FEHILY TIMONEY

DESIGNING AND DELIVERING
A SUSTAINABLE FUTURE

EIAR FOR POWERSTOWN BIOENERGY

Volume 2 - Main Body of the EIAR

Chapter 4 - Alternatives Considered

Prepared for:

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4. ALTERNATIVES CONSIDERED

4.1 Introduction

The purpose of this chapter is to describe the reasonable alternatives considered by the developer during the design and pre-application phases of the Proposed Development and to outline the main reasons for selecting the preferred option, taking into account the likely effects on the environment.

This chapter sets out the reasonable alternatives, and the design progression that has been considered during the evolution of the proposed development. The introduction to the proposed development, including details of the planning procedure, is outlined in Chapter 1, - Introduction, and the existing and proposed development are described in Chapter 3 - Description of the Proposed Development, both in Volume 2 of this EIAR.

The 2014 EIA Directive (Directive 2014/52/EU) (European Commission, 2014) restated and amended the requirement to consider project alternatives of the 2011 EIA Directive (Directive 2011/92/EU) (European Commission, 2011) and introduced the concept of 'reasonable alternatives'.

Article 5(1) of the 2014 EIA Directive states that the developer shall include:

"5(1)(d) a description of the reasonable alternatives studied by the developer, which are relevant to the project and its specific characteristics, and an indication of the main reasons for the option chosen, taking into account the effects of the project on the environment.
5(1)(f) any additional information specified in Annex IV relevant to the specific characteristics of a particular project or type of project and to the environmental features likely to be affected".

Annex IV, Part 2, of the Directive states:

"Annex IV (2) A description of the reasonable alternatives (for example in terms of project design, technology, location, size, and scale) studied by the developer, which are relevant to the proposed project and its specific characteristics, and an indication of the main reasons for selecting the chosen option, including a comparison of the environmental effects".

In relation to alternatives, the Guidelines for Planning Authorities and An Bord Pleanála on carrying out Environmental Impact Assessment (Department of Housing, Planning and Local Government, 2018) Section 4.2 states that the information provided must include:

"(a) A description of the project comprising information on the site, design, size and any other relevant features of the project";

Reasonable alternatives are defined in Sections 4.12 and 4.13 of the Guidelines for Planning Authorities and An Bord Pleanála on carrying out Environmental Impact Assessment (Department of Housing, Planning and Local Government, 2018) as:

"Reasonable alternatives may relate to matters such as project design, technology, location, size and scale."

However, there is no requirement for each of these alternatives to be assessed in detail and the guidance states that a broad description of each main (and reasonable) alternative studied and the key environmental issues associated with each is sufficient.

Section 3.4.1 of the Environmental Protection Agency (EPA) Guidelines on the Information to be contained in Environmental Impact Assessment Reports (Environmental Protection Agency, 2022) states that:

"the objective is for the developer to present a representative range of the practicable alternatives considered. The alternatives should be described with 'an indication of the main reasons for selecting the chosen option'. It is generally sufficient to provide a broad description of each main alternative, and the key issues associated with each, showing how environmental considerations were taken into account in deciding on the selected option. A detailed assessment (or 'mini-EIA') of each alternative is not required".
The following are considered in this chapter:

- do nothing scenario (Section 4.3)
- alternative locations (Section 4.4)
- alternative design and site layouts (Section 4.5)
- alternative technologies (Section 4.6)

4.2 Statement of Authority

This chapter was written by Eibhlín Vaughan and reviewed by Bernie Guinan and Tanya Ruddy, Fehily Timoney and Company (FT).

Eibhlín is a Project Environmental Scientist in the Circular Economy and Environment Department at FT. She holds a First Class Honours Bachelor's Degree in Environmental Science from Trinity College Dublin and a Master of Engineering Science Degree from University College Dublin. She has three years of experience supporting with Environmental Impact Assessment Reports (EIARs) for infrastructure projects. Eibhlín provides technical support to the EIAR teams for a variety of projects.

Tanya is a Technical Director who works in the Circular Economy and Environment group at Fehily Timoney and Company. She has 25 years post qualification experience in environmental consultancy. She is the EIAR Coordinator for the proposed development. Tanya is a Chartered Scientist (CIWEM) and holds a BA in Environmental Science and a master's in environmental management. She is also a Chartered Environmentalist (CIWEM) and Chartered Waste Manager (MCIWM). She provides advice on statutory consents including planning applications, licence applications with supporting EIAR and NIS. Tanya provides consultancy advice to the circular economy, environmental, sustainable infrastructure and environmental planning sectors and to the construction sector on materials management including waste management and to industrial emission discharge and waste licensees. Tanya is experienced in environmental monitoring and interpretation. She is experienced in project management of complex projects for both the public and private sector including the management and coordination of planning applications to An Coimisiún Pleanála and local planning authorities, licence applications to the EPA and waste facility permit applications to local authorities. Tanya is an expert project manager who has led and successfully delivered a wide range of strategic and complex projects. She has expertise in assessing the effects of projects on a wide breadth of environmental topics. Tanya was responsible for peer review of the assessment contained in this chapter.

Bernie is Director with FT and is a Chartered Waste Manager. She has 25 years' experience in delivering and managing projects and infrastructure delivery for a wide variety of sectors. Bernie has extensive experience in all aspects of strategic management planning and infrastructure development in Ireland, the UK, KSA and UAE. She is an experienced planning policy analyst and strategic planner. She has in-depth knowledge of all environmental and planning policy, legislation and guidance. She has been providing environmental, planning and waste management consultancy services to public bodies for over 25 years. She has a vast amount of experience coordinating EIA, SEA and AA projects, including national, large-scale and complex projects.

4.3 Do Nothing Scenario

Annex IV, Part 3 of the EIA Directive states:

"A description of the relevant aspects of the current state of the environment (baseline scenario) and an outline of the likely evolution thereof without implementation of the project as far as natural changes from the baseline scenario can be assessed with reasonable effort on the basis of the avail ability of environmental information and scientific knowledge".

This is referred to as the 'Do Nothing' scenario and is presented as an alternative to the proposed development considered. In the 'Do Nothing' scenario for the proposed development, the site would continue to operate as an active quarry for the foreseeable future, with permitted planning permission likely to be invoked. Current activities include the extraction of sand and gravel for one-off construction projects, along with the acceptance of waste soils from similar developments. Planning permission was granted by Carlow County Council in February 2014 (Ref. P13/187) for sand and gravel extraction and site restoration at Kilcarrig Quarries, subject to conditions including a waste facility permit, with an estimated extraction capacity of up to 400,000 tonnes and an expiry date of 16 February 2029. This was estimated at the time as c80,000 tonnes per annum over 15 years. A waste facility permit allows for the acceptance if inert soil and stones for restoration of the quarry at a maximum quantity of 52,000 tonnes over 5 years. This permission was granted in 2022 and expires in April 2027.

In July 2024, Carlow County Council (Planning Ref. 23/60263) granted conditional planning permission to change the use of an existing quarry at Powerstown, Co. Carlow, to a soil recovery facility over 4.84 ha, involving the infilling of inert, uncontaminated material (c.199,500 tonnes over eight years). Following appeal, An Coimisiún Pleanála upheld the decision and granted permission (ABP Ref. PL01.320180) with revised conditions on 19 May 2025. The permission has not yet been invoked. Refer to Chapter 1, Introduction, in Volume 2 of this EIAR for further details on the planning history of the existing development.

Ireland has binding renewable energy targets set by the European Union. Ireland is obliged to ensure that 80% of the total electrical energy consumed is generated from renewable resources by 2030. This is to help reduce the nation's CO_2 emissions and to promote the use of indigenous renewable sources of energy. These targets have been incorporated into national policy in the Climate Action Plan 2025, which is to be read in conjunction with the Climate Action Plan 2024.

The National Biomethane Strategy (Government of Ireland, 2024) sets out the necessary policy and regulatory measures, and provides a roadmap, to developing a biomethane industry of scale in Ireland. The Strategy is Ireland's first major policy statement on biomethane and is an important milestone in the development of an indigenous sector. Ireland is recognised by the European Commission as having one of the largest potentials for biomethane production in Europe on a per capita basis due to its substantial agriculture sector.

The main objective of the Strategy is "to deliver on the ambitious target set by Government as part of the agreement on the sectoral emission ceilings. The ambition is to scale up indigenously produced biomethane by up to 5.7 TWh per annum by 2030". The Strategy recognises that "biomethane has the potential to progressively replace fossil gas supplies at a national level as we substantially reduce our use of gas over the next 15 to 20 years."

