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DESIGNING AND DELIVERING
A SUSTAINABLE FUTURE

EIAR FOR POWERSTOWN BIOENERGY

Volume 2- Main Body of the EIAR

Chapter 12 – Soils, Geology and Hydrogeology

Prepared for:

Greengate Biogas 001 Ltd.

Greengate Biogas

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12. LAND, SOIL, GEOLOGY AND HYDROGEOLOGY

12.1 Introduction

This chapter has been prepared to examine the potential impacts of the proposed development on existing geological conditions within the study area. The effects of the proposed development are considered, taking account of mitigation measures to reduce or eliminate any residual impacts on land, soils, geology and hydrogeology. The assessment also considers the cumulative impacts associated with other nearby developments.

The elements for assessment is comprised of the following:

- a commercial anaerobic digestion (AD) facility, as described in detail in Section 3.3 of Chapter 3 of this EIAR (proposed development)
- proposed gas pipeline

The proposed development is defined in Chapter 1 – Introduction, and a detailed description of the proposed development is set out in Chapter 3 - Description of the Existing and Proposed Development, in Volume 2 of the EIAR.

12.2 Statement of Authority

This chapter has been prepared by Ian Higgins and reviewed by Tom Clayton. Ian Higgins is a Technical Director with over 25 years' experience working in geotechnical engineering. Ian holds an honours degree in Engineering Geology from the University of Sunderland and a Masters Degree in Geotechnical Engineering from Heriot-Watt University. He is a member of Engineers Ireland, the Geological Society of London and Institute of Geologists of Ireland and is a Chartered Geologist.

Ian has been responsible for the preparation of land, soil, geology and hydrogeology chapters for EIARs for a range of development including biogas plants, renewable energy developments, SID applications and other infrastructure:

- Powergen Renewable Gas Facility, Co. Laois. Planning was granted in 2020 by Laois County Council for an 80,000 tpa anaerobic digestion facility, biomethane cleaning plant and gas to grid entry unit, junction upgrade on the R445 and an 1.5 km extension of the GNI local grid network. This planning was subject to a third party appeal to An Bord Pleanála who upheld LCC decision to grant.
- Biocore Anaerobic Digestion Facility, Co. Laois. 90,000 tpa, application in preparation.
- Edenderry Power Ltd. – Continued use of Edenderry Power Plant exclusively using Biomass, 2020-2031. Planning permission granted by Offaly County Council. Renewable energy project.
- Over 25 windfarm EIARs as listed in Ian's CV.

Tom Clayton MEng. (Distinction) Civil Engineering - a Chartered Engineer with 17 years of experience within the geotechnical sector. Tom has expertise in large infrastructure projects including transport geotechnics (for road, rail, underground rail schemes, active travel and greenway schemes), deep excavations and shafts and Energy Geotechnics. Tom has experience in assessment of soils, geology and hydrogeology for EIAR for a variety of project types including renewable energy and strategic infrastructure developments as listed on his CV.

CV's for Ian Higgins and Tom Clayton are included in Appendix 1.1 of Volume 3 of this EIAR.

12.3 Characteristics of the Proposed Development

The proposed development is an anaerobic digestion (AD) facility for the production of renewable natural gas (RNG) and biogenic liquified carbon dioxide (biogenic CO_2) from agricultural residues including liquid farmyard manures (LFYM) and Solid Farmyard Manures (SFYM) collectively referred to as 'feedstocks'. All of the feedstocks will be compliant with Annex IX of the Renewable Energy Directive. The proposed development is described in detail in Chapter 3 of this EIAR. A glossary of terms and acronyms is in Chapter 1 of this EIAR.

In addition to the proposed development, the project includes a proposed gas pipeline. Gas Networks Ireland as the Statutory Undertaker will be responsible for obtaining development consent for the proposed gas pipeline. The assessment of the gas pipeline route is included in this EIAR. The gas pipeline route is 9.6 km from the biomethane network entry facility (BNEF) at the proposed development to an existing Above Ground Installation (AGI) at Clogrennan, Co. Carlow. The proposed development and the proposed gas pipeline route is described in Chapter 3 of Volume 2 of this EIAR.

In terms of the soils, geology and hydrogeology environment, the proposed development is located in an operational and partially restored sand and gravel quarry. The site is depressed with respect to the surrounding lands which is beneficial for screening and means that significant excavations are not required. The proposed pipeline route will be located along a road network. The proposed design facilitates the capture of all storm water preventing infiltration. The deepest excavation required is between 3-5 m into made ground below existing ground levels and at least 2-11 m above groundwater levels. This is to facilitate the construction of the HDPE lined stormwater pond, which is the first construction activity scheduled. There are no concrete works in this excavation. Foundations for the buildings are stone piles.

12.4 Assessment Methodology

The guidelines and methodology for impact assessment are detailed in Chapter 1 of Volume 2 of the EIAR, i.e. Guidelines on the Information to be Contained in Environmental Impact Assessment Reports (EPA, 2022). Legislation and policies relevant to the project are detailed in Chapter 2 of Volume 2 of the EIAR. Additional - specific guidelines and sources were considered in this assessment:

In summary the methodology adopted for this assessment includes:

- review of appropriate guidance and legislation
- characterisation of the receiving environment
- review of the proposed development
- assessment of potential effects
- identification of mitigation measures
- assessment of residual impacts

The assessment methodology and criteria are outlined in Section 12.4.

The study area, for the purposes of assessing the baseline conditions for the Land, Soils, Geology and Hydrogeology Chapter of the EIAR, extends beyond the site boundaries and includes potential receptors with which there may be a pathway to/from the proposed development and receptors that may be indirectly affected by the proposed development. The extent of the wider study area was based on the Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements (Institute of Geologists of Ireland, 2013) which recommend a minimum distance of 2.0 km from the Site.

12.4.1 Relevant Guidance

The general EIA guidelines are listed in Chapter 1, other topic specific reference documents used in the preparation of this section include the following:

- Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes (National Roads Authority (renamed Transport Infrastructure Ireland), 2009)
- Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements (Institute of Geologists of Ireland, 2013)
- European Union (2000/60/EC) Water Framework Directive (European Commission, 2000)
- European Union (2006/188/EC) Groundwater Directive (European Comission, 2006)
- European Communities Environmental Objectives (Groundwater) Regulations (S.I. No. 9 of 2010) (Government of Ireland, 2010) as amended
- European Communities (Water Policy) Regulations (S.I. No. 722 of 2003) (Government of Ireland, 2003)

12.4.2 Water Framework and Groundwater Directives, Status and Risk Assessment

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 – known as the Water Framework Directive (WFD) (European Commission, 2000) requires EU member states to aim to reach good chemical and ecological status for surface and ground waters; with good ecological status for surface waters and good quantitative status for groundwaters. The WFD established a strategic framework for managing the water environment.

The implementation of the 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
- the Dangerous Substances Directive (76/464/EEC) repealed in 2013

Under the WFD large geographical areas of aquifer have been subdivided into smaller groundwater bodies for them to be effectively managed.

The overriding purpose of the is to achieve at least “good status” in all European waters and ensure that no further deterioration occurs in these waters. European waters are classified as groundwaters, rivers, lakes, transitional and coastal waters. The first cycle of river basin management planning, which covered the period 2009-2015, developed plans and associated programmes of measures based on eight River Basin Districts (RBDs) within the island of Ireland. These plans set ambitious targets that envisaged that most water bodies would achieve good status by 2015 or at the latest by 2027.

The Groundwater Directive (European Comission, 2006) 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 take account of 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 in groundwater.

12.4.3 Consultation

This EIAR chapter has been compiled in light of the comments received from consultees throughout the EIA process, the relevant elements of which are summarised hereunder and presented in detail in Chapter 5 - EIA Scoping and Consultation. Of the consultees contacted, no specific comments relating to geology or hydrogeology were received at the time of consultation or before submission. Both An Coimisiún Pleanála and Carlow County Council noted the adjacent closed landfill and advised establishing a baseline pre development in light of activities in the surrounding area. Refer to Section 12.5.6.7.

12.4.4 Impact Assessment Methodology

As outlined in Section 12.1, the aim of this chapter is to identify the impacts of the construction, operation and decommissioning of the proposed development and associated works on the existing land, soils, geology and hydrogeology of the study area.

The following elements were examined to determine the potential impacts of the proposed development on the Land, Soils, Geology and Hydrogeology within the study area:

- characterisation of the land, soils, geology and hydrogeology underlying the study area
- evaluation of the potential impacts of the proposed development

The baseline geological and hydrogeological conditions within the study area were determined following a desktop review of publicly available information, including aerial photography, EPA and GSI online databases. Site walkovers and intrusive investigations were also carried out.

The Conceptual Site Model (CSM) identifies potential contaminants, receptors and exposure pathways that may be present based on the construction and operational phase of the proposed development. The identification of potential “contaminant linkages” is a key aspect of the evaluation of potentially contaminated land and in quantifying the potential risk associated with Proposed Developments. An approach based on this methodology has been adopted within this report.

At the impact assessment stage, any potential beneficial or adverse impacts associated with the development are identified and assessed with reference to the baseline environment. This requires consideration of:

- quality of effects (sensitivity of receptor)
- significance of effects (severity)
- description of extent and context of effects (character/ magnitude)
- probability of effects
- duration and frequency of effects
- type of effect (direct, indirect, residual, etc.)

Following the assessment of the existing environment, the unmitigated impacts of the proposed development during the construction, operational and decommissioning phases on sensitive receptors identified were determined. The evaluation of the significance of the impacts was undertaken in accordance with the guidance (Institute of Geologists of Ireland, 2013)

Where potential significant impacts were identified, mitigation measures are recommended to minimise impacts on the environment to acceptable levels of significance. The residual impact from the proposed development was then appraised considering the recommended remedial measures. The residual impacts from the proposed development are presented in Section 12.2 of this chapter.

12.4.5 Evaluation Criteria

During each phase (construction, operation, maintenance and decommissioning) of the proposed development, several activities will take place on site, some of which will have the potential to cause impacts on the geological regime at the proposed site and the associated Land, Soil, Geology and Hydrogeology. These potential impacts are discussed throughout this chapter. Mitigation measures, where required, are presented in Section 12.7.

12.4.5.1 Assessment of Magnitude and Significance of Impact on Land, Soils and Geology

An impact rating has been developed for each of the phases of the proposed development based on the guidance (Institute of Geologists of Ireland, 2013). In line with this guidance, the receiving environment (Geological Features) was first identified.

Using the NRA rating criteria in Appendix C of the guidance (Institute of Geologists of Ireland, 2013), the importance of the geological and hydrogeological features are rated (Table 12- 1 & Table 12- 2) followed by an estimation of the magnitude of the impacts on geological and hydrogeological features (Table 12- 3 & Table 12- 4).

This determines the significance of the impact prior to application of mitigation measures as set out in Table 12- 1:

Table 12-1: Criterian Rating Importance of Geological Features(NRA, 2009/IGI,2013)

Magnitude	Criteria	Typical Example
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. Volume of peat and/or soft organic soil underlying the site is significant on a national or regional scale	• Geological feature on a regional or national scale (NHA). • Large existing quarry or pit. • Proven economically extractable mineral resource
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. Volume of peat and/or soft organic soil underlying the site is significant on a local scale	• 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 high fertility soils • Moderately sized existing quarry or pit • Marginally economic extractable mineral resource

Magnitude	Criteria	Typical 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. Volume of peat and/or soft organic soil underlying the site is moderate on a local scale	• 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
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. Volume of peat and/or soft organic soil underlying the site is small on a local scale	• 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 • Uneconomic extractable mineral resource

Table 12-2: Criteria Rating Site Importance of Hydrogeological Features (NRA, 2009/IGI, 2013)

Importance	Criteria	Typical Example
Extremely High	Attribute has a high quality or value on an international scale	• Groundwater supports river, wetland or surface water body ecosystem protected by EU legislation e.g., SAC or SPA status
Very High	Attribute has a high quality or value on a regional or national scale	• Regionally Important Aquifer with multiple wellfields. • Groundwater supports river, wetland or surface water body ecosystem protected by national legislation – e.g., NHA status. • Regionally important potable water source supplying >2500 homes Inner source protection area for regionally important water source.
High	Attribute has a high quality or value on a local scale	• 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.
Medium	Attribute has a medium quality or value on a local scale	• Locally Important Aquifer • Potable water source supplying >50 homes. • Outer source protection area for locally important water source.
Low	Attribute has a low quality or value on a local scale	• Poor Bedrock Aquifer. • Potable water source supplying <50 homes.

The assessment of the magnitude of an impact incorporates the timing, scale, size and duration of the potential impact. The magnitude criteria for impact on Geological and Hydrogeological features are outlined in Tables 12.3 and 12.4 respectively.

Table 12-3: Estimation of Magnitude of Impact on Geological Features (NRA, 2009/IGI, 2013)

Magnitude	Criterion	Description and Example
Large Adverse	Results in loss of attribute	• 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 • Requirement to excavate and replace high proportion of peat, organic soils and/or soft mineral soils beneath alignment
Moderate Adverse	Results in impact on integrity of attribute or loss of part of attribute	• 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 • Requirement to excavate and replace moderate proportion of peat, organic soils and/or soft mineral soils beneath alignment
Small Adverse	Results in minor impact on integrity of attribute or loss of small part of attribute	• 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
Negligible	Results in an impact on attribute but of insufficient magnitude to affect either use or integrity	• No measurable changes in attributes
Minor Beneficial	Results in minor improvement of attribute quality	• Minor enhancement of geological heritage feature
Moderate Beneficial	Results in moderate improvement of attribute quality	• Moderate enhancement of geological heritage feature

Magnitude	Criterion	Description and Example
Major Beneficial	Results in major improvement of attribute quality	• Major enhancement of geological heritage feature

Table 12-4: Estimation of Magnitude of Impact on Hydrogeological Features (NRA, 2009/IGI, 2013)

Magnitude of Impact	Criteria	Typical Examples
Large Adverse	Results in loss of attribute and /or quality and integrity of attribute	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.
Moderate Adverse	Results in impact on integrity of attribute or loss of part of attribute	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. Calculated risk of serious pollution incident >1% annually.
Small Adverse	Results in minor impact on integrity of attribute or loss of small part of attribute	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.
Negligible	Results in an impact on attribute but of insufficient magnitude to affect either use or integrity	Calculated risk of serious pollution incident <0.5% annually.

The matrix in Table 12- 5 determines the significance of the impacts based on the importance and magnitude of the impacts as determined by Tables 12.1 to 12.4.

Table 12-5: Ratings of Significance of Impact for Geology/Hydrogeology (NRA, 2009)

Importance of Attribute	Magnitude of Impact			
	Negligible	Small Adverse	Moderate Adverse	Large Adverse
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	Slight/Moderate

The determination of the significance of each impact for this site is discussed in Section 12.6

12.4.6 Desk Study - Methodology

Prior to undertaking the site walkovers and intrusive site investigations, a desk study was undertaken to help determine the baseline conditions within the study area and planning boundary to provide relevant background information. The desk top study involved an examination of the following sources of information:

- OSI (2026), Current and historic Ordnance Survey Ireland mapping and ortho-photography
- General Soil Map of Ireland (Taluntais, 1980)
- Geological Survey of Ireland (2026) GSI Public Data Viewer (www.spatial.dcenr.gov.ie)
- Environmental Protection Agency (2026) Review of the EPA online mapping (http://gis.epa.ie/Envision)
- Study of the proposed layout of the development

To determine the existing hydrogeological regime within the study area the following EPA and GSI online datasets (2026) and mapping from the sources outlined above were reviewed:

- Catchment & Management Units
- Groundwater Bodies Status and Risk
- Drinking Water Protection Areas
- Groundwater Resources (Aquifers)
- Groundwater Wells and Springs (Groundwater wells assumed to be present in every dwelling within 1 km of the site boundary)
- Karst Features
- Groundwater Vulnerability

12.4.7 Site Investigations and Field Assessments - Methodology

A site walkover was undertaken by an Engineering Geologist working for Fehily Timoney and Company (FT) and under supervision of Ian Higgins during December 2024 to determine the baseline characteristics of the proposed development site.

