeframe of use of vehicles, plant and other equipment as part of existing licensed operational activities. This includes site roadways, parking areas and waste processing areas.	Accidental emission / release of potentially hazardous substances (principally hydrocarbons), resulting in a short-term localised effect on soil and groundwater quality. Small localised events	Soils	Medium	Emergency Response Plan	Small Adverse	Slight Adverse	-
		Groundwater: Locally Important Aquifer (Lm) (LO)	Medium		Small Adverse	Slight Adverse	-
		Groundwater: Poor Aquifer (PI) (DR, BC, WL)	Low		Small Adverse	Imperceptible	-
		Off-site Private Groundwater Units	Low		Negligible	Imperceptible	-
		Bog of the Ring PWS and wetland	Very High		Negligible	Imperceptible	-

9.9 Monitoring

Condition 6 and Schedule C of Waste Licence Reg. W0129-02 define the scope of environmental monitoring delivered by the site operator to demonstrate that effect that current operations have upon the local environment. The following monitoring schedules are of relevance to this chapter:

- Groundwater (quality and level);
- Leachate (quality and level) within infilled cells; and
- Surface water including discharges (quality).

All of the above monitoring regimes will continue under the proposed development as the Industrial Emissions licence will remain fully implemented throughout until surrendered following site restoration. The number of monitoring wells used for groundwater monitoring will be increased for compliance monitoring in the new industrial emissions licence.

9.10 References

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2. Directive 2006/118/EC of the European Parliament and of the Council of 12 December 2006 on the protection of groundwater against pollution and deterioration (daughter to 2000/60/EC) (Groundwater Daughter Directive).
3. Directive 2013/39/EU of the European Parliament and of the Council of 12 August 2013, amending Directives 2000/60/EC and 2008/105/EC as regards priority substances in the field of water policy.
4. The Groundwater Directive (80/68/EEC)
5. The Dangerous Substances Directive (76/464/EEC)
6. The Local Government (Water Pollution) Act, 1977 to 1990.
7. The Local Government (Water Pollution) Regulations, 1978 (SI No 108 of 1978).
8. The Protection of Groundwater Regulations, 1999 (SI No 41 of 1999). This is due to be repealed and replaced by the Waste Water Discharge (Authorisation) Regulations, 2007 (SI 684 of 2007) in 2013.
9. The Local Government (Water Pollution) (Amendment) Regulations, 1999 (SI No 42 of 1999).
10. European Communities Environmental Objectives (Groundwater) Regulations 2009 (S.I. No. 9 of 2010)
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26. Geological Survey of Ireland (19th Century). 1:10,560 scale Bedrock Series geology Map Sheet Dublin 14/2.
27. Geological Survey of Ireland (1901). 1:63,360 scale Bedrock Series geology Map Sheet 102 (1901).
28. Geological Survey of Ireland National Draft Bedrock Aquifer map.
29. Geological Survey of Ireland Groundwater Database.
30. Geological Survey of Ireland Quaternary Geology map of Dublin.
31. Jones, G.Ll. (2009). Conodate Report on the geology of the landfill site Hollywood, Naul, Co. Fingal.
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33. APEX (2010). Report on the Geophysical Survey at the MEHL Integrated Waste Facility Site in Naul, Co. Dublin.
34. Site investigation report: IGSL (2010) Ground Investigation Factual report on MEHL Integrated Waste Management Facility.
35. Borehole logs and well records for monitoring wells drilled as part of the current EPA waste licence (see below).
36. On site hydraulic test records including pump tests, infiltration testing, etc.
37. Patel Tonra (2010). Historic groundwater level and quality monitoring data.
38. Minerex (2010) Well survey report.