The development of the Strategy is focused on a framework of five interlinking pillars seen as critical to target delivery, these are:

- sustainability
- demand for biomethane
- bioeconomy and the circular economy
- economics of biomethane
- enabling policy requirements

The benefits that Ireland can realise from the development of a new agri-centric biomethane industry include the following:

- meet its legally binding climate targets
- helps to reduce agriculture sector emissions
- diversification option for farmers
- opportunity to replace chemical fertiliser with a supply of biobased fertiliser
- helps reduce Ireland's energy emissions
- improves gas security and diversification of supply
- stimulation of the rural economy

The Strategy outlines the importance of biomethane production for ensuring security of energy supply in Ireland, as c. 75% of Ireland's gas supply is currently imported from the UK, with biomethane (along with hydrogen in the future) playing a key role in ensuring a domestic supply of renewable gas to diversify gas supply and displace fossil gas.

The preferred delivery model combines a limited number of larger, centrally located plants with smaller farm-scale facilities, reflecting a balance between environmental performance and feedstock availability. Achieving the national target will require over 20 large commercial-scale Anaerobic Digestion (AD) plants, or a greater number of smaller facilities. The proposed development aligns with this strategic approach by contributing materially to national targets while efficiently utilising locally available manure feedstocks. The proposed development fully aligns with the National Biomethane Strategy objectives to support the delivery of indigenously produced biomethane by up to 5.7 TWh per annum by 2030.

At a local level, the Carlow County Development Plan (Carlow County Council, 2022) and in the Carlow County Renewable Energy Strategy (Carlow County Council, 2022) support the expansion of renewable energy infrastructure and the sustainable use of local resources (refer to Chapter 2, Planning, Policy, and Need, in Volume 2 of this EIAR). In the 'Do Nothing' scenario, the proposed development would not proceed and thus would not contribute towards achieving the EU, national, and county strategies, policies and objectives outlined in these documents.

If the development of a biomethane project is not pursued, the site will remain in operation as a sand and gravel quarry, whilst continuing to restore the site in accordance with the restoration plan.

In the 'Do Nothing' scenario, the prospect of generating biomethane from residual agricultural residues would be lost at this site.

The nation's ability to produce biomethane and reduce greenhouse gas emissions to meet EU and National targets, as set out above, would be impeded. This is likely to contribute to Ireland incurring significant financial penalties from the EU if targets are not achieved, and result in continued global warming. Additionally, it would affect Ireland's commitment to "pursue efforts" to limit warming as agreed to in the Paris Agreement (2015). This will result in continued significant negative effects to air quality and climate.

In the 'Do-nothing' scenario, importation of fossil fuels including natural gas to maintain growing energy supply will continue and Ireland's energy security will remain vulnerable.

Under the 'Do-Nothing' scenario, the socio-economic benefits associated with the proposed development will be missed. These benefits include the creation of c. 200 no. jobs during the construction phase and 30 during the operational phase of the Proposed Development.

In the "Do-Nothing" scenario, the potential environmental effects of the proposed development as set out throughout this EIAR will not occur. Table 4-1 compares the likely effects of retaining the existing quarry operations under Planning Reference P13/187 with the residual effects of the Proposed Development across the environmental topics addressed in the individual EIAR chapters.

Refer to each respective EIAR Chapter in Volume 2 of this EIAR for full details of residual effects.

Table 4-1: Comparison of Potential Residual Environmental Effects – Proposed Development vs 'Do-nothing' Alternative

Environmental Consideration	Residual Effect of the Proposed Development	'Do-nothing' Alternative
Traffic and Transport	With mitigation applied, the construction impacts will be reduced although they will remain not significant during spikes or periods of relatively intense works which will in any case be of short duration and typically restricted to single days. During the operational stage, impacts are forecast not to be significant whilst the mitigation measures aim to reduce impacts from vehicle trips generated by the proposed development. The residual operational effect is assessed as a negative, not significant, direct impact on the receiving network, which is likely to occur and would persist over the long term.	In the 'Do Nothing' scenario, the traffic environment is expected to remain generally consistent with the baseline, with traffic flows on the public road network assumed to grow in line with the latest growth factors set out in PE-PAG-02017 Project Appraisal Guidelines: Unit 5.3 Travel Demand Projections (Transport Infrastructure Ireland, 2021). Since the site of the proposed development would not progress, there would be no direct increase in traffic on the receiving roads and therefore no significant effect on local traffic conditions, capacity, queues, delays or on the level of service of the receiving road network in the study area.
Population and Human Health	There are no significant residual impacts on human health and population as a result of construction, operation or decommissioning of the proposed development and the proposed gas pipeline.	Under the 'Do Nothing' scenario, the proposed development would not be developed. The existing use of the site as a quarry, along with the surrounding agricultural land uses, would remain unchanged. The landowner is likely to proceed with the most recent planning consent associated with the existing site activities (planning ref: PL01.320180 2025, refer Section 1.4.4 of Chapter 1, Introduction, in Volume 2 of this EIAR). Baseline conditions relating to population and human health would largely remain as they are at present, with ongoing quarry and agricultural operations continuing to generate typical levels of traffic, noise, dust, and emissions. No additional benefits to local human health associated with renewable energy generation, improved agricultural residues management, or reduced regional greenhouse gas emissions would arise under this scenario.

Environmental Consideration	Residual Effect of the Proposed Development	'Do-nothing' Alternative
Air Quality	Following the implementation of appropriate mitigation measures, no significant residual impacts on air quality are predicted during the construction and operational phases of the proposed development and no cumulative impacts are predicted. Construction-phase effects are primarily associated with dust generation and are expected to be short-term, direct, negative and not significant, with dust control measures ensuring compliance with relevant EU ambient air quality standards. Operational emissions are predicted to remain within applicable limit values, resulting in negative but not significant long-term effects on air quality. While there is potential for cumulative dust impacts if construction coincides with other nearby developments, the application of best-practice mitigation measures ensures that any such effects would remain short-term, localised, and not significant.	Under the 'Do Nothing' scenario, the proposed development is not developed and there are no process emissions from the proposed site and no changes in traffic emissions associated with the proposed development which could impact local air quality. Without the proposed development, in the 'Do Nothing' scenario, ambient air quality at the whole proposed project site will remain as per the baseline.
Climate	The residual effects of the proposed development in terms of greenhouse gas emissions are considered to be minor adverse, long-term, and direct for both the construction and operational phases, primarily due to material use, energy consumption, and transport-related emissions. However, with mitigation measures exceeding standard requirements, these impacts are not considered significant and are aligned with Ireland's trajectory towards net zero. Furthermore, the development's production of renewable biogas provides an overall beneficial residual effect by contributing to reduced downstream CO_2e emissions at a national level, supporting the transition to a low-carbon energy system.	Under the 'Do Nothing' Scenario, the proposed development will not be constructed, no construction works associated with the proposed development will take place and any previously identified or recorded effects of the climate will remain as predicted or recorded.

Environmental Consideration	Residual Effect of the Proposed Development	'Do-nothing' Alternative
Noise and Vibration	No significant residual impacts will arise because of the construction/operational/decommissioning works associated with the proposed development. During construction, residual effects are expected to be negative, slight, and short-term in nature, with gas connection works giving rise to slight to moderate temporary effects following mitigation. Traffic-related impacts during construction are anticipated to be negative but not significant and short-term. During operation, noise emissions are predicted to remain below best-practice limit values and existing ambient noise levels at all sensitive receptors, resulting in negative, slight and long-term effects. Traffic increases during operation are expected to cause negative, moderate and long-term effects. Decommissioning activities are predicted to result in negative, slight and temporary effects, with no significant residual impact overall.	It is expected that under the 'Do Nothing' scenario, the existing noise sources and baseline noise environment would remain unchanged. A negligible increase in road traffic noise on the local road network may occur, due to population growth and predicted road traffic increases.
Biodiversity	All impacts can be appropriately mitigated and adequately prevented or reduced below acceptable thresholds that will prevent any significant impacts on biodiversity. The impacts that are reduced will also not act cumulatively with any projects as no projects are proposed within their limited Zones of Interest.	Under the 'Do Nothing' scenario, the site would continue to be managed as it has been operating, i.e. as a quarry. It is likely that faunal assemblages in the scrub, tree lines and hedgerows will persist within the site. Species using the muddy ponds and quarry faces are unlikely to continue utilising the site as the quarry is back-filled, shaped and rehabilitated to grassland. This scenario does not vary greatly in relation to the project proceeding on site, where the treelines and hedgerows and limited scrub will be retained in situ. In the absence of any active management of the site to maintain the rehabilitated grasslands, the existing scrub will encroach and expand to cover the site.