The site assessment works undertaken comprised the following:

- Walk over inspections of the study area with recording of salient geomorphological features at proposed infrastructure locations.
- Recording of GPS co-ordinates of site investigation locations using a hand-held GPS.

Intrusive site investigations were undertaken by Causeway Geotech Ltd (CGL) under the supervision of an Engineering Geologist from FT during December 2024 and October 2025. These included trial pits, dynamic probes and boreholes across the proposed site, all associated laboratory testing, as well as a groundwater pump test. The findings are presented in Section 12.5 and the site investigation report is included as Appendix 12.1 in Volume 3 of this EIAR.

12.5 Baseline Environment

The receiving environment is described hereunder. This includes descriptions of the underlying quaternary and bedrock geology, areas of geological heritage, areas of economic interest with respect to geological resources and potential for soil contamination. This section also includes a summary of site-specific information obtained during site walkovers and intrusive site investigations undertaken as part of the baseline assessment works.

The site is located along the L3045, which is accessed along the Carlow to Kilkenny road - the R448 Regional Road. The site is located directly to the south of Carlow County Council's closed Powerstown Landfill site and to the west of the operational Recycling Centre, co-located on the landfill site both of which are under an EPA licence (Waste Licence no. W0025-04).

The site is quarried by Kilcarrig Quarries Ltd. and has been backfilled with imported inert soil and overburden from quarrying. This made ground, and groundwater on site was tested as part of the baseline assessment, see 12.5.11.

The site of the proposed development is within a rural area and is surrounded by agricultural land. There are a small number of residential properties in proximity to the application site located in a linear fashion along the surrounding roads.

The proposed pipeline route from the proposed development site to Clogrennan, Co. Carlow is described in Chapter 3. The route will be in road or along the grass verge of the roads and therefore in made ground, with the exception of crossings where horizontal direction drilling will be used to cross under the River Barrow and to cross the M9 motorway and two land drains.

12.5.1 Historical Land Use

Historical mapping and aerial photography available from the Ordnance Survey of Ireland website (OSI, 2026) and Google Earth (Google Earth, 2026) were reviewed and key observations on-site and off-site are summarised in Table 12- 6. The proposed pipeline route follows the regional and local road network.

Table 12-6: Historical Land Use of Proposed Development Site

Date	Source)	Description
1837-1842	OSI 6 Inch	Agricultural fields, a single dwelling on the local road.
1888-1913	OSI 25 Inch	No change
1995	OSI Aerial	No change
1996-2000	OSI Aerial	No change onsite. Powerstown landfill visible to the north of the site. Separate quarry visible to the southeast of the site.
2001-2005	OSI Aerial	Evidence of excavation of sand and gravel onsite (western and central area). No quarry activity in eastern extent of site. Separate quarry to southeast has expanded.
2006-2012	OSI Aerial	No change
2009		As previous
2015		Western area of quarry restored.
2013-2018	OSI Aerial	Evidence of expansion of quarry to the east. Powerstown landfill was partially capped. Separate quarry to the southeast has expanded further
2019		Quarry activity in eastern area of the proposed development site. Central area of proposed development site is restored to grassland. Capping programme at Powerstown Landfill at completion stage
2021-2026		Northern and eastern area of proposed development site being filled

12.5.2 Soils

The soils beneath the majority of the proposed development and pipeline route have been mapped by Teagasc (GSI, 2026) as shallow, well-drained mineral soils (mainly basic) classified as Renzinas and Lithosols, derived from limestone sands and gravels parent materials (IFS Soil Code: BminSW). Small areas of Alluvium (AlluvMN) and Till classified as deep, well drained mineral soil, grey brown podzolics (BminDW) and brown podzolics (AminDW) are also encountered along the proposed pipeline route. It is proposed to lay the pipeline in the existing road network or verges. Therefore the soils environment is made ground both at the proposed development and along route of the proposed gas pipeline with the exception of the river and motorway crossings.

The mapped soils at the site are presented in Figure 12-1.

12.5.3 Quaternary Deposits

The quarry has been backfilled with imported inert fill and overburden from quarrying activities. The Quaternary Geology underlying the proposed development is discussed below and presented in Figure 12.2.

The subsoils present within the development site and wider study area were taken from the Geological Survey of Ireland (GSI) online mapping - Quaternary Geology of Ireland (1:50,000 scale) and comprise:

- Gravel derived from Limestone (GLs)
- Cut over raised peat (Cut)
- Alluvium (A)

As shown in Figure 12.2 the proposed development site is underlain by Gravel derived from Limestone.

The majority of the proposed gas connection route is in road (made ground) and underlain by Gravel derived from Limestone with limited areas of Alluvium and Till derived from Limestone indicated along the proposed gas route.

12.5.4 Quaternary Geomorphology

The Geological Survey of Ireland (GSI) mapping records the proposed development site and pipeline route as being part of a glaciofluvial terrace, part of the Barrow river system.

12.5.5 Solid Geology

The Geological Survey of Ireland (GSI) 1:100,000 scale bedrock geology map shows that the proposed development and pipeline route is underlain by the Millford, Ballysteen and Ballyadams Formations.

The Millford Formation is described as comprising a dolomitised peloidal calcarenitic limestone. The Ballysteen Formation is described as a dolomitised dark-grey muddy limestone.

The proposed gas pipeline route traverses the Millford Formation and the Ballyadams Formation. The Ballyadams Formation comprises a crinoidal wackestone/packstone limestone.

The bedrock geology of the proposed development and surrounding area is presented in Figure 12.3.

During the ground investigation bedrock was encountered at depths ranging from 14m to 20m below ground level (bgl). A map showing the ground investigation locations is located in Appendix 12.1 of Volume 3 of this EIAR.

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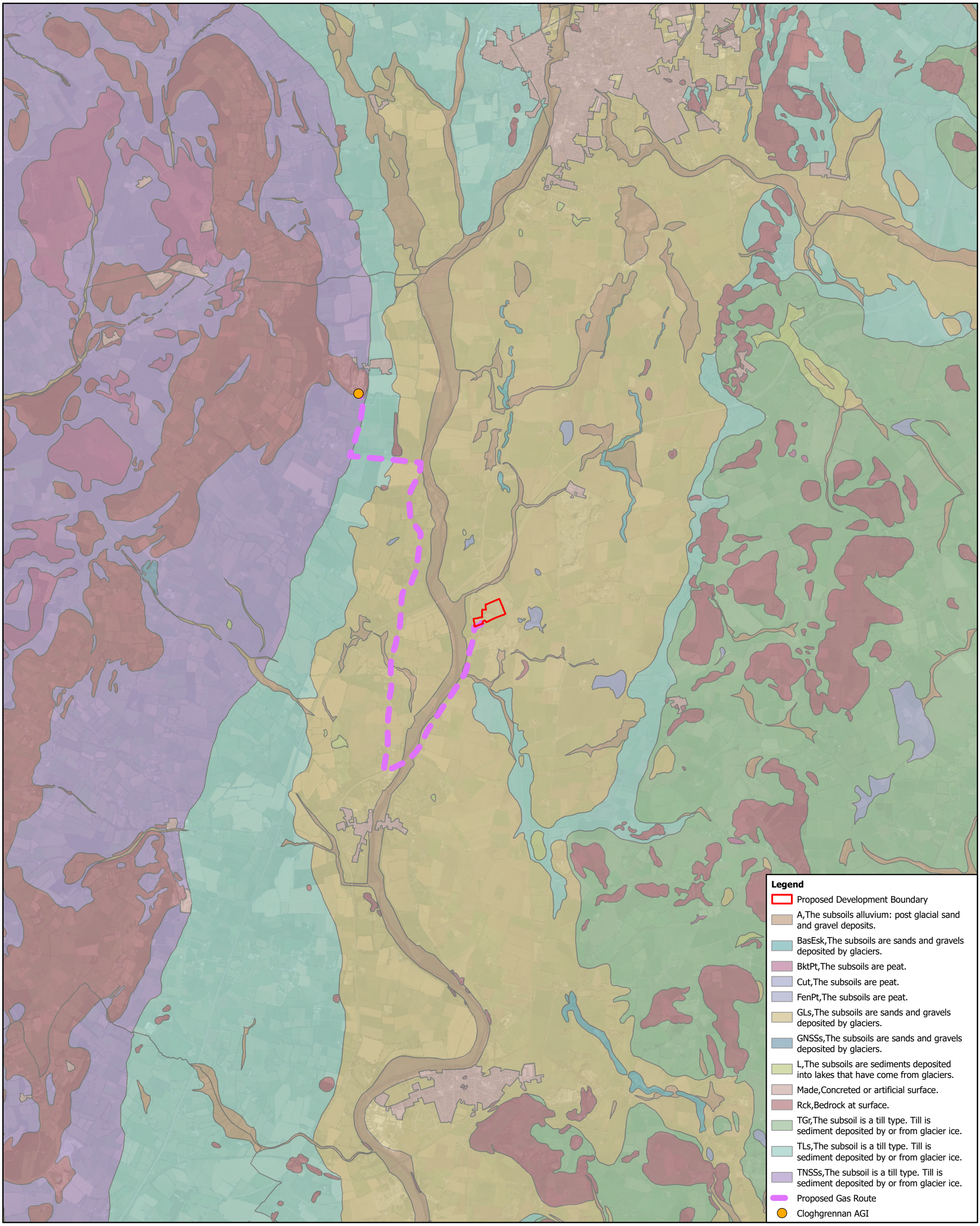

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	CLIENT: Greengate Biogas		
PROJECT: Powerstown Bioenergy	**SCALE:** 1:50,000	**REVISION:**	0
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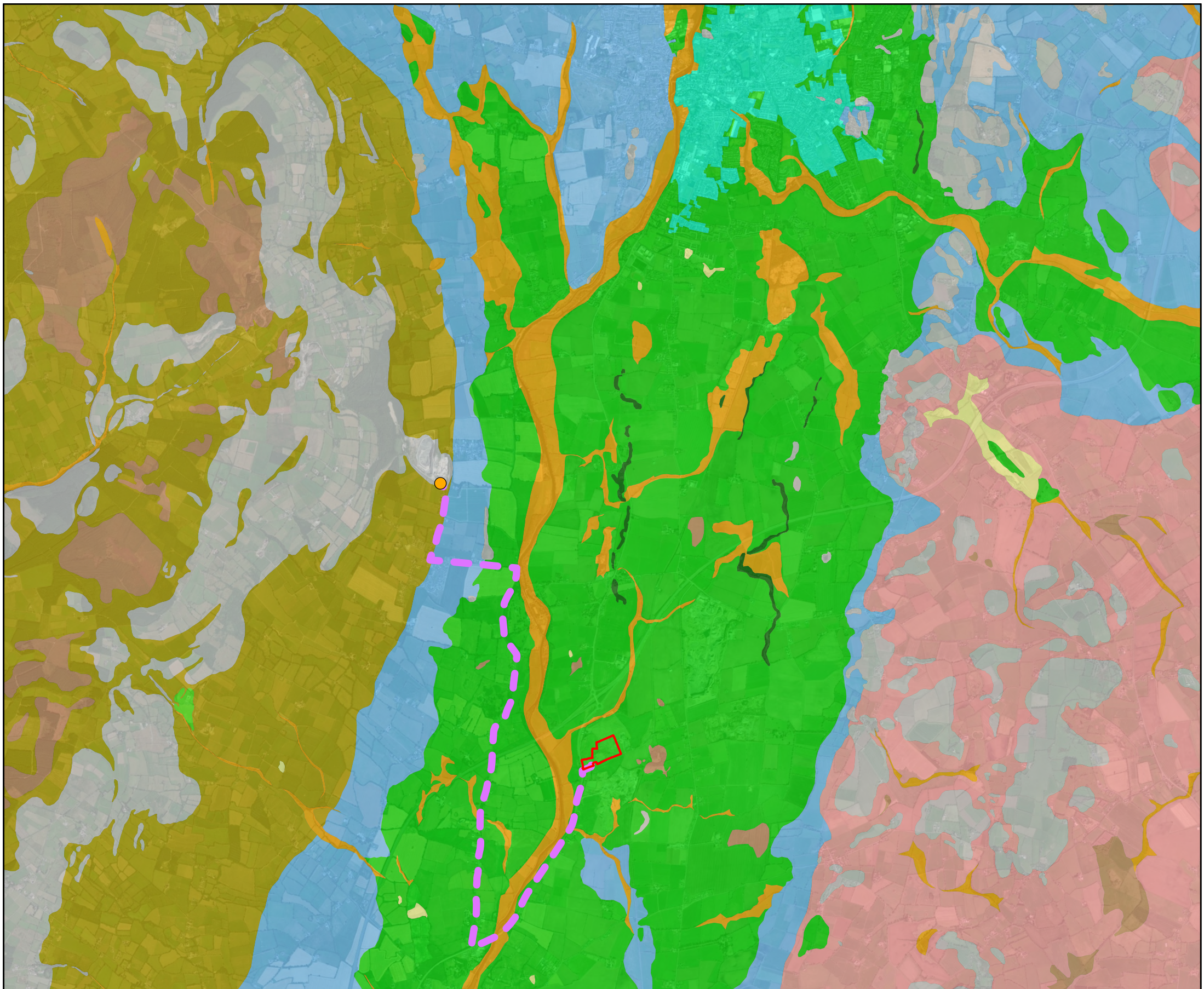

