Limerick WWTP Upgrade and Regional Bioresource Centre

EIAR Chapter 2 - Alternatives

June 2026

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2 ALTERNATIVES

2.1 Introduction

This Chapter describes how Limerick WWTP Upgrade and Bioresource Centre Project, hereafter referred to as "Proposed Development", was planned and designed through a staged process, as applied to all major infrastructure projects. This Chapter presents an overview of the reasonable alternatives studied during the project development stages which have been informed by relevant policy / plans, previous studies and how these alternatives have been developed and refined as part of the ongoing design development and Environmental Impact Assessment (EIA) process.

The Section describes the following reasonable alternatives that have been considered, including:

- The 'do-nothing' (business as usual) scenario;
- Alternative treatment locations;
- Alternative technical solutions.

This Chapter is divided according to the alternatives considered for the Wastewater Treatment Plant (WWTP), Stormwater Storage Tank, and the Regional Bioresource Centre (RBC). It examines the various alternatives studied by the Applicant, relevant to the Proposed Development and its specific characteristics and provides the main reasons for selecting the chosen option. It also includes a comparison of the environmental effects. Apart from exploring some new options in the course of this analysis, several relevant previous studies were re-examined.

2.2 Environmental Impact Assessment Requirements

Article 5(1)(d) of Directive 2011/92/EU, as amended by Directive 2014/52/EU (European Union 2014) requires an Environmental Impact Assessment Report (EIAR) to include *'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'*.

The Guidelines on the Information to be contained in Environmental Impact Assessment Reports (EPA 2022) notes the following in respect of alternatives:

'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. (EPA 2022).'

Annex IV point 2 of the Directive 2014/52/EU on the effects of certain public and private projects on the environment requires an EIAR to include:

'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.'

2.3 Do Nothing Scenario

2.3.1 Introduction

The 'The 'Do-Nothing' or 'Business as Usual' scenario considers the consequences if the proposed works are not implemented, and the Limerick WWTP and the existing Sludge Hub facility continue to operate at their current treatment capacity. This scenario accounts for the continuation of current management regimes and prevailing environmental trends, with no upgrades or improvements made to the existing systems.

The overarching objectives of the Proposed Development, as established in the Preliminary Business Case, are as follows:

- To upgrade and expand the existing wastewater treatment process at the WWTP;
- To increase stormwater storage capacity; and
- To develop a Regional Bioresource Centre (RBC), in alignment with Uisce Éireann's National Wastewater Sludge Management Plan (NWSMP).

Under the Do-Nothing scenario, these objectives would not be achieved. Without enhancements to the treatment and storage systems, the demand on the existing infrastructure will continue to grow, and the current capacity will be insufficient to meet future predicted requirements (see Chapter 3 – The Proposed Development). Consequently, the Do-Nothing scenario would give rise to environmental, economic, and social impacts, as outlined below.

2.3.2 Limerick WWTP

The Urban Wastewater Treatment (UWWT) Directive (91/271/EEC) and the European Communities (Urban Wastewater Treatment) Regulations 2001 (S.I. No. 254 of 2001), as amended, establish standards for the collection, treatment, and monitoring of urban wastewater discharges. The primary driver for the proposed Limerick WWTP Upgrade Project is the imminent overloading of the existing plant due to predicted population growth. Without intervention, this would result in risks to human health and non-compliance with both the UWWT Directive and the EPA Wastewater Discharge Licence (WWDL) D0013-01.

Constructed in the early 2000s to serve a population equivalent (PE) of 130,000, the existing Limerick WWTP is now hydraulically overloaded despite several incremental upgrades. It can no longer adequately treat wastewater from the Limerick agglomeration, and any increase in loadings will lead to insufficient dilution in the receiving waters, posing a significant risk to the aquatic environment within the Lower River Shannon SAC.

The Water Framework Directive (2000/60/EC) aims to prevent deterioration of water quality and achieve 'Good Status' for all water bodies. The assimilative capacity of the Lower River Shannon has long been a concern for the Department of the Environment, Heritage and Local Government (DEHLG), making adequate WWTP capacity essential for maintaining downstream water quality. Under the Do-Nothing scenario, there would be no potential for improving the quality of receiving waters and a heightened risk of further deterioration.

Projected population growth and underutilised industrial discharge licences exacerbate the overloading risk. Industrial licensees may increase production at any time, generating additional wastewater and further straining the plant's limited capacity to assimilate future loadings. National Development Plan population forecasts indicate that existing facilities are already insufficient to meet anticipated future demand. Therefore, substantial upgrades are required to ensure compliance with the UWWT Directive, the EPA Waste Water Discharge (Authorisation) Regulations 2007 (S.I. No. 684 of 2007), and relevant Uisce Éireann design and capacity guidelines.