Environmental Consideration	Residual Effect of the Proposed Development	'Do-nothing' Alternative
Soils, Geology, and Hydrogeology	Following mitigation, impacts on land, soils, geology and hydrogeology during construction are assessed as neutral to negative, imperceptible to slight, and temporary to permanent, while operational impacts are assessed as neutral to negative, imperceptible to slight, and short- to long-term, with no uncontrolled emissions. Overall, no significant residual effects on land, soils, geology or hydrogeology are predicted.	Under the 'Do Nothing' scenario, it is likely that the current land use will continue for the foreseeable future. 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 to 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 the road network would not be required. The impact on the Land, Soils, Geology and Hydrogeology would remain largely unaltered as a result and Negligible.
Surface Water and Hydrogeology	Following the implementation of design-based, construction and operational mitigation measures, the residual impacts of the proposed development on surface water hydrology and water quality are not significant. Potential risks associated with runoff from operational areas, accidental spillages, roof drainage, overland flows and lagoon discharges are effectively managed through a multi-stage drainage system incorporating bunding, interception, attenuation, real-time water-quality monitoring, automatic isolation and controlled discharge at greenfield runoff rates. Routine inspection and maintenance of drainage infrastructure and the lagoon ensure continued performance over the lifetime of the development.	Under the 'Do Nothing' scenario, the impact on the hydrological regime and surface water quality within the proposed development and the wider study area would remain largely unaltered. Surface water will continue to infiltrate to ground as per current site conditions. In the absence of the proposed development, there is no requirement for a proposed gas pipeline from the site to the Clogrennan AGI. It is assumed that landowner would invoke the latest permission for import of 199,500 tonnes of soil and stone over 8 years. There is no discharge from site allowed and storm water would continue to discharge to ground The potential 'Do Nothing' scenario impacts are neutral.

Environmental Consideration	Residual Effect of the Proposed Development	'Do-nothing' Alternative
	As a result, the operation of the proposed development will not lead to deterioration in surface water quality, increased flood risk, or adverse effects on downstream receptors, including the Powerstown Stream and the River Barrow, and remains compliant with Water Framework Directive objectives.	
Archaeology and Cultural Heritage	No residual effects on the known cultural heritage resource are predicted to occur because of the proposed development. The mitigation measures presented in r 15, in Volume 2 of this EIAR will provide for either the preservation in-situ of any currently unknown, sub-surface archaeological features that may exist within the proposed gas network connection route by avoidance or the proper and adequate recording of any such features by full archaeological excavation. Preservation in situ shall allow for a negligible magnitude of impact resulting in a potential imperceptible significance of effect in the context of residual impact on the unrecorded archaeological resource. Preservation by record shall allow for a high magnitude of impact, albeit ameliorated by the creation of a full and detailed archaeological record, the results of which shall be publicly disseminated. This shall result in a potential slight/moderate range of significance of effect in the context of residual impacts on the unrecorded archaeological resource.	In a 'Do Nothing Scenario' the proposed development would not be implemented and there would, therefore, be no negative effects to any of the known cultural heritage constraints within the reviewed study areas detailed in Chapter 15, in Volume 2 of this EIAR. This includes any potential unrecorded, sub-surface archaeological materials within these study areas. No significant effects on the known cultural heritage resource are predicted to arise as a result of a 'Do-Nothing' scenario.

Environmental Consideration	Residual Effect of the Proposed Development	'Do-nothing' Alternative
Landscape and Visual	The proposed development is considered to have Moderate-Slight residual impacts on the receiving landscape; however, this reduces substantially beyond the immediate locality. The pipeline corridor is considered to have Imperceptible residual impacts on the receiving landscape. The residual visual effect of the proposed development within the immediate landscape is deemed to be Moderate-Slight to the immediate east, and Slight to the west, north, and south. The residual visual effect of the project within much of the wider landscape is deemed to be Slight to Imperceptible.	The primary effect of the 'Do Nothing' Scenario would be that potential impacts and effects on the landscape and visual aspect of the proposed development would not directly occur. The existing development would continue to operate under its current planning permission and invoke its latest planning consent to complete quarrying operations to exhaust the sand and gravel reserves and to restore the quarry to agricultural land. Perimeter vegetation around this area would continue to mature, and the wider landscape context would likely continue to be managed for agriculture. The gas pipeline route, which is contained along existing roads, would likely be managed as roadside verge. The existing vegetation contained within these verges would continue to change over time.

4.4 Alternative Locations

Three sites were identified as possible locations for the proposed development. These are

- Powerstown, County Carlow
- Clonmelsh, County Carlow
- Jamestown, County Tipperary

The Powerstown site, shown in Figure 4-1, is a 9 hectares (ha) brownfield site, located at Powerstown, Milford, County Carlow. It is approximately 2.5 km north of Leighlinbridge, approximately 6 km north of Bagenalstown, approximately 2.5 km north-west of Nurney village, 8.6 km south of Carlow and 15 km south-west of Tullow.

The site is located 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 located along the L3045 which is accessed from the R448 Regional Road.

The site has been quarried by Kilcarrig Quarries and has been partially restored[1]. Further details for this site are presented in Chapter 3, Description of the Proposed Development, in Volume 2 of this EIAR.

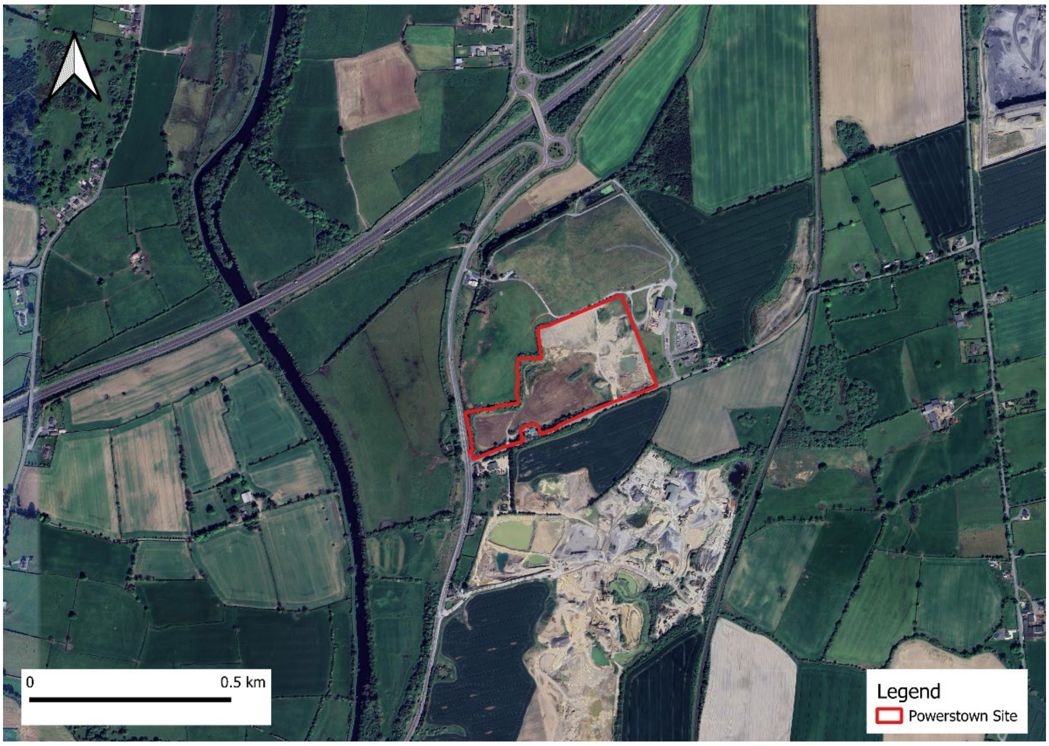

Figure 4-1: Powerstown Site

[1] Planning Ref's.: 01/300 and PL01.129838

The Clonmelsh site is divided into three lots Lot 1 - 107 ha (operational quarry - brownfield), Lot 2- 38 ha (agricultural - greenfield) and Lot 3- 6 ha (agricultural -greenfield), as presented in Figure 4-2. The entire land holding (Lot 1 -3) is in receivership, and the receiver would only consider offers for an entire Lot. Consequently, the developer considered Lot 3 only as a possible location for the development.