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PROJECT: Powerstown Bioenergy	**SCALE:** 1:50,000	**REVISION:**	0
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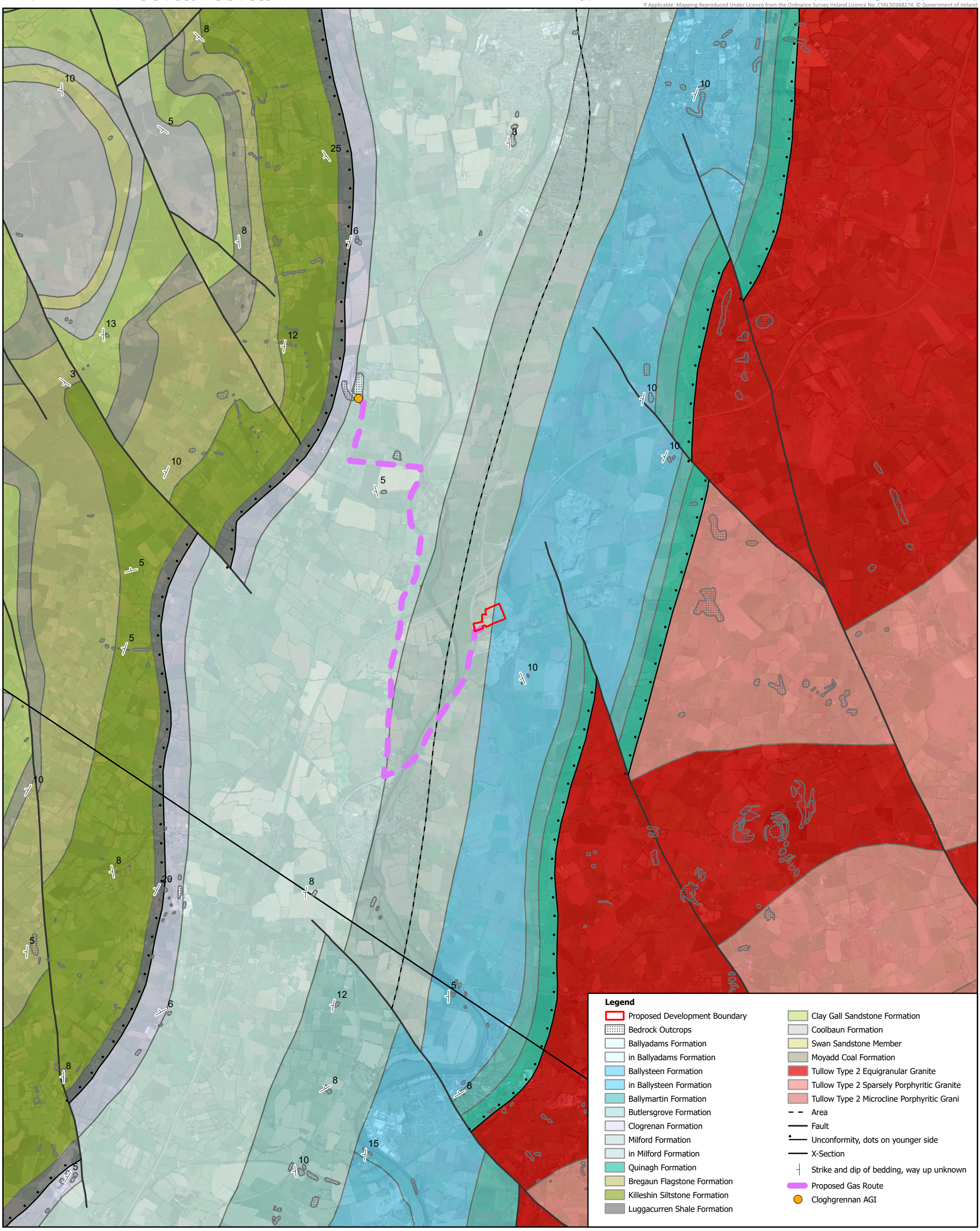

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12.5.6 Hydrogeology

12.5.6.1 Groundwater Vulnerability

The Groundwater Vulnerability within the proposed development site boundary is classified by the GSI as 'High'. Along the proposed gas pipeline route, the vulnerability ranges from 'Medium' to 'Extreme'.

Based on the GSI aquifer vulnerability mapping, overburden deposits are >3 m deep across the proposed development site.

A summary of the groundwater vulnerability for the proposed development site is presented in Table 12- 7. This table outlines the standard ratings of vulnerability used by the GSI, with the existing site conditions highlighted based on the findings of the ground investigation.

Table 12-7: Groundwater Vulnerability

Vulnerability Rating	Hydrogeological Conditions		
	Subsoil Permeability (Type) and Thickness		
	High Permeability (sand/gravel)	Moderate Permeability (sandy soil)	Low Permeability (clayey subsoil, clay, peat)
Extreme (E)	0 - 3.0 m	0 - 3.0 m	0 - 3.0 m
High (H)	> 3.0 m	3.0 -10.0 m	3.0 - 5.0 m
Moderate (M)	N/A	>10.0 m	5.0 - 10.0 m
Low (L)	N/A	N/A	>10 m

12.5.6.2 Groundwater Bodies (GWB) Description

The proposed development site and the proposed gas pipeline route is located within the Athy-Bagenalstown Gravels GWB, (also referred to as the Bagenalstown GWB by the GSI). Figure 12-4 is a map of groundwater bodies.

The descriptions of the GWB within the study area have been taken from the 'Summary of Initial Characterisation' draft reports for each defined GWB (GSI WFD Groundwater Working Group, 2003). The GWB Characterisation Reports are available from the GSI Public Data Viewer. Site specific data including depth to bedrock and subsoil type encountered during intrusive investigations has been used to supplement and validate the published information.

Athy-Bagenalstown Gravels GWB/Bagenalstown GWB

The Athy-Bagenalstown Gravels GWB/Bagenalstown GWB underlies the proposed development and associated gas connection route. Within the overburden, the glacial sands and gravels are described by the GSI (2026) as being part of a regionally important gravel aquifer.

Based on information published by GSI on the Athy-Bagenalstown Gravels GWB/Bagenalstown GWB: 'there is hydraulic continuity between the Barrow Valley sands and gravels and the underlying aquifer. Under natural non-pumping conditions, the flow regime in the aquifer is severely restricted, as there is no natural discharge down-dip. Hence the aquifer will be full of water and circulation will be limited to the near surface zone. Under pumping conditions leakage will occur from the sands and gravels into the aquifer.'

The GSI (GSI, 2026) has classified the bedrock beneath the proposed development and the proposed pipeline route as a Regionally Important Aquifer - Karstified (diffuse) (Rkd).

Regionally important aquifers are capable of supplying regionally important abstractions (e.g. large public water supplies), or 'excellent' yields (>400 m^3/d). 'Karstification' is the process whereby limestone is slowly dissolved away by percolating waters. Karstification frequently results in the uneven distribution of permeability through the rock, and the development of distinctive karst landforms at the surface (e.g. swallow holes, caves, dry valleys), some of which provide direct access for recharge/surface water to enter the aquifer.

The GSI groundwater recharge map provides an estimate of the average amount of rainwater that percolates down through the subsoils to the water table over a year. The map accounts for rainfall that percolates diffusely through soils and subsoils but does not take into account water that enters aquifers at points (e.g., at sinkholes) or along linear features (e.g., along sinking streams/rivers). Groundwater recharge amounts are estimated by considering soil drainage, subsoil permeability, thickness and type, the ability of the aquifer to accept the recharge, and rainfall.

The GSI states that diffuse recharge will occur via rainfall percolating through the subsoil or areas of outcropping rock. In the Barrow valley the bedrock aquifer will mainly recharge along the slopes of the Castlecomer Plateau, because of a thin subsoil covering. As streams cross the shale/limestone area, water frequently enters the aquifer via swallow holes.

In this case, the groundwater flows to the west northwest, towards the River Barrow, with a shallow groundwater gradient (Plate 12.1). It is inferred that the river is in hydraulic continuity with the water table in the gravel aquifer.

Table 12-8: Summary of Aquifer Classifications & Characteristics

Groundwater Body	European Code	Aquifer Name	GSI Aquifer Classification	Groundwater Body Status	Transmissivity (m2/day)
Athy-Bagenalstown Gravels GWB/ Bagenalstown	IE_SE_G_157 IE_SE_G_160	Unnamed	Regionally Important Aquifer - Karstified (diffuse)	Good	Typically, 2-200 m2/d

According to interim classification work carried out as part of the Water Framework Directive and published by the EPA, the Athy-Bagenalstown Gravels GWB /Bagenalstown groundwater body is classified as having 'Good' status in terms of water quality and quantity.

12.5.6.3 Groundwater Supply Sources

A review of published information on groundwater supply sources within the study area was undertaken to identify potential groundwater dependant receptors at potential risk from the proposed development. These include group water schemes (GWS), source protection zones and private supply wells with information on these features obtained from the GSI Groundwater database and site walkovers.

12.5.6.4 Source Protection Zones

The GSI maintains a database of Public Supply Source Protection Areas. From a review of the database there are no Public Supply Source Protection Areas within the proposed development site boundary, however the proposed pipeline route passes through the Ballinabranna Group Water Scheme zone of contribution boundary. Excavations for the proposed pipeline are shallow (m) whereas the 2 no .groundwater supply well are in bedrock, downslope of the proposed route. There will be no impact on the group water scheme.

12.5.6.5 Groundwater Wells and Springs

Based on a review of the GSI Groundwater Wells and Springs database there are 27 No. Groundwater Wells recorded (500m to 1 km accuracy) within 2 km of the proposed development site.

Table 12- 9 outlines details of groundwater wells and springs held within the GSI dataset and those identified during site assessments within 2 km of the proposed development. Based on the topography and hydrology of the area, groundwater flow direction is to the west-northwest, towards the River Barrow.

Table 12-9: Summary of Wells within 2km of the Proposed Development (GSI,2026)

Location ID	Easting (ITM)	Northing (ITM)	Type	Total Depth (m BGL)	Current Use	Yield Class	GSI Location Accuracy (m)
2615NWW053	272510	168850	Borehole	13.1	Industrial	Poor (32.7)	1 km
2615NWW054	272510	168810	Borehole	12.5	Industrial	Poor (30.5)	1 km
2615NWW055	272510	168770	Borehole	36.6	Industrial	Moderate (43.6)	1 km
2615NWW056	270720	168610	Borehole	17.4	Industrial	Good (27.3)	500 m
2615NWW057	270720	168560	Borehole	13.7	Industrial	Moderate (87.3)	500 m
2615NWW074	271920	167150	Borehole	12.2	-	Poor (14.2)	1 km
2615NWW128	269340	169710	Borehole	25.0	-	Moderate (87.3)	500 m
2615NWW152	270720	168850	Borehole	23.0	Industrial		10 m
2615NWW154	270700	168770	Borehole	9.0	Industrial		10 m
2615NWW155	270890	168830	Borehole	8.0	Industrial		10 m
2615NWW250	270500	169500	Borehole	2.8	Agricultural and Domestic	Poor	500 m
2615NWW257	270740	168730	Borehole	21.0	Industrial	Good	20 m
2615NWW260	270630	168820	Borehole	16.0	Industrial	Poor	20 m
2615NWW261	270510	168760	Borehole	14.0	Industrial	Good	10 m

Location ID	Easting (ITM)	Northing (ITM)	Type	Total Depth (m BGL)	Current Use	Yield Class	GSI Location Accuracy (m)
2615NWW262	270500	168540	Borehole	79.3	Industrial	Good (32.7)	20 m
2615NWW264	270700	168870	Borehole	13.1	Industrial		20 m
2615NWW265	270890	168840	Borehole	15.0	Industrial	Good (21.8)	20 m
2615NWW266	270720	168630	Borehole	22.0	Industrial	Good (27.3)	20 m
2615NWW267	270670	168570	Borehole	25.3	Industrial	Good (49.1)	20 m
2615NWW268	270550	168980	Borehole	15.8	Industrial		20 m
2615NWW271	271070	168870	Borehole	22.9	Industrial	Good (27.3)	20 m
2615NWW272	271080	168860	Borehole	18.0	Industrial	Poor (2.2)	20 m
2615NWW273	270930	168940	Borehole	12.9	Industrial	Good (32.7)	20 m
2615NWW274	270930	168940	Borehole	12.9	Industrial	Good (32.7)	20 m
2615NWW275			Borehole	3.6	Industrial	Good (32.7)	20 m
2615NWW424	270620	170120	Borehole	20.7	Agricultural and Domestic -	Poor (21.4)	100 m
2615NWW426	270660	170020	Borehole	25.9	Agricultural and Domestic -	Good (218.2)	100 m

12.5.6.6 Karst Features

According to the GSI datasets, there are no karst features recorded within 2km of the proposed development site or along the gas connection of grid connection routes. The nearest karst feature (a spring) is located approximately 10 km to the south-west of the proposed development site.

12.5.6.7 Powerstown Landfill Groundwater Quality

Annual groundwater monitoring reports are produced for the neighbouring closed Powerstown landfill site in accordance with the IE Licence requirements. Monitoring has been carried out on a quarterly basis over the lifetime of the licence. The groundwater flow contours show groundwater flows in a north westerly direction meaning the proposed development is upgradient of the closed landfill, see Plate 12.1. A summary of the data from 2025 (the most recent available) (Carlow County Council , 2026) indicates that are two upgradient wells (RCA1 and RCA2) located in the Recycling Centre, two 'background wells' (GW3 and GW6) and the remaining wells are downgradient, some on site and some off site downgradient of the landfill boundary (BH1, BH2, BH3, BH4, GW8). Results are compared to both the Groundwater Threshold Values (GTVs) in European Communities Environmental Objectives (Groundwater) Regulations, 2010 (S.I. No. 9 of 2010) and also with trigger levels set by the licence for certain wells (with historically elevated levels of contaminants).

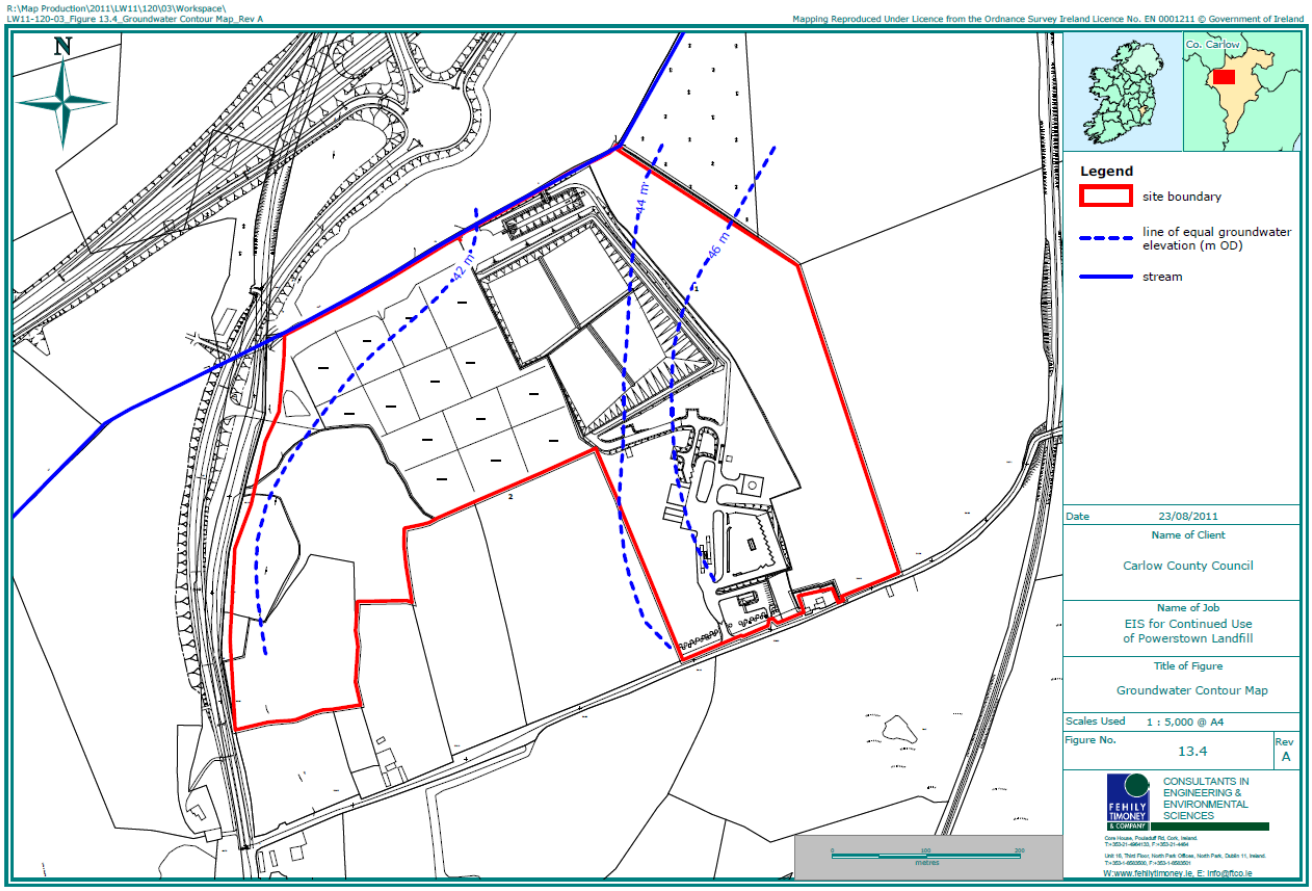

Plate 12-1: Groundwater Contour Map for Powerstown Landfill and Recycling Centre

The 2025 groundwater report (Carlow County Council , 2026), includes 5 year trends for ammonia at each of the monitoring locations. All other parameters monitored are within licence and legislative limits. The upgradient and background wells show ammonia levels below the GTV over the past 5 years with single peaks in the range 0.35 mg/l up to 2.5 mg/l, Off site downgradient well ammonia levels were below the GTV with the exception of one incident at GW8 in Q1 2025 where ammonia was recorded at 0.65 mg/l. This elevation against the normal trend was also seen at downgradient wells RAC1 and GW7 and cross gradient well GW3. No reason was given for the elevated result, but levels returned to normal and below the GTV in the remaining three quarters of 2025. Overall results show some impact from ammonia, likely derived from leachate in the unlined oldest portion of the landfill (phase 1) to the west, however results do not indicate migration off site. Leachate is collected from a network of wells and conveyed to a leachate tank for offsite treatment. The proposed development site is upgradient of the landfill in groundwater terms.