Furthermore, the Do-Nothing option would be inconsistent with Uisce Éireann's 2030 energy efficiency target to design, build, and operate assets that are 50% more energy efficient.

From a circular economy perspective, the Do-Nothing scenario may initially appear advantageous, as it would require only limited materials for ongoing maintenance and repair. However, many critical items of infrastructure are nearing the end of their design life and will soon require significant refurbishment or replacement.

In the context of continued population and employment growth, the absence of the proposed upgrades would constrain both regional and local economic development. Restrictions on new residential, commercial, and industrial connections could be imposed due to insufficient treatment capacity.

Overall, the Do-Nothing scenario would result in major negative environmental, economic, and public health impacts due to inadequate wastewater treatment capacity. It is therefore not considered a reasonable alternative for the Proposed Development.

2.3.3 Regional Bioresource Centre

Under the Do-Nothing scenario, the existing Sludge Hub Centre at Limerick WWTP would continue to operate at its current treatment capacity, with only routine maintenance undertaken. No new sludge treatment infrastructure would be provided to accommodate future increases in sludge generation.

The Limerick Sludge Hub currently treats a combination of indigenous primary sludge, waste activated sludge (WAS) and imported liquid and cake sludges. According to operational data, imported sludge is received from Counties Limerick, Clare and Tipperary.

In September 2016, Uisce Éireann published the National Wastewater Sludge Management Plan (NWSMP), which establishes a national framework for the sustainable management, treatment, storage, and reuse or disposal of wastewater sludge over a 25-year period. The NWSMP projects that the volume of wastewater sludge generated nationally will increase by more than 80% by 2040, driven primarily by population growth and the completion of new or upgraded wastewater treatment plants.

The NWSMP identifies the need for a network of Regional Bioresource Centres (RBCs) and satellite dewatering centres to deliver long-term sustainable sludge management. Major RBC sites in the Southern Region, including Limerick, are envisaged to be upgraded to incorporate advanced anaerobic digestion (AAD) processes. These upgrades would enable the production of a Class A biosolid, offering significant environmental and operational benefits, including reduced sludge volumes, stabilised organic matter, and opportunities for beneficial reuse in line with circular economy principles.

However, the existing Limerick facility does not currently have the capacity or technology to achieve these outcomes. Under the Do-Nothing scenario, these limitations would persist, preventing the site from fulfilling its strategic regional role and impeding the implementation of the NWSMP.

Transportation remains a significant component of sludge management in terms of both environmental impact and cost. The NWSMP highlights that the current dispersed pattern of sludge generation and transport across Ireland is inefficient and unsustainable in the long term, contributing to increased greenhouse gas emissions, odour, noise, and traffic impacts. Establishing Regional Bioresource Centres and satellite dewatering facilities, as recommended by the plan, would substantially reduce these effects compared with the Do-Nothing scenario.

As outlined in Section 2.3.2, continued population and employment growth in the region will lead to higher wastewater and sludge production. In the absence of the Proposed Development, treatment capacity constraints at the Limerick facility would limit the region's ability to accommodate further residential, commercial, and industrial development.

In summary, the Do-Nothing scenario would result in ongoing operational, environmental, and strategic deficiencies, hindering both regional sustainability and national policy objectives. It is therefore not considered a viable or reasonable alternative to the Proposed Development.

2.3.4 Stormwater Storage

The existing stormwater storage tank at the Limerick WWTP does not have sufficient capacity to accommodate excess storm flows from the drainage network. In 2023, there were approximately 138 significant stormwater overflow (SWO) events exceeding 50 m^3. This level of overflow activity is non-compliant with the requirements of the forthcoming 2024 Recast Urban Waste Water Treatment Directive (rUWWTD) and Uisce Éireann's latest Technical Standards for Stormwater Management, both of which set stricter limits on untreated discharges and require enhanced stormwater control and monitoring.

Under the Do-Nothing scenario, untreated stormwater discharges to the Shannon Estuary would continue and the treatment plant would remain vulnerable to hydraulic overloading, with insufficient storage capacity to attenuate peak flows.

As network inflows continue to rise in line with population growth, urban expansion, and climate-driven increases in rainfall intensity, the frequency and volume of stormwater spills would be expected to increase. This would perpetuate non-compliance with the UWWT Directive, the Recast UWWTD, and the associated EPA Wastewater Discharge Licence (WWDL D0013-01). Furthermore, it would eliminate any potential for improvement in the quality of receiving waters within the Shannon Estuary and Lower River Shannon SAC, contrary to the objectives of the Water Framework Directive (2000/60/EC).