The Lot 3 site is located at Clonmelsh, Milford, County Carlow. It is approximately 3.5 km north of Leighlinbridge, approximately 7 km north of Bagenalstown, approximately 3.5 km north-west of Nurney village, 7 km south of Carlow and 14 km south-west of Tullow.

The Clonmelsh site - Lot 3 is located along the L3045 which is accessed from the R448 Regional Road.

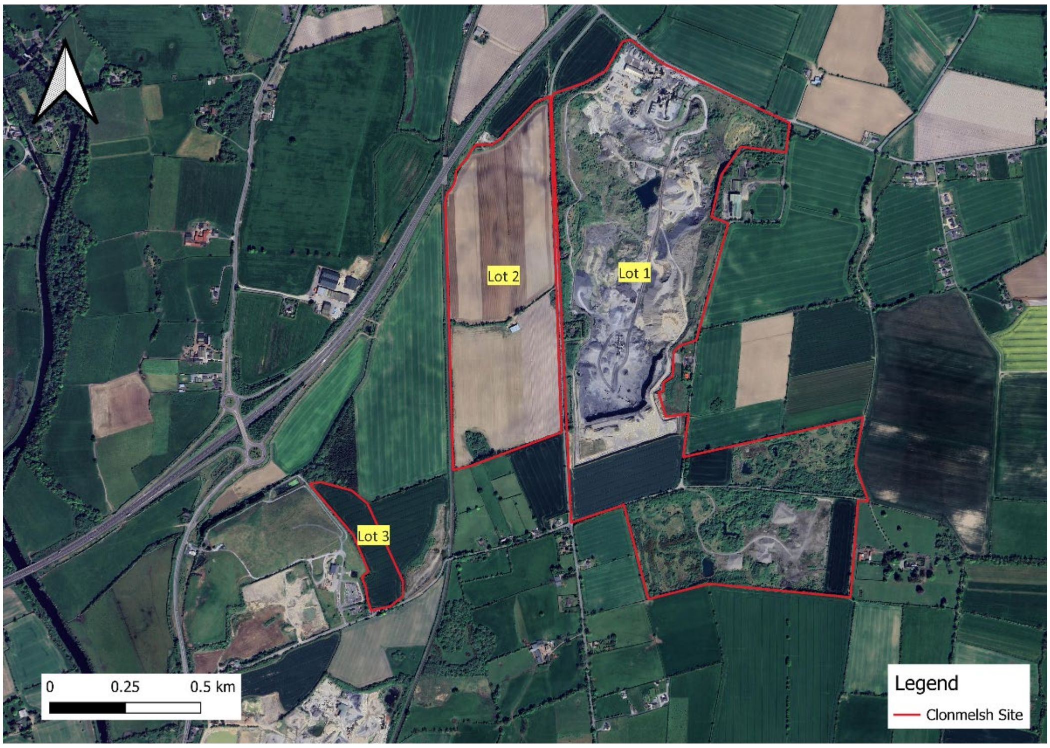

Figure4-2: Clonmelsh Site

The Jamestown site is a 10 ha greenfield, agricultural site, as shown in Figure 4-3.The site is located at Jamestown, Baile Shéamais, Co. Tipperary. It is approximately 4.5 km west of Clonmel, approximately 8.5 km east of Cahir, approximately 15 km south east of Cashel, 2 km south west of Clerihan town, and 3 km south east of Poulmucka village.

The Jamestown site is located along the R687 which is accessed from the N24 National Primary Road.

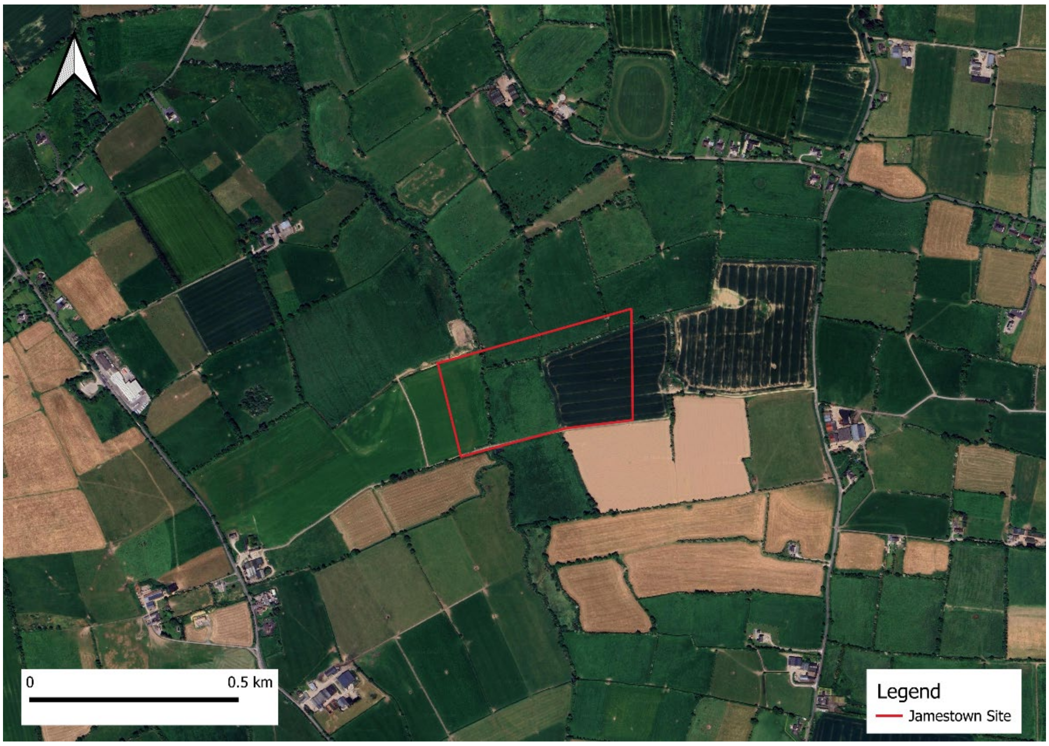

Figure 4-3: Jamestown Site

A detailed site selection process was undertaken by the Applicant using the following criteria:

- Existing Land use
- Landscape and Visual
- Proximity to Electrical Supply
- Proximity to Gas Grid
- Proximity to feedstock and landbank for digestate management
- Transport
- Population and Human Health
- Air
- Climate
- Noise and Vibration
- Biodiversity
- Hydrology and Surface Water
- Leasing Options

The Applicant devised a scoring matrix based on each criterion. Site visits and desk-based studies were completed for all candidate sites. Each candidate site was assessed and an overall score assigned, as per Table 4-2. The site-specific selection criteria and basis for assessment is included in Table 4-3. Criteria are ranked by importance and preference and are assigned weightings from 0 (least preferred) to 2 (most preferred). In addition, criteria were assigned an importance weighting for site selection on a scale of 1 to 4, where 1 represents the least important and 4 represents the most important.

Table 4-2: Scoring system for alternatives assessment

Overall Preference Colour Code	Value
Most Preferred	**2**
Intermediate	**1**
Least Preferred	**0**

Table 4-3: Site-specific selection criteria and basis for assessment

Criteria	Scoring	Score			Weighting	Total Score		
		PT*	CM*	JT*		PT	CM	JT
Existing Landuse	Greenfield or Brownfield (preferred)	2	0	0	4	8	0	0
Landscape and Visual	Site is well screened	2	0	0	3	6	0	0
	Size of site	2	1	2	3	6	3	6
Proximity to Electrical Supply	Km distance, voltage	1	2	0	4	4	8	0
Proximity to Gas Grid	Distance and pressure	1	1	2	4	4	4	8
Proximity to feedstock	Km distance	2	2	1	4	8	8	4
Transport	Proximity to excellent road network (<5 km from motorway network)	2	1	0	3	6	3	0
	Road safety	2	1	0	3	6	3	0
Population and Human Health	No sensitive receptors, rural	2	2	2	4	8	8	8
Air	Sensitive receptors	2	1	0	3	6	3	0
Climate	Construction	2	2	0	3	6	6	0
	Operation	2	2	2	3	6	6	6
	Potential Traffic Generation	2	1	0	3	6	3	0
Noise and Vibration	Sensitivity	2	1	1	3	6	3	3

Criteria	Scoring	Score			Weighting	Total Score		
		PT*	CM*	JT*		PT	CM	JT
Biodiversity	Development requirements	2	0	0	3	6	0	0
	Proximity to sensitive receptors	0	1	2	4	0	4	8
Hydrology and Surface Water	Flood Risk	2	2	2	4	8	8	8
Leasing Options	Economical options available	2	0	1	3	6	0	3
					Total	106	70	54

* PT = Powerstown, County Carlow; CM = Clonmelsh, County Carlow; JT = Jamestown, County Tipperary

The alternative site locations within County Carlow and County Tipperary were assessed under the above criteria, with the site at Powerstown, County Carlow scoring highest overall. The rationale used in the identification of the Proposed Development site at Powerstown, County Carlow is discussed in Section 4.4.1 to Section 4.4.12.