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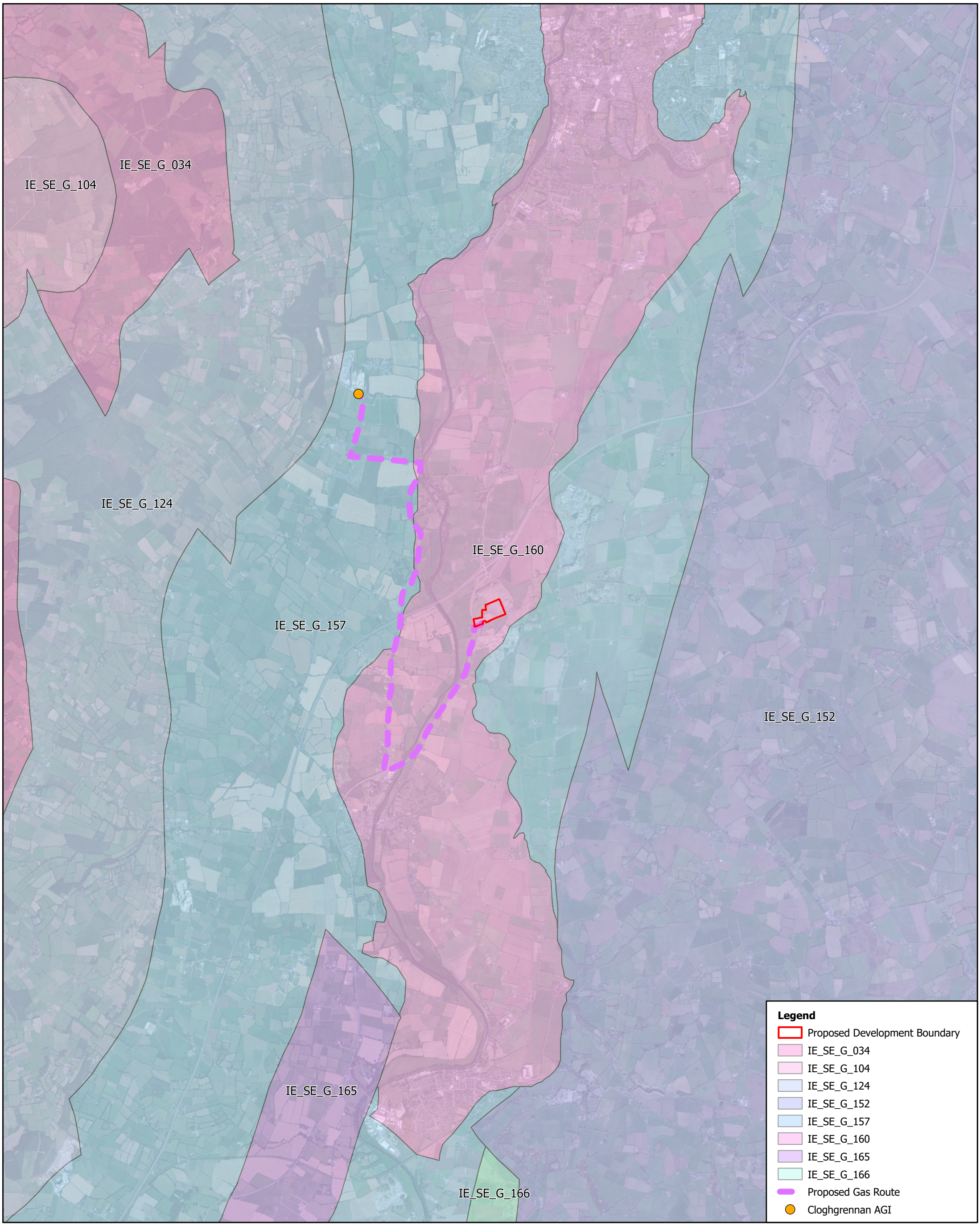

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	CLIENT: Greengate Biogas		
PROJECT: Powerstown Bioenergy	**SCALE:** 1:50,000	**REVISION:**	0
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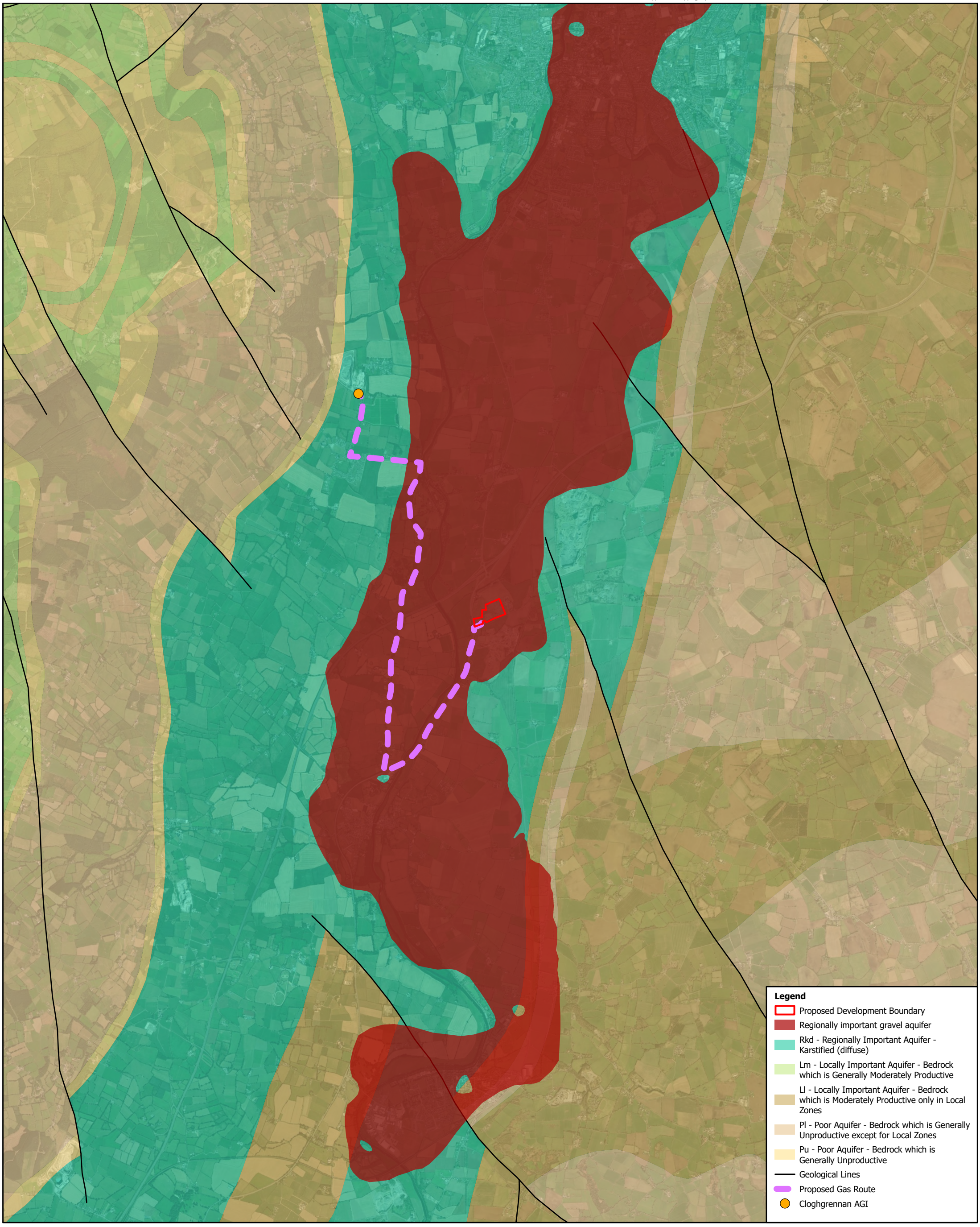

TITLE: Aquifer Classificaiton	**FIGURE NO:** 12.5		
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PROJECT: Powerstown Bioenergy	**SCALE:** 1:50,000	**REVISION:**	0
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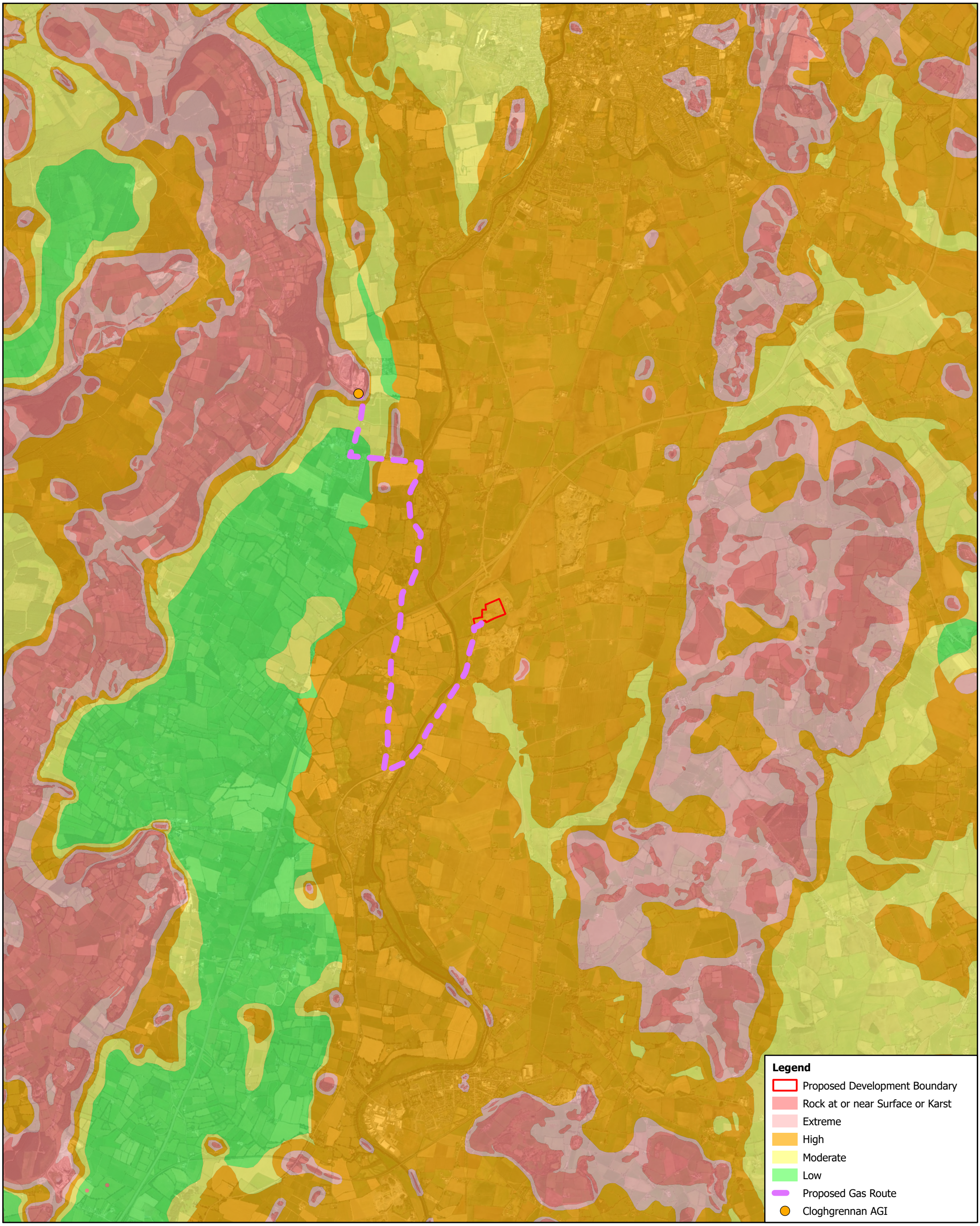

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PROJECT: Powerstown Bioenergy	**SCALE:** 1:50,000	**REVISION:**	0
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12.5.7 Geological Heritage

The GSI - Irish Geological Heritage Section (IGH) and NPWS (National Parks and Wildlife Service) have undertaken a programme to identify and select important geological and geomorphological sites throughout the country for designation as NHAs (Natural Heritage Areas) – the Irish Geological Heritage Programme. This is being addressed under 16 different geological themes. For each theme, a larger number of sites (from which to make the NHA selection) are being examined, to identify the most scientifically significant. The criterion of designating the minimum number of sites to exemplify the theme means that many sites of national importance are not selected as the very best examples. However, a second tier of County Geological Sites (CGS) (as per the National Heritage Plan) means that many of these can be included in County Development Plans and receive a measure of recognition and protection through inclusion in the planning system.

The GSI Online Irish Geological Heritage database indicates that the proposed development site and the proposed gas pipeline route are not located in an area of specific geological heritage interest. The nearest site of significant geological heritage features to the study area is located approximately 1 km to the northeast of the proposed development, which is Morrisey's Quarry, described as a large working quarry with extensive overburden of glacial till. A second heritage feature is located 3.6 km to the northwest of the proposed development, and less than 500 m from the gas pipeline route, recorded as Clogrennane Quarry, described as a large and deep working quarry, and stating that "this active quarry exposes the Lower Carboniferous Ballyadams Formation (thickly bedded wackestones and crinoid-rich calcarenites) at the base of the section and passes upwards into the Clogrenan Formation".

The distribution of Geological Heritage sites within the study area is shown on Figure 12.7.

12.5.8 Economic Geology

The GSI Online Minerals Database accessed via the Public Data Viewer shows a number of active and historic quarries and mineral occurrences surrounding the study area. Their distribution is shown on Figure 12.8. These consist of sand and gravel quarries and recorded mineral occurrences none of which are located within the site boundary.

There are two working quarries within 2 km of the proposed development site, Dan Morrissey's Quarry to the northeast and Kilcarrig Quarries (Powerstown) to the south. An additional quarry is located less than 500 m from the gas pipeline route, Clogrennane Lime Works. The proposed development site itself is a sand and gravel pit (Mary Kelly's Pit), which is currently quarried and being restored by backfilling.

The GSI Aggregates database indicates that there is a very low potential for crushed rock aggregate across the proposed development site, and very low to very high potential along the gas pipeline route, as shown in Figure 12.9. There is also a high to very high potential for granular aggregate across the proposed development site and very low to very potential along the gas pipeline route as shown in Figure 12.10. Within the proposed development site, the majority of this resource has already been extracted and as such this is no longer an accurate assessment of the potential for granular aggregate at the proposed development site.