4.4.1 Existing Landuse

Brownfield sites were the preferred option as they typically have existing infrastructure such as roads, utilities, and existing transport activities which lowers environmental impact and development costs. The redevelopment of brownfield sites also has the potential to repurpose already developed lands, making productive use of land that has already been disturbed, reducing pressure to build on greenfield areas such as farmland or natural habitats.

Powerstown is the preferred option as it is a brownfield site, operating as a quarry. Clonmelsh and Jamestown are both greenfield agricultural land sites, making these sites the least preferred option for this criterion.

The existing land use criterion is closely related to the landscape and visual criterion described in Section 4.4.2.

4.4.2 Landscape and Visual

Site is Well-Screened

A well-screened site reduces the visual impact of development on the surrounding landscape and nearby residents, helping a development to 'blend in' and making it less likely to cause visual intrusion. Powerstown is a quarry site, excavated to a high degree. The Powerstown site is excavated to approximately 10 m below ground level], whilst remaining well connected to high-quality road networks. Jamestown and Clonmelsh are considered the less well-screened sites as they are agricultural lands, at ground level. As such, these sites are more visible from a distance, increasing their landscape impact. This increases the need for mitigation (in the form of earthworks and planting) and may lead to greater restrictions in terms of building dimensions and orientations to reduce visibility.

Size of Site

The size of the site affects how much the development will change the landscape character and views. Larger sites tend to have greater visual impacts and require more careful planning, buffer zones, and screening. Smaller sites may integrate more easily into the existing landscape pattern. Similarly, larger sites are likely to incur greater economic costs for development, requiring a higher upfront and long-term investment. 8-10 ha is required for the proposed development at a minimum.

Powerstown is 9.19 hectares (ha) in size, similar to the size of Jamestown at 10 ha. Powerstown and Jamestown were therefore weighted equally as the most preferred option. Clonmelsh - Lot 3 is 6 ha, making it the least preferred option for this criterion.

4.4.3 Proximity to Electrical Supply

An electrical supply near the proposed development reduces infrastructure costs and complexity in terms of planning and impact assessment, whilst also ensuring reliable, consistent power for construction and future operations.

Clonmelsh was the preferred option for this criterion as there is 10 MVA electrical demand capacity available on-site. The intermediate option for this criterion is Powerstown, where there is a local substation 7 km from the site, with 18 MVa availability and local 38 KV transmission lines. The least preferred option is Jamestown, where there is a local substation 5 km from the site, with a lower capacity 6 MVa availability and local 38 KV transmission lines.

4.4.4 Proximity to Gas Grid

Proximity to the gas grid reduces the cost and complexity of connecting the proposed development to distribution infrastructure, allowing biomethane produced on-site to be injected directly into the network. Shorter connection distances mean lower costs. Proximity to the grid may also improve operational efficiency by ensuring reliable export capacity and easy supply gas to local and national markets.

Jamestown was the preferred option for this criterion, with high pressure 80 bar gas pipeline approximately 1.1 km from the site. Powerstown and Clonmelsh are intermediate options, with a 70 bar gas pipeline approximately 2.6 and 2.9 Km from the respective sites as the crow flies, pre- Gas Networks Ireland assessments. Proximity to Feedstock

Feedstock supply is required to operate the proposed development and is also an important consideration as it directly affects the reliability, economics, and sustainability of such a biomethane project. Siting the proposed development close to its feedstock sources reduces transport distances, lowering haulage vehicle emissions, and traffic impacts. It also ensures ensure a consistent, year-round supply of feedstock s, which is essential for maintaining steady plant operation.

Jamestown, whilst viable and competitive, is the preferred option with approximately 4.1 million tonnes of agricultural feedstock available within 35 km and a high concentration of large livestock farms in this catchment.

Powerstown and Clonmelsh were the intermediate option, as both locations have approximately 3 million tonnes of feedstock available within a 35 km catchment radius of these sites. With this radius there is a high concentration of beef lots to supply feedstock and arable farms to manage digestate.

4.4.5 Transport

Proximity to Excellent Road Network

Transport is a key consideration in site selection as it determines how easily feedstock and digestate can move to and from the proposed development. Good access to suitable roads can minimises haulage distances and consequently vehicle emissions. Due to the nature of the proposed development, large vehicles (including Heavy Goods Vehicles (HGVs)) are required to access the site throughout the operational stage of the proposed development. The provision of suitable transport routes reduces potential impacts on local communities by ensuring that heavy vehicle movements avoid sensitive areas throughout all phases of the proposed development.

Powerstown is the preferred option in terms of access to high-quality road networks. It has a good road network availability at the site. The former N9 national primary road, now the R448, is a high-quality dual carriageway, situated less than 100 m from the first site entrance and less than 200 m from the main site entrance, both on the L3045. The R448 is linked to the M9 motorway, which is 1.2 km from the proposed site entrance (420 m north, as the crow flies).

The proximity of the M9 motorway provides transport and environmental benefits during the operational stage of the proposed development. Direct access to high-quality motorway infrastructure allows heavy goods vehicles to join the strategic road network quickly, reducing journey times, fuel consumption, and associated greenhouse gas emissions. This also minimises the need for HGV movements on local and regional roads, thereby reducing traffic-related impacts on local communities and supporting more efficient and sustainable operation of the proposed development.

Clonmelsh is the intermediate option for this criterion, being approximately 1.4 km from the R448 dual carriageway, and 2.9 km from the M9 motorway. Jamestown is the least preferred option, being approximately 1.2 km from the N24 National Primary Road, and approximately 11 km from the closest motorway, the M8.

Road Safety

Road safety is an important consideration for the proposed development due to the regular movement of HGVs during all stages of the proposed development. Locating the proposed development close to high-quality road infrastructure allows HGVs to access the strategic road network quickly and safely, reducing interaction with local roads, junctions, and sensitive receptors. Powerstown is the preferred option in this regard, benefiting from its close proximity to the R448 dual carriageway and the M9 motorway, thereby minimising travel on minor roads and reducing potential road safety risks for other road users and local communities. Clonmelsh represents an intermediate option with reasonable access to the strategic road network at 1.4 km from the R448, while Jamestown is the least preferred due to its greater distance from motorway infrastructure, being approximately 11 km from the closest motorway which would necessitate longer journeys on lower-order roads.

4.4.6 Population and Human Health

Population/human health is an important criterion as rural locations generally result in fewer people living nearby, which reduces the risk of visual, noise, odour, and traffic impacts affecting residents, making it easier to protect public health and meet regulatory requirements. A rural setting also provides more space and separation for developments such as bioenergy facilities, helping them operate with minimal disturbance while still fitting appropriately into the surrounding landscape.

Powerstown, Clonmelsh and Jamestown were given equal scoring for this criterion. Powerstown is an isolated site and former quarry. There is a commercial property within the immediate proximity of the site, which is owned by the landowner but is not included within the proposed development boundary. It will not be used during the operational phase. The Applicant, Greengate Biogas 001 Ltd., will take vacant possession of this property including all buildings upon approval for application consent. Similarly, Clonmelsh is situated in a remote rural area with low density farm holdings and no immediate receptors, as is the Jamestown site.

4.4.7 Air

Fewer nearby receptors mean fewer people potentially exposed to potential emissions, odour, or dust, during all stages of the proposed development. This is an important consideration during construction, operation, and maintenance of the proposed development. This reduces both human health risk as well as the likelihood of significant air-quality effects. Selecting the site with the lowest receptor count represents a more environmentally suitable and lower-risk choice. Eircode address data were used to identify and count potential sensitive receptors. Within a 1 km radius of each site, Powerstown contained 32 potential receptors, compared with 51 at Jamestown and 38 at Clonmelsh. For this reason, Powerstown is the preferred option from an air-quality perspective.

An additional air quality consideration is the extent of construction activity required at each site. As both Powerstown and Clonmelsh are existing quarry sites, they have already undergone significant excavation and will therefore require less earthworks during development. While mitigation measures will be implemented to manage air quality impacts, selecting a site with fewer sensitive receptors and reduced excavation needs further minimises the risk of dust and particulate emissions affecting the surrounding area. Reduced construction activity is also beneficial in terms of noise impacts, as discussed in Section 4.4.9.

For these reasons, Powerstown, an existing quarry site with the fewest downwind receptors, was the preferred option under this criterion.

4.4.8 Climate

The principal climate-related effects associated with the proposed development are greenhouse gas (GHG) emissions from construction activities, operational energy use, and traffic generated during operation.

Potential for GHG Emissions - Construction

As Jamestown is an undeveloped greenfield site, it would require a greater level of site preparation and associated construction activities compared to Powerstown and Clonmelsh, which already benefit from disturbed ground and established access. As a result, Jamestown is considered the least preferred option in climate terms during the construction phase Powerstown, as the smaller site with a higher proportion of brownfield land, is the preferred option.

Potential for GHG Emissions - Operation

Operational greenhouse gas emissions are similar across all locations. There is no preferred option in terms of operational GHG considerations.

Potential for GHG Emissions - Potential Traffic Generation

Considering the road network as discussed in Section 4.4.5, Powerstown is considered the preferred option in terms of potential for traffic generation during the operational stage of the proposed development. This is due to the Powerstown site combining immediate access to high-quality road infrastructure (R448 and proximity to the M9 motorway) with close proximity to feedstock sources, thereby minimising travel distances, journey times, congestion, and potential for vehicle idling. Clonmelsh is an intermediate option, with reasonable proximity to strategic roads and feedstock. Jamestown is the least preferred, due to its greater distance from motorway infrastructure, which would result in longer vehicle journeys, increased fuel consumption, and higher associated greenhouse gas emissions during operation.

4.4.9 Noise and Vibration

Noise and vibration can affect nearby residents and sensitive receptors, especially in rural areas where background noise levels are low. Biomethane facilities can generate noise from construction, equipment, traffic, and ongoing operations. As discussed in Section 4.4.7, the Powerstown site which has already been excavated will require less construction works and are therefore less likely to emit noise during this period, compared to Jamestown and Clonmelsh. Similarly, an operational quarry site will have background noise levels are likely already higher than that of greenfield, agricultural sites at Jamestown and Clonmelsh. Powerstown is the preferred site in terms of noise and vibration impacts when compared to Jamestown and Clonmelsh.

4.4.10 Biodiversity

Development Requirements

As Powerstown is a brownfield site, operating as a quarry, the potential for biodiversity impacts is lower than at the greenfield Jamestown and Clonmelsh sites.

Proximity to Sensitive Receptors

Jamestown is the most preferred option for this criterion. This site is located approximately 3.5 km from Marlfield Lake pNHA and 4 km from the Lower River Suir SAC. The separation distance reduces the likelihood of direct or indirect effects on designated sites and provides the greatest ecological buffer.

Clonmelsh is moderately constrained and is considered the intermediate option. The River Nore SAC is located approximately 500 m from the site, the pNHA, Cloghristick Wood, is 750 m from the site, and the River Barrow (Nutrient Sensitive Area) is approximately 1 km. While close enough to require careful assessment and mitigation, impacts are likely to be manageable due to the absence of immediate adjacency.

Powerstown is the least preferred option due to its proximity to sensitive receptors. The boundary of the River Barrow and River Nore SAC lies approximately 20 m to the west of the site, with the River Barrow (Nutrient Sensitive Area) at 350 m and pNHA Cloghristick Wood at 500 m. This high level of ecological sensitivity increases the potential risk of adverse effects and would necessitate more stringent safeguards.

4.4.11 Hydrology and Surface Water

A preliminary flood risk assessment was undertaken for these candidate sites, and all were deemed as not having a flood risk. There have been no recorded historic flooding incidents within the proposed development site boundary. A Site-Specific Flood Risk Assessment has been completed for the proposed development and is available in Appendix 13.2 Site Specific Flood Risk Assessment, in Volume 3 of this EIAR.

4.4.12 Site Acquisition

Leasing options were an important economic consideration to reduce upfront capital costs and provide greater flexibility when securing a site. Powerstown's 30-year lease with a 3-year option period to further extend minimises risk, reduces cost, and provides greater project certainty. This was considered advantageous over Jamestown's 30-year lease under a 5-year option. Only Lot purchases would be considered by the received for the Clonmelsh site, limiting flexibility, increasing initial capital requirements, and consequently making it a less favourable option from both a financial and risk management perspective.

4.5 Alternative Site Layouts and Design

The site layout and design evolved iteratively throughout the project development process. Owing to the size and geometry of the Powerstown site, options for layout and design were limited. The layouts presented in this section represent alternative configurations considered during project development. While broadly similar in form, each option reflects progressive optimisation in response to site constraints and design requirements. The layout options are presented in Figure 4-4, Figure 4-5, and Figure 4-6.

The layout review focused on ensuring the design is fully optimised for site geometry, operational efficiency, and constructability by making the most effective use of the topography and available footprint by minimising the number of tanks required and improving internal traffic flows. Consideration was also given to future maintenance access, and the overall functionality of the site. The criteria considered are presented in Table 4-4.

The design process for the proposed development considered potential environmental effects, with mitigation measures incorporated to avoid, reduce, or manage impacts where practicable. Potential effects on biodiversity, water quality, climate, soils, landscape and visual amenity, and noise and vibration have been addressed primarily through avoidance by design.

Figure 4-5 represented the design at the time of public consultation and was presented accordingly. The preferred site design and layout, presented in Figure 4-6, remains largely consistent with that earlier version used during public consultation, with minimal updates. The final configuration reflects an iterative process aimed at achieving a safe, efficient, and spatially optimised design.

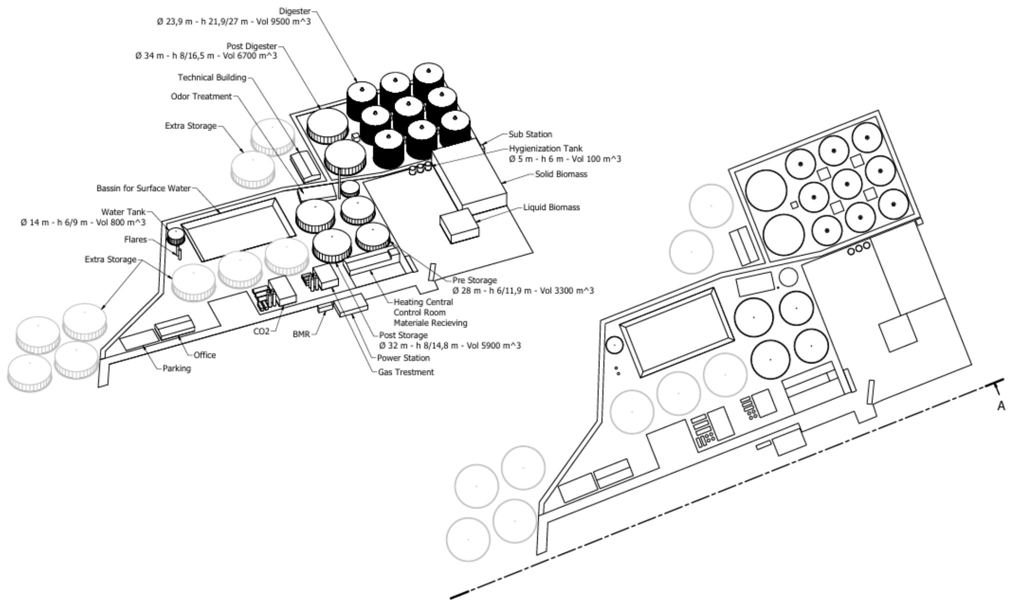

Figure-4-4: Alternative site design and layout considered- Option 1

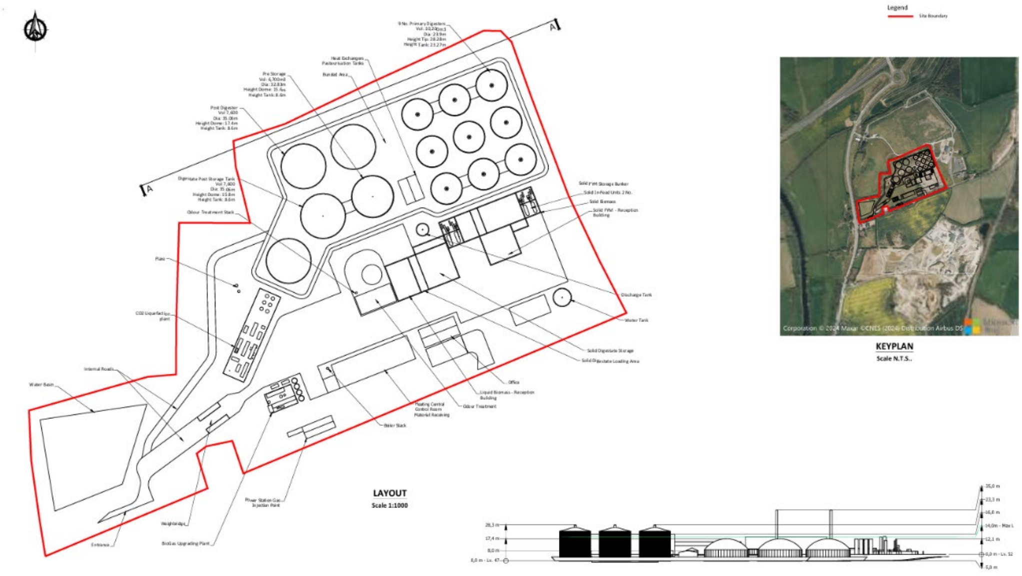

Figure 4-5: Alternative design and layout considered and presented at public consultation - Option 2