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TITLE: Geological Heritage	**FIGURE NO:** 12.7		
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PROJECT: Powerstown Bioenergy	**SCALE:** 1:50,000	**REVISION:**	0
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TITLE: Economic Geology	**FIGURE NO:** 12.8		
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PROJECT: Powerstown Bioenergy	**SCALE:** 1:50,000	**REVISION:**	0
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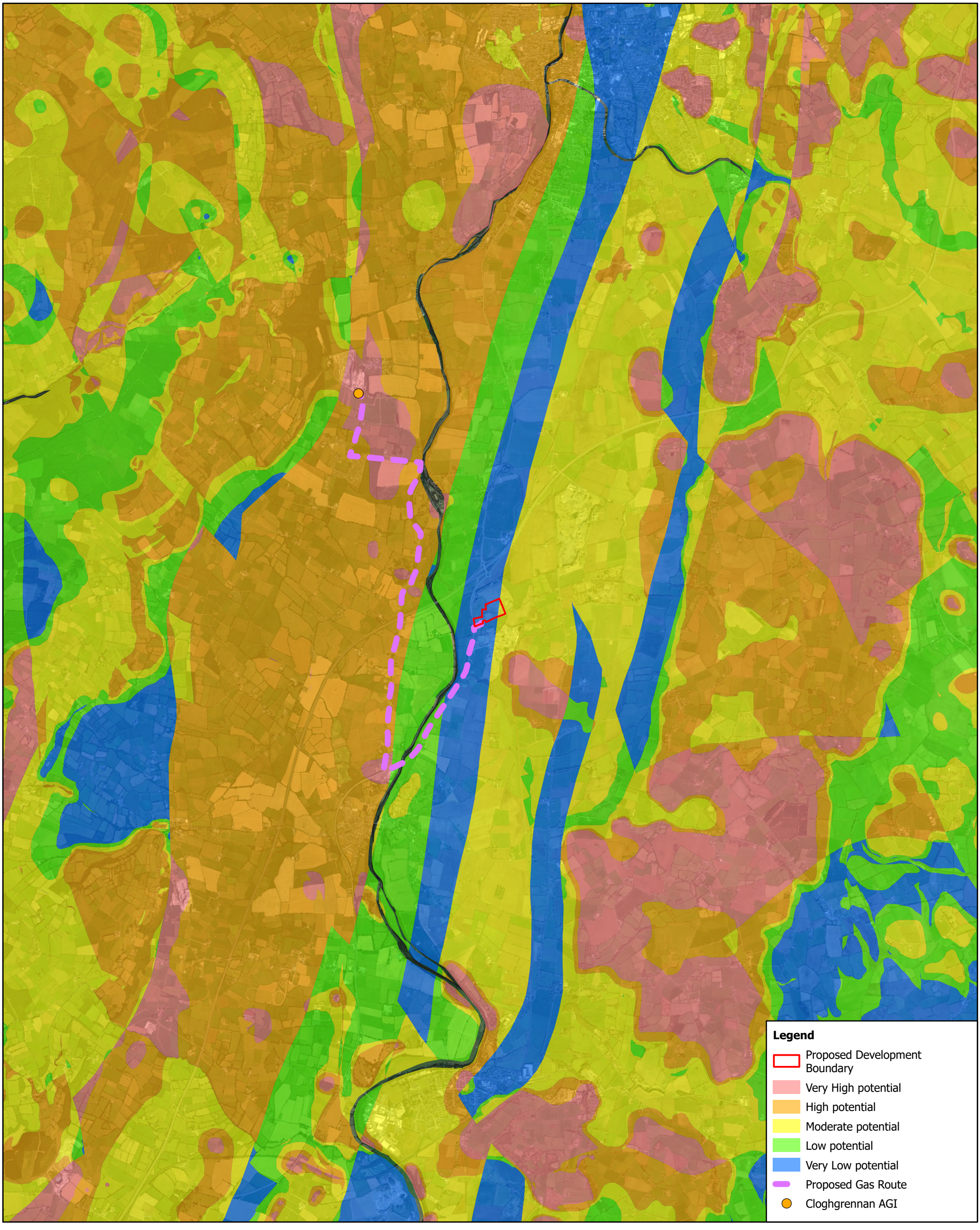

TITLE: Crushed Rock Potential	**FIGURE NO:** 12.9		
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PROJECT: Powerstown Bioenergy	**SCALE:** 1:50,000	**REVISION:**	0
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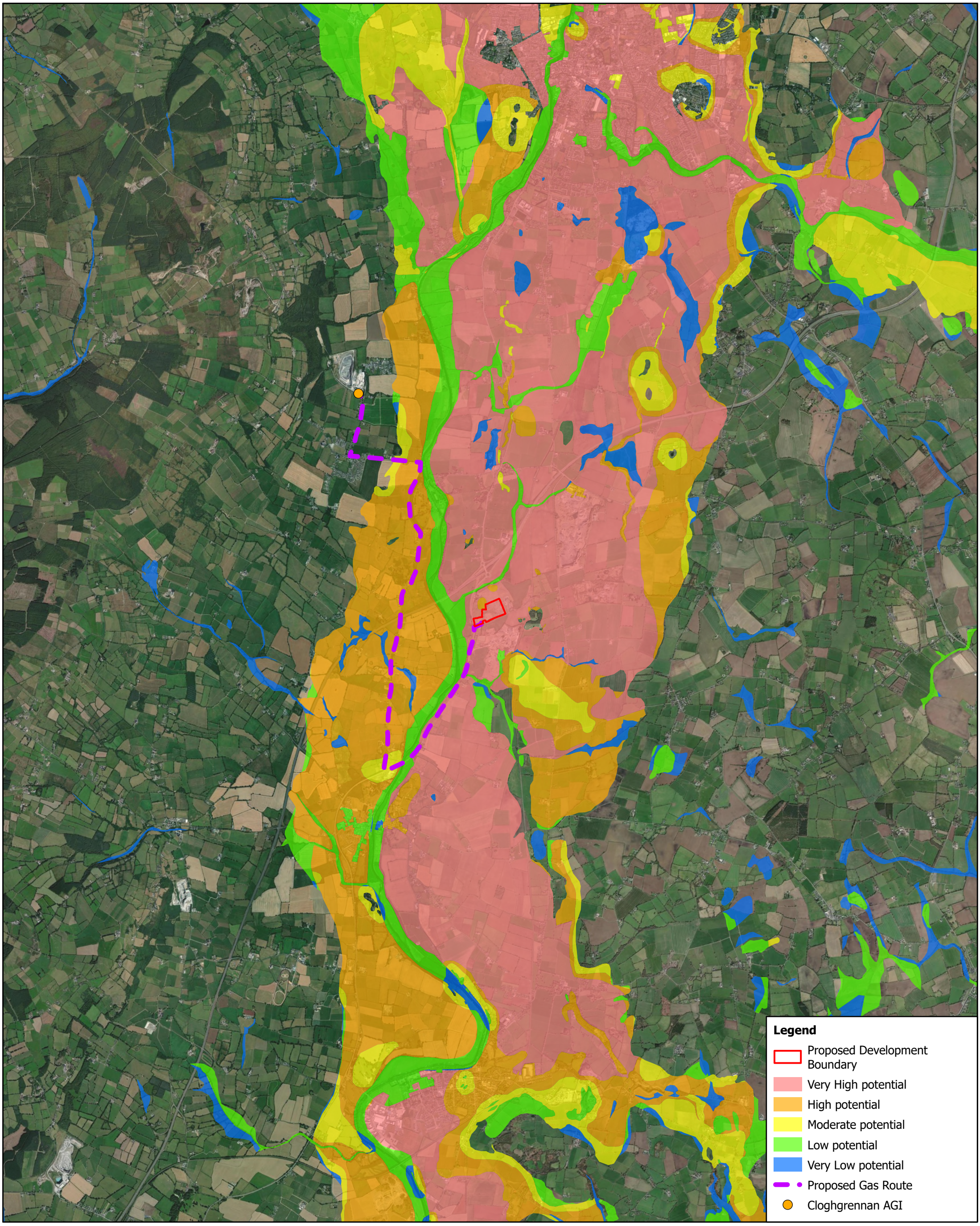

TITLE: Granular Aggregate Potential	**FIGURE NO:** 12.10		
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PROJECT: Powerstown Bioenergy	**SCALE:** 1:50,000	**REVISION:**	0
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12.5.9 Ground Investigation - Results

Intrusive investigations were undertaken by Causeway Geotech Ltd (CGL) under the supervision of an Engineering Geologist from FT during December 2024 and October 2025.

Intrusive investigations were undertaken across the proposed development site, and comprised four boreholes, 12 trial pits, 12 dynamic probes, in-situ testing (SPT's), a pumping test and associated laboratory testing. A copy of the Ground Investigation report is included in Appendix 12.1 in Volume 3 of this EIAR. A copy of the borehole pump test undertaken in October 2025 is included in Appendix 12.2 in Volume 3 of this EIAR. A location plan providing the location of the ground investigation exploratory holes is included in Figure 12-11. Ground investigation locations were selected to investigate subsurface conditions across the site to a sufficient depth to allow for the design of the proposed development.

The geology encountered in the exploratory holes comprises Made Ground overlying cohesive and granular glacial deposits. The Made Ground is comprised of interbedded cohesive and granular deposits which are described in the exploratory logs as sandy gravelly or slightly sandy slightly gravelly or slightly sandy gravelly Clay with low to medium cobbles or sandy slightly gravelly Silt with low to medium cobbles and sandy or silty sandy or slightly clayey sandy Gravel with low to medium cobbles or clayey gravelly or gravelly or Sand. Made Ground was recorded to a depth of between 1.3 and 4.7m bgl in trial pits and boreholes.

The cohesive glacial deposits generally comprise stiff to very stiff sandy slightly gravelly or sandy gravelly Silt or Clay with low to medium cobbles, while the in-situ granular glacial deposits generally comprise sandy or silty sandy Gravel with cobbles and boulders.

The granular glacial material found in the exploratory holes was identified as being of sandstone/limestone lithology. The bedrock is part of the Milford Formation as outlined by the GSI, which comprises limestone.

Standard Penetration tests (SPT's) were conducted in boreholes to provide information on the density and shear strength of the overburden. The results show an increase in strength with depth, which would be considered typical of an overconsolidated glacial material.

Bedrock is described as a medium strong and strong thinly laminated and thinly bedded dark grey and grey Limestone with calcite veins. The bedrock is described as slightly weathered, with closely to medium spaced discontinuities (fractures).

During the ground investigation minor shallow groundwater seepage was recorded in certain trial pits and boreholes. Table 12- 10 shows the groundwater monitoring results from during and post the intrusive site investigations. The remainder of site investigation locations, including rotary holes were noted as being dry during the works. See Figure 12-11 for the locations of exploratory holes.

Table 12-10: Summary of Groundwater Readings

Borehole	Ground Elevation mOD	Groundwater Levels mOD			
		19/12/2024	09/01/2025	13/02/2025	27/02/2025
BH01	50.78	45.28	n/a	42.21	42.85
BH02	44.13	n/a	41.93	42	42.2
BH03	49.43	41.98	n/a	42.22	42.27
BH04	46.57	n/a	33.3	41.29	41.52

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TITLE: Ground Investigation Location Plan	**FIGURE NO:** 12.11		
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PROJECT: Powerstown Bioenergy	**SCALE:** 1:2,500	**REVISION:**	0
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A pump test was undertaken as part of the ground investigation to confirm the capacity of the underlying aquifer to supply the required process water for the operational phase of the proposed development. The results of the pump test are included in Appendix 12.2. A borehole was drilled in the southeastern corner of the proposed development to a depth of 40m. Bedrock was recorded at a depth of 14m bgl. The pump test was undertaken within the bedrock. A pumping rate of 10m^3/hour (equivalent to 240m^3/day) was maintained throughout the 72-hour pump test, which recorded a 1.0m fall in the water level within the pumping well during the pump test. the groundwater level recovered to the pre-pump test level within 30 minutes of completion of the test. Groundwater level monitoring at two of the installed standpipes across the site indicated no change in the groundwater level at those two locations.

The results of the pump test show that the required 120m3/day of process water can be supplied by the pump well within the site. This is below the threshold required for an abstraction licence from the EPA under the Water Environment (Abstractions and Associated Impoundments) Act 2022 and the Water Environment (Abstractions and Associated Impoundments) Regulations 2024. It must be registered with the EPA prior to the construction phase. As a registered abstraction, the operators obligations are:

- Measure the daily rate of the abstraction.
- Maintain records of the results of all measurements.
- Maintain any pipework, storage tanks or other equipment associated with an abstraction to keep water leakage to a minimum; and give notice to the EPA of any changes to the entry on the register of abstractions (e.g. material change, transfer, cessation of abstraction).

12.5.10 Topography of the Proposed Development Site

The sites topography is characteristic of its use as a sand and gravel quarry which has been partially backfilled. The site is depressed with respect to the surrounding lands with steep slopes from the site up to the boundaries with adjacent lands. The existing topography is shown in Drawing No. P24188-FT-XX-XX-DR-CE-0150 and 0151 Existing Site Sections.

A landscaping berm exists beyond the western boundary of the site along the R448. The southern boundary slopes from the site upwards to the L3045. The internal site topography is characterized by irregular stockpiles or infilling to the eastern portion of the site associated with overburden from sand and gravel quarrying. The western portion of the site is generally more regular falling west to east to the lowest point of the site is located centrally along the northern boundary

The following drawing in Volume 4 of this EIAR show the existing and proposed ground levels and the proposed earthworks:

- Drawing No. P24188-FT-XX-XX-DR-CE-0150 Existing Site Sections Sheet 1 of 2
- Drawing No. P24188-FT-XX-XX-DR-CE-0151 Existing Site Sections Sheet 2 of 2
- Drawing No. P24188-FT-XX-XX-DR-CE-0153 Proposed Site Sections Sheet 1 of 2
- Drawing No. P24188-FT-XX-XX-DR-CE-0154 Proposed Site Sections Sheet 2 of 2
- Drawing No. P24188-FT-XX-XX-DR-CE-0300-0303 Proposed Earthworks Cut and Fill Plan and Section Sheets 1 to 3.

These, together with groundwater level data in Table 12-10 shows that:

- The deepest excavation required is for the construction of the proposed stormwater lagoon. The excavation will extend to 44 mOD in this area; groundwater was detected between 33 mOD and 41.5 mOD. The stormwater lagoon is described in Chapter 3 Description of the Existing and Proposed Development in Volume 2 of the EIAR, in summary it is an earthen structure with a liner. There are no concrete works below the liner.
- The tank farm bund will require excavations of soil to 45m OD. The closest boreholes to this are BH01 and BH 02 which show average groundwater levels of 42.75 mOD, i.e. 2.25 m below the level of excavation.
- In areas such as the circulation yard, very limited excavation of soil is required. The surface of the circulation yard will be at an elevation of 49.25 mOD. This requires a subbase and slab thickness of 0.48 m. Groundwater levels are on average at 41 m OD.

It is not anticipated that significant dewatering will be required to control groundwater during the construction of the proposed development. The construction methodology in Section 3.5 of Chapter 3 describes the design controls for excavations, stormwater and groundwater control and concrete pours including dewatering to avoid any interaction with storm water and groundwater in excavations.