Figure 4-6: Preferred site layout and design - Option 3

Table 4-4: Selection criteria and basis for assessment of alternative design and site-layout

Criteria	Score			Weighting	Total Score		
	Option 1	Option 2	Option 3		Option 1	Option 2	Option 3
Buildability	0	1	2	4	0	4	8
Number of tanks Required	0	1	2	2	0	2	4
Operational efficiency	0	1	2	3	0	3	6
Future maintenance access	0	1	2	3	0	3	6
				Total	0	12	24

4.5.1 Alternative Layout Consideration

4.5.1.1 Buildability

One of the primary considerations in site design and layout was optimising earthworks and buildability. By designing a reduced spread of structures as presented in Option 3, in comparison to those in Option 1 and Option 2, the design minimises cut-and-fill requirements and makes better use of the existing topography. This results in a more compact development area.

The transition from the alternative site layouts and designs options presented in Figure 4-4 and Figure 4-5 (Option 1 and Option 2, respectively) to the current layout presented in Figure 4-6 (Option 3) reflects a more efficient, constructible and preferred site design. Therefore, Options 1 and 2 are the least preferred and intermediate options, respectively. Option 3 is considered the preferred option for this criterion for the proposed development.

4.5.1.2 Number of Tanks Required

By increasing the height of four tanks (tertiary and storage tanks) shown in Option 3 by an average of approximately 2 m, the design achieves the required total storage volume while eliminating the need for a fifth tank (see Option 2). This change reduces the site footprint, creates additional space for vehicle circulation and safety clearances, and lowers construction impact associated with foundations, utilities, and instrumentation. A smaller number of tanks also simplifies process control and reduces long-term maintenance demands.

4.5.1.3 Operational Efficiency and Functionality

In Design and layout Option 1 and Option 2, the heating and control building were more dispersed across the site, increasing cable runs, pipe lengths, operational complexity and construction impacts. In Option 3, the preferred option, the heating/control building is positioned more centrally, improving accessibility for operations staff and simplifying service routing.

4.5.1.4 Future Maintenance Access

Reducing the number of tanks improves long-term operational efficiency by simplifying site layout and optimising access for inspection, maintenance, and plant management activities. As presented in Option 3, fewer tanks reduce internal traffic movements and allow clearer circulation routes, facilitating safer and more effective maintenance access over the operational lifespan of the development.

4.5.2 Design Considerations

4.5.2.1 Noise and Vibration

Embedded noise mitigation measures have been incorporated into the proposed development design. The site layout and orientation ensure that noise from external sources such as HGVs and plant will be screened from the closest receptors to the south and maximum distance between noise sources and receptors is achieved. The proposed development will be constructed using Kingspan Quadcore insulated wall and roof panels (or equivalent), which provide a high degree of sound insulation performance and will allow for reduced noise breakout from the proposed operations. The proposed development will also utilise fast acting roller shutter doors, which will ensure that doors will not be left open during operations. HGVs on site will use auto idle shut off technology to avoid engines idling for long periods.

4.5.2.2 Soils, Geology, and Hydrogeology

Potential impacts on land, soils, geology, and hydrogeology are considered through design measures. Site-specific ground investigations, including trial pits, boreholes, groundwater monitoring, and pump testing, were undertaken to inform the design and confirm ground and groundwater conditions. Earthworks have been designed to maximise reuse of site-won materials, reducing the need for imported fill. The tank farm will be fully bunded in accordance with EPA guidance to provide impermeable secondary containment in the event of a leak, with the design subject to EPA approval and ongoing integrity testing. A comprehensive stormwater management system has also been incorporated into the design to protect ground and surface water receptors.

Further details are available in Chapter 12, Soils, Geology, and Hydrogeology, in Volume 2 of this EIAR.

4.5.2.3 Biodiversity

The following measures are incorporated into the design features at site to avoid / prevent impacts on designated sites, flora and fauna through avoidance and design:

- The biogas plant will be built within a lowered topographical setting which retains all water runoff in the site which will only be released during the operational phase when both process water tanks and the storm water lagoon is full during a 1 in 30-year flood event, considering climate change.
- Water management design features are implemented and fitted with automated systems to ensure all water within the storm water lagoon is uncontaminated. Any sensors detecting contamination will result in water being diverted to attenuation area for treatment at an authorised wastewater treatment plant (off site). When pumping to the covered road drain is required in a 1 in 30-year or more flood event, then the water will be of acceptable quality for the receiving water courses (Powerstown Stream).
- Appropriately sized bunding is provided for all tanks and storage areas to contain cumulative spills to prevent impact on the quality of the storm water runoff from the site.

4.5.2.4 Climate

A series of mitigation measures are proposed for the project that will both reduce embedded carbon within the construction phase and reduce GHG emissions during the operational phase. These are outlined in Table 4-5

Table 4-5: Mitigation Measures

Unmitigated	Mitigated
Use Electricity to heat the anime and pasteurisation units	Use of biomass boiler to heat the amine and pasteurisation units
No Solar panels	Solar panels (640,000 kWh)
6F1 and cl804 Used	Geogrid used in yard area to reduce volume of virgin aggregate
Potable water used on site	Harvested rainwater and groundwater water from site used
Standard cladding used	Lower carbon cladding used
Standard concrete used	Lower carbon concrete used
Steel Rebar not sized, new rebar used	Steel rebar sized, recycled rebar used

Unmitigated	Mitigated
Normal Portal Frames	Low carbon steel (electric arc furnace)
Hot rolled asphalt	Mastic Asphalt
New 6F1 used	Recycled 6F1 used
HGV's not backloaded	HGV's backloaded
Grid electricity uses non renewable energy	Grid electricity uses renewable energy
Concrete piles used	Vibro stone columns used

In addition to the measures outlined in Table 4-5:

- Reclamation of bare ground
- Planting 10,665 m² of new hedgerow
- Planting 27,705 m² of new grassland
- Use of an on-site borehole for the water supply

Where the use of the biomass boiler is specified, this will be supplied with biomass from sustainably managed resources such that removal of biomass will be replaced in a manner that represents compliance with the Government of Ireland's commitment to net zero emissions.

4.5.2.5 Hydrology

Due to the proximity of the site to the River Barrow and River Nore Special Area of Conservation (SAC), hydrological considerations were incorporated into the site layout and design to ensure appropriate surface water management, minimise potential impacts on local hydrology, and protect downstream water quality.

The key design measures affecting hydrology include:

- Development of the proposed development within a former quarry, thereby avoiding impacts on natural floodplains and minimising interference with existing surface water flow paths.
- Adoption of a fully separated drainage strategy, comprising three distinct hydraulic networks designed according to runoff quality and risk:
    - a drainage network serving plant carriageways and bunded tank areas
    - a roof water drainage network collecting uncontaminated runoff from building roofs
    - an interceptor drainage network collecting clean overland flows from surrounding lands and quarry cut areas.

Further details on these considerations are available in Chapter 13, Surface Water and Hydrology, in Volume 2 of this EIAR.