12.5.11 Soil and Groundwater Contamination

There are no known areas of soil contamination on the proposed development site or the proposed gas pipeline route. No evidence of soil contamination was noted during site walkovers. As earthmoving equipment is used across much of the proposed development site it is possible that minor fuel spills and leaks have occurred locally in the past.

Due to the presence of local roads within the study area and along the proposed gas and proposed gas pipeline route there is a risk of fuel leakages and other highway related contamination in the upper soils. Soil is imported to the quarry as backfill for restoration in accordance with a waste facility permit at a maximum allowable intake rate of 5,000 tpa. Soils were therefore tested for contaminants to establish the baseline.

14 No. bulk soils samples sourced from trial pits within the proposed development site were submitted for chemical analysis on December 02, 2024. Results for this first round of analysis were received on January 15, 2025.

In line with the sites previous use as a quarry and more recently as a soil recovery facility to facilitate restoration of the spent quarry, soil samples were submitted for the following suite of testing parameters:

- Heavy Metals
- Total Organic Carbon
- Total BTEX
- Mineral Oil
- Total PAHs
- Total PCBs
- Asbestos

The GSI along with the EPA have developed geochemically appropriate levels (GALs) for soil recovery facilities across Ireland specifically in relation to metals and metalloids in uncontaminated soil and stone (GSI, 2023). There are a total of seven defined domains across the country. The GSI (GSI, 2024) defined Geochemical Domains map indicates that the site of the proposed development is located within Domain 2 which is characterised as "carboniferous limestone, shale and related rocks".

Domains allow for a deviation in the relevant trigger levels for Heavy Metals due to deviation in naturally occurring heavy metal concentration as a result of variance in bedrock geochemistry.

Results indicate:

- No exceedance of the heavy metal criteria Limit
- No exceedances of the TOC, Mineral Oil, BTEX, PAH or PCB Limits
- No detections above the laboratory limit of detection for Mineral Oil, BTEX, PAH or PCB Limits
- No asbestos detections

Six no. water samples taken from boreholes were tested for Heavy Metals, Inorganics, PAHS, VOC's and coliforms. Indicator parameters for leachate were analysed to determine if there is any influence on groundwater from the adjacent landfill.

All samples were within limits as set out by the European Communities Environmental Objectives (Groundwater) Regulations 2009-2025.

Two no. groundwater samples were taken in May 2026 at BH01 and BH04 onsite to establish the baseline for a range of parameters as requested by Carlow County Council at scoping consultation. All samples were within limits as set out by the European Communities Environmental Objectives (Groundwater) Regulations 2009-2025. Slightly elevated nitrate concentrations were recorded (29.5 mg/l in BH01 and 20.4 mg/l in BH04), with BH01 exceeding the IGV set out in (EPA, 2003) (25 mg/l) but remaining below the drinking water limit (50 mg/l). Low-level agricultural impact is indicated by simazine detection in BH01 (0.24 µg/l) which is above the drinking water limit (0.1 ug/l) but below IGV (1 ug/l). The certificate for these results is available in Appendix 12, in Volume 3 of this EIAR.

12.5.12 Geohazards

Earthquakes are not likely to occur in the vicinity of the site at a sufficient intensity to pose a risk for the proposed development.

The GSI database (GSI, 2026) indicated that the site is located within an area with a 'low' susceptibility to landslides. There are no recorded landslides recorded on the GSI database (GSI, 2026) at the site or within a 2 km radius of the site.

12.5.13 Importance of the Baseline Environment

The significance of the effects of impacts on soils, geology and land on the site has been assessed as a function of the sensitivity of the receiving environment. The sensitivity of the receiving environment is classified on a 7-point scale from Negligible to High as a function of the characteristics of the land, soils, geology and hydrogeology that are directly impacted by the project. The 7-point scale is from guidance (EPA, 2022) and is described in Chapter 1 of this EIAR.

For this proposed development, the majority of the significant effects on land, soils, geology and hydrogeology relate to the overburden deposits that cover the site and the study area. Therefore, the characteristics of the overburden in the area govern the classification of the sensitivity of the receiving environment for assessing the significance of effects on land, soils, geology and hydrogeology. For the proposed development, the sensitivity of the surrounding land, soils and geology is classified as '**Medium'** based on the potential for granular aggregate extraction from the site.

The receiving water bodies have been assigned a WFD Status of 'good' for groundwater hydraulically connected to site of the proposed development (EPA, 2026). The bedrock aquifer beneath the site is a Regionally Important Aquifer - Karstified (diffuse) (Rkd). The site is not mapped within a groundwater source protection area (SPA) nor it in the vicinity of a significant water supply source.

Overall, taking account of the receiving hydrogeological environment, in accordance with the criteria set out in Table 12- 2, the site is considered to be of '**High**' importance.

12.6 Potential Impacts

The potential impacts on the underlying land, soils and geology at the proposed development site and along the gas pipeline route are assessed in the following sections for the activities associated within each phase (construction, operation and decommissioning) for the proposed development as described in Chapter 3 Description of the Existing and Proposed Development in Volume 2 of this EIAR.

The potential impacts are assessed in accordance with the evaluation criteria outlined in Section 12.4.5. The unmitigated potential impacts are summarised in Table 12- 11 Summary of Potential . The proposed mitigation measures are then considered to reduce or eliminate potential impacts.

12.6.1 'Do Nothing' Impacts

If the proposed development were not constructed, it is likely that the current land uses will continue for the foreseeable future. The quarry operator would continue to operate the site as a sand and gravel quarry whilst continuing to restore the pit area in accordance with the restoration plan. Soils would continue to be imported as backfill material under current planning consent and waste facility permit (planning ref P13/187 in 2013 see Chapter 1, Introduction, in Volume 2 of this EIAR) which consents the import of 80,000 t total over 15 years, which is approximately 5,000 tpa.

It is likely that the landowner would commence the latest planning consent for the existing site (Planning ref: PL01.320180 2025, refer Chapter 1, Introduction, in Volume 2 of this EIAR). A revised waste facility permit would be required to facilitate import of 199,500 tonnes of soil and stone for restoration over 8 years.

The route of the proposed gas pipeline is an existing road and would remain largely unaltered except for maintenance.

The impact on the Land, Soils, Geology and Hydrogeology would remain largely unaltered as a result and of **Negligible** significance.

12.6.2 Construction Phase Impacts

There are features in the wider soils, geology and hydrogeology environment which, in the absence of appropriate design, could be adversely impacted, such as :

- underlying regionally important gravel aquifer and Important Karstified (diffuse) Aquifer (RKd) which are part of the Athy-Bagenalstown Gravels GWB/Bagenalstown GWB
- groundwater flow beneath the site is inferred to be to the west toward the downstream receiving waterbody the River Barrow and the River Barrow and River Nore SAC

However, given the design of the proposed development and proposed construction methodology as per Chapter 3, there is no pathway for effects because:

- deep excavations are not required
- significant dewatering is not required as excavation depths are higher than groundwater levels
- there is a construction phase storm water management system flowing to a lined storm water lagoon
- no infiltration of storm water runoff and no discharge of storm water from the storm water lagoon into the environment (tankered off site)
- stone piles are proposed for foundations
- a groundwater pump test has established the groundwater well can supply the required yield without creating drawdown
- the baseline assessment has established no evidence of contamination in soil or groundwater environment
- best practice engineering / construction industry standard CIRIA (CIRIA, 2023), (CIRIA, 2016) (CIRIA, 2001) and BS EN 206 (BSI, 2026) requires that concrete should not be poured during heavy rainfall or uncontrolled wet conditions. As such the risk of contaminating the overburden during construction will be negligible given the industry requirement for concrete works in essentially dry works conditions, coupled with the groundwater level being below excavation level.
- no concrete batching on site, imported by wagon only

The following on-site activities have been identified as the sources of potential impacts on the existing geological and hydrogeological conditions during the construction phase of the proposed development and are discussed in the sub-headings below:

- excavation/overburden removal
- construction of structures
- contaminated soils

During the construction phase of the proposed development there is limited to no potential for any significant direct effect on the receiving land, soil, geology and hydrogeology environment at the proposed development site taking account of the construction methodology and design of the proposed development.

12.6.2.1 Geological Hazards

Earthquakes are not likely to occur in the vicinity of the site at a sufficient intensity to pose a risk for the proposed development. The GSI database (GSI, 2026) indicates that the site of the proposed development is located within an area of 'low' susceptibly to landslides.

All aggregates imported to the site for use in the proposed development will be subject to strict quality control procedures in accordance with the design specification and relevant Building Regulations therefore avoiding any potential issues with pyrite in aggregates.

The site is identified as being located within a 'Medium' Radon Area. The design and specification for all buildings will be in accordance with current Building Regulations and therefore any potential issues associated with radon will be addressed and avoided. Therefore, the potential effect on soils and geology associated with radon at the site is considered **neutral, direct, permanent** and of **Imperceptible significance**. No effect on hydrogeology is anticipated.

12.6.2.2 Excavation/Overburden Removal

The soils underlying the site are considered to be of 'Medium' importance due to being located within a regionally important sand and gravel aquifer, in an area of 'Very High' granular aggregate potential. The existing site is a partially restored quarry with Made Ground as per Section 12.5.9. The construction of the proposed development will require the excavation of 98,900 m^3 of the Made Ground (soil and subsoil) to depths of up to 5.0 mbgl. The majority of this material will be used to reprofile the site. A total of 5,000 m^3 of material (inert soil) will be removed from the site to a licensed soil recovery facility or permitted waste facility or for reuse under an Article 27 notification. Construction of the proposed gas pipeline route will involve the excavation of 10,944m^3 of material, comprising road pavement and glacial overburden deposits This material will be removed from the site to a licensed soil recovery facility or permitted waste facility. Accordingly, there will be a **negative, direct, permanent** effect of **Not Significant** significance on soil and geology at the proposed development and along the gas pipeline route. No effect on hydrogeology is anticipated.

12.6.2.3 Construction of Structures

The construction of the proposed development will result in the conversion of permeable surfaces to hardstanding surfaces at the site. This sealing of land has a long-term impact on the underlying soil, reducing the water infiltration. The gas pipeline route will be mainly in road or road verge, with no change to land sealing.

The construction of the proposed development requires excavations of up to 5.0 m below current restored ground levels. It is proposed to install vibro stone columns below the foundations of the heavily loaded structures (such as the digestion tanks) to improve the bearing capacity of the soil and reduce the anticipated settlement. Details are included in Chapter 3 of this EIAR. In order to construct the foundations a compacted infill granular layer is also required on top of the stone columns, on which a concrete blinding is poured. Steel reinforcement will be installed, with shuttering erected around this to facilitate the final concrete pour. Infilling and compaction of excavations around structures is then conducted to ensure structural integrity. The risk of contaminating the overburden during construction will be negligible given the industry requirement for concrete works in essentially dry works conditions, coupled with the groundwater level being below excavation level.

The construction works will result in a reduction in the infiltration of rainfall into the groundwater through a reduction in the permeable surfaces across the site. This will result in a **negative, direct, long-term, Not Significant** effect on the groundwater aquifer.

12.6.2.4 Horizontal Directional Drilling (HDD)

Four locations have been identified along the proposed pipeline route as described in Chapter 3 of Volume 2 of this EIAR, where a trenchless construction method such as Horizontal Directional Drilling (HDD) will be utilised to cross the pipeline under the River Barrow and the M9 motorway and under two existing land drain crossings of the L3043. Standard design controls to avoid impacts are described in Chapter 3 and in Appendix 3.1 CEMP in Volume 3 of this EIAR.

Direct impacts to the existing environment associated with the proposed HDD works (specifically where crossing the River Barrow) include:

- Potential for overburden collapse to impact on soils and geology at the proposed HDD locations at water crossings during the advancement of the HDD bore.

This will result in a **negative, direct**, **temporary** effect of **Imperceptible** significance on the soils and geology within a localised area along the proposed gas pipeline route. No effect on hydrogeology is anticipated.

12.6.2.5 Export of Excess or Unsuitable Soils

The existing site currently comprises some areas of made ground associated with the restoration of the site The reuse of soils onsite will be subject to an assessment of their suitability for use, in accordance with engineering and environmental specifications that will be determined during the detailed design phase. Given that there is no evidence of soil contamination from testing carried out, there is no requirement to remove soils from the site, except for potentially unsuitable material (engineering) exported as inert soil to an appropriate facility or for reuse, it is considered that there would be a **neutral, direct, permanent** effect of **Slight** significance on the quality of soils underlying the site. The removal of unsuitable materials offsite will be undertaken in accordance with applicable statutory requirements and waste management legislation. No effect on hydrogeology is anticipated.

12.6.2.6 Importation of Fill Materials

The importation of 54,342m^3 of imported aggregate fill materials will be required for the construction of the proposed development (e.g., granular material beneath road pavement, construction of building and tank foundations and for drainage and utility bedding / surrounds etc). The potential effects may include loss of attribute and changes in the geological regime at the source site. It is anticipated that the required aggregates identified for importation onsite will be **indirect** and have a **negative, permanent** effect of **Imperceptible** significance on the soils and geology at the source site taking account of the fact that the statutory consent process would have required the necessary environmental effects to be assessed and mitigated as appropriate at the source site. No effect on hydrogeology is anticipated.

12.6.2.7 Hydrogeological Flow Regime

During the construction phase there will be no direct discharges to or abstraction from surface water. There will be no direct discharges to groundwater at the proposed development. Water required for construction will be supplied by rainfall which will be collected in the storm water lagoon with top ups as required from the on-site groundwater well. The potential effect of this change on the groundwater levels and flow regime associated with the works will be **negative, direct, temporary effect** of **Imperceptible** significance.

Due to the groundwater levels on the site as per Section 12.5.9 it is anticipated that limited groundwater will be encountered during excavations for the construction of the proposed development. Therefore, there may be a requirement for localised and limited dewatering or sump pumping on a temporary basis during the excavations. These construction measures to manage dewatering during excavations and concrete works are described in Section 3.5 of Chapter 3. No effect on hydrogeology is anticipated as a result of the proposed excavation works.

12.6.2.8 Groundwater Quality

During the construction phase of the proposed development, there will be a temporary reduction in impermeable surfaces across the proposed development, and the groundwater vulnerability is expected to temporarily increase within the site. In areas like the Athy Bagenalstown Gravels GWB/Bagenalstown GWB, there can be a high degree of interconnection between groundwater and surface water. There are no groundwater wells recorded as being for agriculture or domestic use to the west of the site (down gradient).

Hazardous material including fuels and oils will be used onsite, however due to the level of groundwater relative to the proposed excavation depths (see Section 12.5.9) and the construction methodology described in Chapter 3, there are no effects associated with these works on the underlying soils, geology and hydrogeology.

Cementitious material will be used during the construction of the proposed development, however due to the level of groundwater relative to the proposed excavation depths (see Section 12.5.9) and the construction methodology described in Chapter 3, there are no effects associated with these works on the underlying soils, geology and hydrogeology.

Where dewatering of excavations is required or where water must be pumped from the excavations, water will be discharged by the contractor, following appropriate treatment to the storm water management system, (see Chapter 3 and Chapter 13 of this EIAR).

There will be no discharge of untreated water (groundwater / storm water runoff) to sewer, watercourses or groundwater during the construction phase of the proposed development. Therefore, there will be no potential effects on the receiving water environment.

Foul water and excess stormwater during the construction phase of the proposed development will be collected and removed by tanker in accordance with waste management legislation and managed accordingly. Therefore, the proposed development will not cause a potential effect associated with foul water or storm water from the site at any receiving waterbody or Natura 2000 sites.