4.5.2.6 Landscape and Visual Impact

A key measure embedded within the design of the proposed development for mitigation against potential impacts on the landscape and visual element is the colour scheme of the proposed structures. The proposed development is located within a reasonably well vegetated landscape and will generally be seen against this backdrop from higher elevations, or as part of a vegetated tree line from lower elevations. With the primary objective of minimising the visual impact of the built structures by allowing these structures to be as unobtrusive as possible against their backdrop, the proposed colour scheme references colours found in the surrounding local landscape, including greens and recessive greys. Refer to Chapter 16, Landscape and Visual Impact, in Volume 2 of this EIAR.

4.6 Alternative Technologies

4.6.1 Best Available Technique

The processes outlined in Chapter 3, Description of the Proposed Development, in Volume 2 of this EIAR were selected following a thorough review of Best Available Techniques (BAT) and regulatory requirements. The chosen technologies, processes and techniques represent established industry standards, are widely proven in operational settings, and support the effective implementation of robust emission-control measures.

4.6.2 Odour Control

Odour control is achieved using a combination of technology and operational controls. Technologies can include the use of either biofilters or photo-oxidation.

Biofilters use microorganisms immobilised in a bed of porous media to degrade odorous compounds. Biofilters, are well established and effective, passive systems with low energy demand. However, biofilters have limitations, one of the most significant of which is land take requirements. This type of odour control system is also sensitive to weather and loading variations. The microbes in the media require a moist, warm environment (ideally 25°C to 45°C) to break down odorous compounds. Cold, dry, or excessively rainy weather can significantly hinder efficiency. Optimal operation of biofilters relies on stable moisture content (50-70%) and consistent airflow, often requiring adjustments to handle peak loads.

An alternative to biofilters is the use of photo- oxidation for odour and volatile organic compound (VOC) control. Photo -oxidation uses high-intensity UV light combined with controlled ozone generation to break down odorous compounds and VOCs at a molecular level. The process converts these compounds into less harmful substances such as oxygen, water vapour, and Carbon Dioxide (CO_2), typically at ambient temperatures. Photo-oxidation based technologies are used in biogas and anaerobic digestion plants, wastewater treatment facilities, waste management operations, and food-processing industries. It is considered advantageous for locations with high odour sensitivity or variable odour loads, as it requires minimal land take, delivers consistently high odour removal, and responds rapidly to changing conditions.

Photo-oxidation based technologies are the preferred option for odour control for the proposed development because they are capable of effectively treating both high-intensity point sources of odour and lower-level background odour emissions within a single, compact system. This flexibility allows odour control to be targeted where it is most needed while maintaining consistent overall performance. In addition, Photo-oxidation based technologies require less day-to-day maintenance than a conventional biofilter, improving operational reliability and reducing ongoing maintenance demands, making it a more suitable solution for the proposed development.

The system offers greater redundancy than the biofilter alternative, operating in four modular parts with built-in duty and standby capacity, which ensures robust performance and reliability under fluctuating load conditions. By comparison, the biofilter option was not considered sufficiently modular or adaptable, making it less suitable for the operational flexibility required on this site.

4.6.3 Gas Upgrading

The heating value of biogas is primarily affected by the quantity of methane. Biogas upgrading is a process involving removal of non-valuable components (mainly CO_2) from biogas. Therefore, the gas upgrading process is an essential consideration in the production of high value biomethane.

Two technologies were considered for gas upgrading: membrane separation and amine separation.

Membrane separation is an established and suitable technology for biogas purification and upgrading. This separation technique uses polymeric membranes to separate the CO_2 from the methane in biogas while under high pressure.

The amine separation process uses an amine-based system to separate desulphurised biogas into purified biomethane and biogenic CO_2 by absorbing acidic gases into the amine solution, regenerating it through heating, and recycling it for continuous operation.

The amine separation technique was considered the preferred option. While membrane systems offer excellent purity and very low methane losses, they are significantly more electricity-intensive and therefore less suitable in areas where grid capacity is limited. In contrast, the amine process delivers higher methane capture (>99.5%), requires far less electrical power, and recovers approximately 80% of its heat demand internally, making it far more compatible with more constrained grid conditions. Its closed-loop design also minimises solvent and water use, providing stable long-term operation with low resource inputs. Given the limited availability of grid import capacity and the desire to avoid additional electrical load, amine upgrading emerged as the more practical, economical, and energy-efficient option for the site.

Amine separation technology was selected because it offers the lowest overall methane slip, at approximately 0.1%, compared with around 0.5% for membrane systems, resulting in improved gas recovery and stronger climate performance. Amine systems also provide higher operational availability, as they typically require lower routine maintenance and experience fewer performance fluctuations. In addition, the energy costs associated with amine upgrading are lower, which is a key consideration in Ireland where electricity prices are relatively high. Overall, the combination of reduced methane losses, improved reliability, and lower energy expenditure makes amine separation the preferred option.

4.6.3.1 Amine Heat Source

For amine systems, heat can be sourced from electricity, gas, biomass, diesel, etc. However, biomass generally offers the strongest overall advantages. While onsite biogas is the most common heat source, using it reduces the volume of upgraded biomethane available for export to the gas grid and reduces the project's carbon-intensity (CI) score . Diesel is carbon-intensive and costly, and electricity can be low-carbon but is usually expensive to run at the thermal load required for amine regeneration.

Biomass is the preferred option for the proposed development as it provides a renewable, indigenous fuel that delivers the lowest CI score. By sourcing heat from biomass, the proposed development avoids consuming biomethane that would otherwise achieve higher value as an exported renewable gas, while also strengthening the proposed development's overall sustainability credentials.

4.6.4 Pretreatment

Two technologies were considered for solids pretreatment: shredder and hammermill.

Hammermills are commonly used for pretreatment in Europe. These systems use high-speed rotating hammers to pulverise straw into a fine, consistent particle size, which can improve mixing and digestion efficiency. Their performance is optimal when a very uniform fibre length is provided.

However, Irish straw is typically 50 mm long, coarse, and used as full-length bedding, unlike the finer, material common across much of Europe. This long-strand Irish straw must be chopped to reduce fibre length, improve pumpability, and ensure efficient digestion. The shredder is the preferred option due to the specific characteristics of Irish feedstocks, where material arriving at the digester is far less processed than in continental systems and therefore requires mechanical size reduction to ensure stable AD performance. Furthermore, a shredder also helps remove contaminants such as grit and stones that often end up in bedding, protecting downstream equipment and reducing wear on mixers and pumps.

4.6.5 Water Supply

Two water supply options for the process were assessed as part of the alternatives assessment: groundwater and mains water. The preferred option is to utilise groundwater from an on-site well which makes use of a local water resource. The alternative option of using mains water was considered but not selected, as it would be more carbon-intensive due to the energy required for abstraction, treatment and long-distance distribution. The on-site groundwater supply represents a more carbon-efficient and sustainable solution for meeting the water demands of the proposed development.

4.6.6 On-Site Power Generation

The inclusion of on-site solar photovoltaic panels was considered, with the alternative being reliance solely on grid-supplied electricity. Installation of solar panels was identified as an option, as it enables direct generation of renewable electricity at the source of demand. This approach reduces reliance somewhat on grid-supplied electricity, which is typically more carbon-intensive due to upstream generation and transmission losses. This would result in higher operational emissions over the lifetime of the development. Incorporating on-site solar panels therefore represents a more carbon-efficient and sustainable energy solution, aligning with best practice in reducing operational greenhouse gas emissions.

4.6.7 Carbon Dioxide Capture

The proposed development includes the capture and liquefaction of CO_2 produced directly from the anaerobic digestion. This approach treats CO_2 as a valuable resource rather than the alternative - venting to atmosphere. This enables its use in a range of downstream applications and reducing reliance on imported industrial CO_2. The scale of production is such that the proposed development could, in principle, contribute significantly to meeting Ireland's annual CO_2 demand independently, significantly enhancing national supply security. In addition, the availability of concentrated biogenic CO_2 creates future opportunities for integration with processes involving longer-chain hydrocarbons, supporting emerging carbon-utilisation technologies and contributing to a more circular, low-carbon economy.

4.7 Summary

The alternatives assessment demonstrates that the selected location, design, layout, and technology represent the most efficient, environmentally responsible, and operationally stable solution for the proposed development.

Three different sites were considered for the development of the proposed development. Furthermore, a range of site configurations, process options, and technologies were examined, with each assessed against spatial constraints, environmental performance, constructability, and long-term operational needs.

The final layout incorporates optimised land use, reduced earthworks, improved building placement, and enhanced storage efficiency, while the design considers mitigation against potential environmental effects. The chosen treatment technologies offer high reliability and strong environmental and economical outcomes.

Overall, the preferred options provide a balanced solution that meets project objectives while minimising potential impacts.

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