12.6.3 Operational Phase Impacts

During the operational phase of the proposed development there is limited to no potential for any direct effect on the receiving land, soil, geology and hydrogeology environment at the proposed development site taking account of the operational design for the proposed development.

The potential accidental release of hazardous materials, including feedstocks or digestate in the tank farm, fuels, oils, or chemicals used on-site, could impact the receiving land, soil, geological and hydrogeological environment. Such an event could only occur through the failure of secondary containment or a major incident. In such a case, the effect would be **negative, direct, unlikely**, **long-term** effect of **Moderate** significance. However, considering the operational design, the requirement for bunding in accordance with the IE licence and the Environmental Management System (EMS) that will be implemented for the proposed development, which includes measures to effectively manage and mitigate such incidents, this scenario is deemed **unlikely**. The EMS will ensure that all necessary precautions and response strategies are in place to prevent environmental harm, thereby significantly reducing the likelihood of such an occurrence.

At full capacity, the proposed development will produce digestate (liquid and solid) for off-site transportation as bio-based fertiliser to local receivers. The land spreading and management of digestate will be carried out by the receiver in compliance with the European Union (Good Agricultural Practice for Protection of Waters) Regulations 2025 and Nutrient Management Plans.

12.6.3.1 Hydrogeological Regime

From the results of the site investigation, the existing capacity for infiltration and recharge to the aquifer beneath the site is high due to the exposure of granular deposits as a result of the historic quarrying activity. The change in cover from brownfield land to paved areas within the proposed development will result in a minor reduced infiltration potential within a localised portion of the Athy Bagenalstown Gravels GWB/Bagenalstown GWB. Therefore, it is considered that there will be little to no change to the overall recharge potential to the aquifer at the site. Taking account of the baseline hydrogeological setting and nature of the proposed development there will be a **neutral, direct, likely**, **long-term** effect of **Imperceptible** significance on the hydrogeological flow regime within a very localised zone of the aquifer.

It is proposed that the drinking water supply (potable water) for the proposed development will be supplied by tanker delivery. Water used to supply the process water tanks will result in the extraction of 120 m^3/day (monthly average) from an on-site groundwater well. Given the permeability of the groundwater regime, the results of the pump test and recharge potential across the GWB, this extraction will result in a **negative**, **direct, likely, temporary** effect of **Slight/Moderate** significance on the hydrogeological flow regime within a very localised zone of the aquifer.

During the operational phase there will be no discharges to groundwater at the proposed development. Storm water runoff from the proposed development will be stored in the on-site lagoon for reuse as process water and only discharged from the site in the event of a 1 in 30 year storm event if the lagoon and process water tanks are full and the stormwater is confirmed as clean by continuous monitoring equipment. Such discharge will be into permanent drainage that feeds into the Powerstown Stream. Therefore, potential effects to the hydrogeological flow regime will likely be **neutral, direct, unlikely** and **permanent** effect of **Imperceptible** significance.

No public health issues associated with the land, soil, geology and hydrogeology conditions at the site have been identified for the Operational Phase of the proposed development. Human health is assessed in Chapter 7 of this volume.

12.6.4 Major Accidents and Natural Disasters

This section considers the potential for major accidents and natural disasters to give rise to significant effects on land, soils, geology and the hydrogeological environment during the operational phase of the proposed development.

12.6.4.1 Flooding

The site lies lower than surrounding lands forming an enclosed basin. This means that extreme rainfall events could generate localised flooding within the proposed development.

However, the site is outside OPW Flood Zones A and B and the storm water lagoon is designed for a 1 in 30 year event with freeboard (including allowance for climate change). The design and operation of the facility under an IE licence includes bunds, integrity testing and a drainage system to isolate bunded areas to allow tankering of potential spills. Therefore, potential effects to the hydrogeological flow regime will likely be **negative, unlikely** and **temporary** effect of **Imperceptible** significance. A flood risk assessment is included in Appendix 13.1 of Volume 3 of this EIAR.

12.6.4.2 Fire

A firewater risk assessment was carried out as part of the design of the proposed development and demonstrates sufficient firewater retention within structures on site. This report is contained in Appendix 3.2 of Volume 3 of this EIAR. There are no potential effects on soils, geology or hydrogeology as a result of a fire at the proposed development.

12.6.5 Decommissioning Phase Impacts

It is considered that the potential decommissioning impacts will be similar to those identified in the construction phase.

However, the overall risk of disturbance to underlying soils at the site during the decommissioning phase will be significantly reduced from that of the construction phase. The areas of hardstand and access roads associated with the proposed development are to remain in-situ. It is proposed to retain these elements of the construction and cover with overburden material to allow for re-vegetation of the development site.

This approach significantly reduces the risk of exposing underlying soils, thereby lowering the potential for sediment mobilisation, erosion, or contaminated runoff compared with the construction phase.

Any remaining risks during decommissioning relate primarily to:

- Localised disturbance of ground surfaces during removal of infrastructure.
- Potential mobilisation of residual contaminants from tanks, bunds, or drainage systems.
- Accidental spills during dismantling or cleaning of equipment

These risks are short-term and can be effectively managed through standard decommissioning controls. There is no potential for significant impacts as a result of the decommissioning of the proposed development.

12.6.6 Cumulative Impacts

12.6.6.1 Construction Phase

The phasing/commencement of any other future permitted developments in the locality (as referenced in Chapter 1) could potentially result in the scenario where a number of other construction sites are in operation at the same time as the proposed development.

The majority of excavated soils will be reused and repurposed for landscaping purposes and for the construction of earth berms on site. There will be removal of a small volume (5,000m^3) of excess soil and subsoil for recovery from site to licensed or permitted facilities or for reuse. Where materials are removed to licensed or permitted facilities, the proposed development will have an effect on capacity at such sites. This will result in a **negative, slight** and **permanent** effect on such sites. Where material is suitable for reuse, there will be a **positive, slight and permanent** effect on the receiving site.

Considering the design and construction methodology outlined in Chapter 3 of this EIAR, the development is not considered to significantly contribute to cumulative adverse impacts to the associated hydrogeological network.

12.6.6.2 Operational Phase

No potential cumulative impacts have been identified in respect of land, soils, geology and hydrogeology associated with the operational phase of the proposed development.

In the absence of the design and construction methodology outlined in Chapter 3 of this EIAR, surface sealing (bunding, paving, buildings on previously exposed ground), reduction in recharge to groundwater, and rapid transmission of runoff to surface water systems has the potential to contribute to the catchment hydrogeological response to rainfall. Considering the design and construction methodology outlined in Chapter 3 of this EIAR and in this report and the expected residual effect pending successful implementation of those measures, the proposed development is not considered to significantly contribute to cumulative adverse impacts to the associated hydrogeological network.

12.6.7 Summary of Potential Effects

Table 12-11: Summary of Potential Effects

Activity/Source of Effect	Potential Effect	Description of Effects (Soils and Geology)	Description of Effects (Hydrogeology)
Geological Hazards	Radon buildup in buildings	Neutral, Imperceptible, direct and permanent	None
Excavation/Overburden Removal	Sealing of overburden, Contamination of overburden	Negative, Not Significant, direct and permanent	None
Construction of Structures	Soil contamination/reduction in infiltration/groundwater recharge	Negative, Imperceptible, direct, temporary	Negative, Not Significant, direct and long-term
Horizontal Directional Drilling (HDD)	Sealing/erosion of soil	Negative, Imperceptible, direct and temporary	None
Contaminated Soils	Disposal of unsuitable materials	Neutral, Slight, indirect, and permanent	None
Importation of Fill Materials	Loss of attribute and changes to geological regime at source	Negative, Imperceptible, indirect and permanent	None

Activity/Source of Effect	Potential Effect	Description of Effects (Soils and Geology)	Description of Effects (Hydrogeology)
Hydrogeological flow regime/Temporary dewatering of excavations	Discharge to groundwater/lowering of groundwater table	None	None
Accidental fuel spills/Concreting works	Hydrocarbon/Concrete spillages and leaks	None	None

12.7 Mitigation by Avoidance and Design

Mitigation by avoidance and design forms the primary control on potential impacts to land, soils, geology and hydrogeology receptors. As part of the design, the following was carried out:

- Excavation of trial pits and advancement of boreholes to establish overburden and bedrock characteristics:

  Trial pits and boreholes were carried out across the site. Trial pits were undertaken to identify the materials present on the site and to recover samples for laboratory testing. Boreholes were installed to establish depth to bedrock and bedrock properties, and to confirm the overburden materials present below the base of the trial pits. Standpipes were installed in the borehole to allow for the recording of groundwater levels within the site. A pump test was also undertaken in a specifically drilled well to confirm that a significant proportion of the process water could be supplied from the groundwater at the site.

- Reuse of site won materials:

  The majority of the fill materials required for the earthworks on the site will be site won, reducing the volume of imported materials required for the proposed development.

- Tank Farm Bund

  As per Chapter 3, the tank farm bund is designed in accordance with Guidance to Storage and Transfer of Materials for Scheduled Activities (EPA, 2004). The tank farm will be bunded in its entirety to ensure enough containment is provided in the unlikely event of a leak at the proposed development.

  The tank farm bund will be impermeable and provide the required storage volume for the proposed tank farm i.e. the greater of; 110% of the largest single tank volume (110% of 12,206m^3 = 13,427m^3) or 25% storage of the sum of all tanks (25% of 32,280m^3 = 8,070m^3) contained within the bund. The bund will be designed and subject to EPA approval prior to construction and subject to certification prior to operation. Regular integrity testing will be a condition of the IE licence.

- Storm Water Management

  A storm water management system has been designed for the proposed development as described in Chapter 3 and Chapter 13 of this EIAR. It will be subject to EPA approval prior to construction and subject to IE licence for operation. There will be no discharge of stormwater from the proposed development during the construction phase. Any excess water will be tankered off site for reuse or treatment if required. There is no process water generated at the proposed development. All sanitary foul water will be tankered off site for treatment at a private wastewater treatment plant.

- Horizontal Directional Drilling

  As per Section 3.6 of Chapter 3, the construction method for HDD has in built environmental controls the following of which are relevant to protection of soils, geology and hydrogeology:

  - use of a fully degradable drilling fluid
  - appropriate storage of drilling fluid
  - collection of excess drilling fluid for appropriate treatment as a waste material
  - launch and reception pits to be located outside of motorway reservation, which includes the drainage system
  - launch and reception pits to be located >10 m from stream bank at crossing point ID3
  - minimum environmental protection measures as per Section 3.6.1 of Chapter 3 of this EIAR

- Concrete

  Concrete batching will not take place at the proposed development or along the proposed pipeline route. The import by concrete wagon has been assessed in Chapter 6 Traffic and Transportation.

12.7.1 Construction Phase Methodology

During the Construction Phase, all works will be undertaken in accordance with the Construction Environmental Management Plan (CEMP) in Appendix 3.1 of Volume 3 of this EIAR. Following appointment, the Contractor will be required to further develop the CEMP to provide detailed construction phasing and methods to manage and prevent any potential emissions to ground and surface water with regard to the relevant industry standards (e.g., C532 Control of Water Pollution from Construction Sites (CIRIA, 2001), C811D Environmental Good Practice on Site, (CIRIA, 2023), Concrete-specification, performance, production and conformity (BSI, 2026) and ICE Earthworks Theory And Practice and Earthworks Specification for Road Works Series 600 (TII, 2024).

The CEMP identifies the minimum requirements with regard to the appropriate mitigation, monitoring, inspection and reporting mechanisms that need to be implemented throughout construction. Compliance with the CEMP does not absolve the appointed contractor or its sub-contractors from compliance with all legislation and bylaws relating to their construction activities. The CEMP will be implemented for the duration of the construction phase, covering construction and waste management activities that will take place during the construction phase of the proposed development.

The GSI holds records of groundwater wells in the vicinity of the proposed grid connection route and HDD locations. However, trenches are shallow (1.2 m deep) and will only be open for a short period.

Depending on the ground conditions, presence of services, traffic management required, weather conditions, etc., the rate of installation of pipe laying will vary between 50m and 100m per day. Dewatering is therefore unlikely to be required and no impacts on wells is envisaged.

12.7.1.1 Importation of Aggregates and Materials

Contract and procurement procedures will ensure that all imported aggregates and materials required for the construction phase of the proposed development will be sourced from reputable suppliers operating in a sustainable manner and in accordance with industry conformity/compliance standards and statutory obligations. The importation of aggregates and materials will be subject to management and control procedures which will include testing for contaminants, invasive species and other anthropogenic inclusions and assessment of the suitability for use in accordance with engineering and environmental specifications for the proposed development. Therefore, any unsuitable material will be identified prior to unloading / placement onsite.

12.7.1.2 Reuse of Soils

Soil and subsoil materials to be reused within the proposed development (i.e., for landscaping on site) will be subject assessment of the suitability of for use in accordance with engineering and environmental specification for the proposed development. A small volume of surplus material, 5,000m^3, will be transported of off-for reuse or recovery.

Soil excavated from trenches along the proposed gas pipeline route will be taken to a licenced or permitted facility for disposal or recycling where required. If feasible, the upper layers of tarmac and asphalt will be excavated separately to the lower engineered fill layers. The lower engineered fill layers will be reused. The tarmac/asphalt layers will be taken to a licenced facility for disposal or recycling.

All temporary cuts/excavations will be carried out such that they are stable or adequately supported. Gravel fill will be used to provide additional support to temporary cuts/excavations where appropriate. Unstable temporary cuts/excavations will not be left unsupported. Where appropriate and necessary, temporary cuts and excavations will be protected against the ingress of water or erosion.

12.7.1.3 Protection of Soils

The extent of the required work area and the bulk excavation at the site will be minimised to prevent unnecessary excavation of soil and tracking over soil and subsoil outside of the excavation work areas as a result of compaction and rutting from construction traffic.

Dedicated internal haul routes will be established and maintained by the contractor to prevent tracking over unprotected soils. Movement of vehicle onsite will be restricted during and after periods of heavy rainfall.

12.7.1.4 Export of Soil and Waste

Where required, surplus materials or materials not suitable for reuse will require removal offsite in accordance with the procedures outlined in the CEMP and all statutory legislation. It will be the Contractor's responsibility to either; obtain a waste collection permit or, to engage specialist waste service contractors who will possess the requisite authorisations, for the collection and movement of waste off-site.

The re-use of soil and subsoil offsite will be undertaken in accordance with all statutory requirements and obligations including where appropriate re-use as by-product in accordance with Article 27 of the European Communities (Waste Directive) Regulations 2011 (SI No. 126 of 2011) as amended.

Any surplus material not suitable for re-use as a by-product and other waste materials arising from the construction phase will be removed offsite by an authorised contractor and sent to the appropriately authorised (licensed/permitted) receiving waste facilities. As only authorised facilities will be used, the potential effects at any authorised receiving facility sites will have been adequately assessed and mitigated as part of the statutory consent procedures.

Any waste soils will be transported under a valid waste collection permit issued under the Waste Management (Collection Permit) Regulations 2007, as amended and will be delivered to an appropriately authorised waste management facility.

Materials and waste will be documented prior to leaving the site and pipeline route. All information will be entered into a waste management register kept on the site.

12.7.1.5 Control and Management of Stockpiles

Stockpiles of loose materials pending re-use onsite will be sealed/covered for the duration of the works and not located in areas where sediment laden runoff may enter existing surface water drains along the gas pipeline route. To help shed rainwater and prevent ponding and infiltration, the sides and top of the stockpiles will be regraded to form a smooth gradient with compacted sides reducing infiltration and silt runoff. Where required, silt fences will be erected at the toe of stockpiles to prevent run-off. The silt fences will be monitored daily by the appointed contractor, and silt will be removed as required. In accordance with guidelines (Inland Fisheries Ireland, 2016), stockpiles will not be allowed within 30m of any open watercourses or drainage.

12.7.1.6 Concrete Works

The cementitious grout and other concrete works during the construction phase will avoid any contamination of ground or groundwater through the use of appropriate design and methods implemented by the Contractor and in accordance with the CEMP and relevant industry standards.

Where cast-in-place concrete is required (i.e., building foundations), all work will be carried out in dry conditions and be effectively isolated from any groundwater.

All ready-mixed concrete will be delivered to the Site by truck. Concrete batching will take place offsite, wash down and wash out of concrete trucks will take place into a container located within a controlled bunded area which will then be emptied into a skip for appropriate compliant removal offsite in accordance with all relevant waste management legislation. Where concrete shuttering is used, any excess concrete is not to be disposed of onsite. A suitable risk assessment for wet concreting shall be completed prior to works being carried out.

12.7.1.7 Handling of Fuels, Chemicals and Materials

The Contractor's construction compound will be located on site for the duration of the project and shall primarily consist of site offices and associated welfare facilities, car parking facilities, materials drop-off and storage areas and set down areas for HGVs.

Fuel will be transported to the site in dedicated mobile units based on supply requirements. Fuelling and lubrication of equipment will be conducted in accordance with the procedures outlined in the CEMP, within a designated area of the compound, clearly marked and situated away from any drains. A dedicated fuel filling point will be established onsite within the compound, where all equipment will be brought for refuelling.

Fuel storage areas and refuelling points will be bunded and located away from storm water drainage and features. The bunds will comply with the Environmental Protection Agency guidelines (EPA, 2013). All tank and drum storage areas will be bunded to a volume not less than the greater of the following:

- 110% of the capacity of the largest tank or drum within the bunded area or
- 25% of the total volume of substance that could be stored within the bunded area

As documented in the CEMP, the appointed contractor will maintain an emergency response action plan and emergency procedures will be developed by the appointed contractor in advance of any works commencing. Construction staff will be familiar with the emergency response plan.

Strict supervision of contractors will be adhered to in order to ensure that all plant and equipment utilised on-site is in good working condition. Any equipment not meeting the required standard will not be permitted for use within the proposed development Site. Only emergency breakdown maintenance will be carried out on-site. Drip trays and spill kits will be available on-site to ensure that any spills from vehicles are contained and removed off-site.

Spill kits will be made available onsite and identified with signage for use in the event of an environmental spill or leak. A spill kit will be kept in close proximity to the fuel storage area for use in the event of any incident during refuelling or maintenance works. Heavy machinery used on the Site will also be equipped with its own spill kit.

Where portable generators or similar fuel containing equipment is used during the construction phase of the proposed development, they will be placed on suitable drip trays. Regular monitoring of drip tray content will be undertaken to ensure sufficient capacity is maintained at all times

In addition, good housekeeping (e.g., site clean-ups, use of disposal bins, etc.) will be implemented on the site.

12.7.1.8 Control and Management of Water

There will be no direct discharge to groundwater during the construction phase of the proposed development.

There may be a temporary increase in the exposure of the underlying shallow groundwater during excavation works. Storm water runoff will be prevented from entering open excavations with sandbags or other approved methods proposed by the appointed contractor. Furthermore, the appointed contractor will ensure that machinery does not enter the groundwater if encountered during construction. During construction, excess water will be pumped to the permanent storm water lagoon location to be stored, before being tankered off-site.

Given the vulnerability of the underlying groundwater at the site, the construction methodology will adhere to guidance (CIRIA, 2023) (BSI, 2026) or similar best practices. This approach aims to minimize the risk of creating temporary conduits between potential surface contamination sources and the underlying groundwater. The construction method will include procedures to prevent any potential effect on water quality. This includes measures to stop surface runoff or other fluids from entering open excavations and the surrounding formation. When lubricants, drilling fluids, or additives are required, the contractor will use biodegradable, and non-hazardous compounds under controlled conditions.

Where dewatering of shallow groundwater is required or where storm water runoff must be pumped from the excavations, water will be managed in accordance with best practice standards (i.e. groundwater control design and practice (CIRIA, 2016), the CEMP and regulatory consents to minimise the potential effect on the local groundwater flow regime of the underlying aquifer. Any water removed from excavations will be pumped to the storm water lagoon and removed off-site in sealed tankers.

The proposed pipeline route and internal cable trenches could provide preferential pathways for groundwater and contaminant movement. Trenches will be excavated during dry periods where possible in short sections and left open for minimal periods, to avoid acting as a conduit for storm water flows. To further mitigate the risk of cable trenches becoming preferential pathways, clay plugs (or other low permeability material) will be installed at intervals along the trench to stop/inhibit water movement

Unauthorised discharge of water (groundwater / surface water runoff) to ground, drains or watercourses will not be permitted.

A regular review of weather forecast will take place, insofar as possible, ground excavation works will be scheduled during period of dry weather to minimise potential for silt laden runoff into the storm water management system.

12.7.1.9 Horizontal Directional Drilling (HDD)

GNI will prepare a method statement for HDD at each of the proposed locations. The method statement will define the sequence of events and shall incorporate environmental controls as list in Chapter 3 and Appendix 3.1 CEMP.

- The crossing works area will be clearly marked out with fencing or flagging tape to avoid unnecessary disturbance;
- There will be no storage of material / equipment or overnight parking of machinery inside the 15m buffer zone;
- Before any ground works are undertaken, double silt fencing will be placed upslope of the watercourse channel along the 15m buffer zone boundary;
- Additional silt fencing or straw bales (pinned down firmly with stakes) will be placed across any natural surface depressions / channels that slope towards the watercourse;
- Silt fencing will be embedded into the local soils to ensure all site water is captured and filtered;
- The area around the bentonite batching, pumping and recycling plant will be bunded using terram (as it will clog) and sandbags in order to contain any spillages;
- Drilling fluid returns will be contained within a sealed tank / sump to prevent migration from the works area;
- Spills of drilling fluid will be clean up immediately and stored in an adequately sized skip before been taken off-site;
- If rainfall events occur during the works, there will be a requirement to collect and treat small volumes of surface water from areas of disturbed ground (i.e. soil and subsoil exposures created during site preparation works);
- This will be completed using a shallow swale and sump down slope of the disturbed ground; and water will be pumped to a proposed percolation area at least 50m from the watercourse;
- The discharge of water onto vegetated ground at the percolation area will be via a silt bag which will filter any remaining sediment from the pumped water. The entire percolation area will be enclosed by a perimeter of double silt fencing;
- Any sediment laden water from the works area will not be discharged directly to a watercourse or drain;
- Works shall not take place during periods of heavy rainfall and will be scaled back or suspended if heavy rain is forecasted;
- Daily monitoring of the compound works area, the water treatment and pumping system and the percolation area will be completed by a suitably qualified person during the construction phase. All necessary preventative measures will be implemented to ensure no entrained sediment, or deleterious matter is discharged to the watercourse;
- If high levels of silt or other contamination is noted in the pumped water or the treatment systems, all construction works will be stopped. No works will recommence until the issue is resolved and the cause of the elevated source is remedied;

- On completion of the works, the ground surface disturbed during the site preparation works and at the entry and exit pits will be carefully reinstated and re-seeded at the soonest opportunity to prevent soil erosion;
- The silt fencing upslope of the river will be left in place and maintained until the disturbed ground has re-vegetated;
- There will be no batching or storage of cement allowed at the watercourse crossing;
- There will be no refuelling allowed within 100m of the watercourse crossing; and,
- All plant will be checked for purpose of use prior to mobilisation at the watercourse crossing.

Mechanical Stabilisation

Mechanical Stabilisation will be required where HDD is proposed in gravelly, non-cohesive subsoils. This will be managed by installing steel conductor casing through the shallow gravels to bypass the cover zone (i.e. the material above the bore depth) where fluid would be most likely to breach the surface. This casing acts as a physical barrier, protecting the riverbed from pressure spikes and ensuring returns are directed back to the entry pit rather than into the sensitive substrate. Note that mechanical stabilisation may only be needed on the River Barrow crossing.

Fracture Blow-out (Frac-out) Prevention and Contingency Plan:

- The drilling fluid/bentonite will be non-toxic and naturally biodegradable (i.e., Clear Bore Drilling Fluid or similar will be used). Biocompatible Drilling Fluids (European Standards) utilize NSF/ANSI Standard 60 or CE-marked additives which are high-performance, biodegradable viscosifiers and will be used to provide the necessary "gel strength" to suspend heavy gravel cuttings. Fluid loss will be controlled using biodegradable sealants, which create a thin, flexible filter cake on the borehole wall to prevent fluid migration into the aquifer. These products break down naturally, ensuring no permanent alteration to the hydraulic conductivity of the aquifer.

Real-time annular pressure monitoring will be mandatory. By keeping pressures below the Delft Equation limits, operators can detect lost circulation before it becomes a surface fracture blow-out (frac-out release of drilling fluid through cracks/fissures/weaknesses in the substrate).

- The area around the drilling fluid batching, pumping and recycling plants will be bunded using terram and/or sandbags to contain any potential spillage;
- One or more lines of silt fencing will be placed between the works area and the adjacent river;
- Spills of drilling fluid will be cleaned up immediately and transported off-site for disposal at a licensed facility;
- Adequately sized skips will be used where temporary storage of arisings are required;
- The drilling process / pressure will be constantly monitored to detect any possible leaks or breakouts into the surrounding geology or local watercourse;
- This will be gauged by observation and by monitoring the pumping rates and pressures. If any signs of breakout occur then drilling will be immediately stopped;
- Any frac-out material will be contained and removed off-site;
- The drilling location will be reviewed, before re-commencing with a higher viscosity drilling fluid mix; and,
- If the risk of further frac-out is high, a new drilling alignment will be sought at the crossing location.

The above measures are standard best practice measures for HDD works and have been successfully employed in multiple projects across Ireland.

12.8 Mitigation Measures

Mitigation measures for land, soils, geology and hydrogeology have been developed in accordance with the mitigation hierarchy of avoidance, prevention, reduction, and control, as set out in the guidelines (EPA, 2022). The mitigation measures as outlined below, will ensure that there will be no significant effect on the receiving land, soil, geology and hydrogeology.

The measures outlined in this section of the report will ensure that there will be no significant effect on the receiving groundwater environment and associated receptors (e.g., Natura 2000 sites). The effective implementation of these measures will ensure that the proposed development will not have any effect on compliance with the EU Water Framework Directive and the European Communities Environmental Objectives (Groundwater) Regulations (S.I. No. 9 of 2010 and as amended) as amended individually or in combination.

12.8.1 Construction Phase Mitigation Measures

The design measures and construction phase methodology have been developed to avoid any potential for significant effects on land, soils and hydrogeology during the construction phase. Therefore, no mitigation measures are required.

12.8.2 Operational Phase Mitigation

During the operational phase of the proposed development there is limited to no potential for any effect on the receiving land, soil, geological and hydrogeological environment due to avoidance by design and therefore there is no mitigation required in regard to the proposed development.

The procedures set out in the EMS under a condition of the IE licence will be strictly adhered to for the duration of the operational phase of the proposed development. The EMS will be a condition of the IE licence to operate.

Accident prevention and emergency response procedures developed in accordance with the conditions of the EMS, will be strictly implemented during the operational phase of the proposed development and spillage kits will be available on-site including in vehicles operating on-site. All staff will be familiar with emergency procedures for in the event of accidental fuel spillages.

During the operational phase there will be no discharges to groundwater at the proposed development. Stormwater runoff from the proposed development will be stored within the settlement lagoon and reused as process water. During a storm event, the water level the pond will be controlled by discharging to a permanent drainage connection into the Powerstown Stream to the north of the site in accordance with the IE licence. Therefore, potential effects to the hydrological flow regime will likely be '**neutral', 'imperceptible'** and **'permanent'.** There will be no discharges of process water to ground or surface water.

12.8.3 Decommissioning Phase Mitigation

It is considered that the potential decommissioning impacts will be similar to those identified in the construction phase.

However, the overall risk of disturbance to underlying soils at the site during the decommissioning phase will be significantly reduced from that of the construction phase. The areas of hardstand and access roads associated with the proposed development are to remain in-situ. It is proposed to retain these elements of the construction and cover with overburden material to allow for re-vegetation of the development site.

This approach significantly reduces the risk of exposing underlying soils, thereby lowering the potential for sediment mobilisation, erosion, or contaminated runoff compared with the construction phase.

Any remaining risks during decommissioning relate primarily to:

- Localised disturbance of ground surfaces during removal of infrastructure.
- Potential mobilisation of residual contaminants from tanks, bunds, or drainage systems.
- Accidental spills during dismantling or cleaning of equipment.

These risks are short-term and can be effectively managed through standard decommissioning controls.

The decommissioning (if required) of the gas pipeline will be under the control of GNI.

12.9 Water Framework Directive

The findings of the risk-based assessment identified that in the absence of any mitigation and avoidance measures there will not be a potential effect on the water quality within receiving water bodies associated with the proposed development, specifically within the Bagenalstown GWB, the River Barrow and downstream waterbodies. There is no identified potential effect to transitional or coastal waterbodies attributed to the separation distances and anticipated assimilation capacity of the receiving water bodies taking account of the existing baseline conditions and WFD status.

The mitigation measures as outlined above, including the implementation of a robust CEMP during the construction phase will prevent any significant effect on the receiving groundwater environment. Hence, the proposed development will not have any effect on the European Communities Environmental Objectives (Groundwater) Regulations, 2010 (S.I. No. 9 of 2010), as amended 2012 (SI 149 of 2012) and 2016 (S.I. No. 366 of 2016).

The proposed development will not cause a deterioration in the status of waterbodies hydraulically connected with the proposed development or gas pipeline route, taking account of design avoidance and mitigation measures that will be implemented.

There will be no effect to the existing WFD status of water bodies associated with the proposed development or gas pipeline route including the waterbodies comprising the River Barrow, downstream waterbodies, or the Bagenalstown GWB as a result of the proposed development taking account of embedded design avoidance and mitigation measures.

12.10 Indirect Impacts

There are no indirect effects on receiving water bodies, such as the River Barrow. There will be no change in GWB status in the underlying GWB resulting from the construction of the proposed development.

12.11 Residual Impacts

12.11.1 Summary of Residual Impacts

Residual effects are defined as 'effects that are predicted to remain after all assessment and mitigation measures. They are the remaining 'environmental costs' of a project and are the final or intended effects of a development after mitigation measures have been applied to avoid or reduce adverse effects.

A site-specific Construction Environmental Management Plan (CEMP) (see Appendix 3.1 of Volume 3 of this EIAR) will be updated before and implemented throughout the duration of the construction phase. This document will contain all the necessary procedures required to prevent and minimise any environmental risks posed by the project on the surrounding environment

The overall impact on land, soils, geology and hydrogeology anticipated during the construction phase of the project following the design of the proposed development and the construction methodology described in Chapter 3 is considered to be **neutral to negative, imperceptible to slight**, and **temporary to permanent**.

The overall impact on land, soils, geology and hydrogeology anticipated during the operational phase of the project following the design of the proposed development and the construction methodology described in Chapter 3 is considered to be **neutral to negative, imperceptible to not significant**, and **short-term to long-term**. There are no uncontrolled emissions anticipated as a result of the proposed development.

Overall, there are no significant residual effects on land, soils, geology and hydrogeology anticipated as a result of this proposed development.

12.12 References

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