2.3.5 Conclusion

A comparison of the Do-Nothing and Do-Something scenarios demonstrates the environmental advantages of the Proposed Development:

- **Wastewater Treatment:** Do-Nothing maintains insufficient treatment capacity, increasing risks to water quality and regulatory non-compliance. Do-Something upgrades the WWTP, improving treatment efficiency, compliance, and environmental resilience.
- **Regional Bioresource Centre:** Do-Nothing perpetuates inefficiencies in sludge treatment and transport, contributing to higher greenhouse gas emissions and limiting resource recovery. Do-Something enables advanced anaerobic digestion, reduced sludge volumes, and beneficial reuse aligned with circular economy principles.
- **Stormwater Storage:** Do-Nothing continues repeated overflows and water quality risks, while Do-Something improves storage capacity, reduces overflows, and enhances compliance with the Recast UWWTD.

The Do-Nothing scenario would result in greater and more persistent adverse environmental effects across all project elements, whereas the Proposed Development (Do-Something scenario) would deliver improved environmental performance, regulatory compliance, and long-term resilience. Accordingly, the Do-Nothing scenario is not considered a reasonable or sustainable alternative.

2.4 Alternative Locations

2.4.1 Limerick WWTP Capacity Upgrade

The Limerick WWTP Upgrade Project was initially included in Uisce Éireann's 2017 – 2021 Investment Plan, which primarily focused on conducting a Feasibility Study Report and Optioneering. During this phase, the project aimed to identify and evaluate various upgrade options to determine the most viable solutions for improving the plant's performance and compliance with environmental regulations. As the project progressed, it transitioned into Uisce Éireann's Capital Investment Plan for 2020 – 2024. This shift marked a new phase of development, focusing on the implementation of the selected upgrade options identified during the feasibility and optioneering phase.

Given the focus on expanding existing infrastructure, no formal site selection process was undertaken for the upgrade of the WWTP. The upgrades were designed to enhance the current facility, leveraging its existing location and infrastructure to optimise efficiency, promote circular economy and minimise disruption. This resource-efficient approach allowed for a more streamlined and cost-effective implementation, ensuring that the upgrades could be completed within the planned timeline and budget while minimising land use and adverse consequences for the environment.

The upgraded capacity provided by Limerick WWTP and Castletroy WWTP (also identified within the Investment Plan and being progressed as a separate project) will cater for future population growth and industrial development in the area, in line with population projections for Limerick as set out within the National Planning Framework (NPF) Implementation Roadmap.

The existing infrastructure is primarily based within the main WWTP site at Limerick. A second ancillary site was established at Corcanree in recent years to facilitate a new pumping station established as part of sewer network upgrade works. Flows from the Limerick Main Drainage network are pumped via Corcanree PS for treatment, with Corcanree PS accounting for 90% of flows from the network while a second pumping station (Mungret PS), which is located on the WWTP site, accounts for the remaining 10% of the flow to the WWTP.

To support the upscaling of existing capacity at Limerick, additional stormwater storage is also necessary. Refer to Section 2.4.3 for details on alternative locations for the stormwater storage tank, which influenced the decision-making process for the placement of the WWTP infrastructure. Acquiring additional land, as discussed in 2.4.3, was identified as the optimal solution as this acquisition ensures that land will be available within the WWTP site for future plant upgrades.

2.4.1.1 Recommendation

The assessment of alternatives demonstrates that upgrading the existing Limerick Wastewater Treatment Plant (WWTP) at its current location represents the most appropriate and sustainable option for meeting future wastewater treatment needs in the Limerick agglomeration. The existing site provides established infrastructure, operational continuity, and sufficient space for the proposed works, eliminating the need for new land development or greenfield construction.

Retaining and enhancing the current facility minimises environmental impacts, reduces cost and construction complexity, and supports a circular economy approach through the reuse of existing assets. This strategy ensures continued compliance with the Urban Waste Water Treatment Directive (91/271/EEC) and the EPA Wastewater Discharge Licence (WWDL D0013-01), while providing capacity to accommodate projected population and industrial growth in line with national and regional planning objectives.

The preferred option is supported by the following assessment of environmental effects relative to alternative locations.

- Existing Site Upgrade vs. Greenfield/New Sites: Upgrading the current WWTP avoids land take, habitat loss, and additional construction-related emissions that would arise from developing a new site. Greenfield alternatives would likely result in greater environmental impacts, including disruption to undeveloped land and local ecology.
- Operational and Resource Efficiency: Leveraging existing infrastructure reduces the materials, energy, and embodied carbon required for construction. New sites would require entirely new supporting infrastructure, resulting in higher overall environmental impacts.
- Water Quality and Compliance: Maintaining the WWTP at its current location ensures operational continuity and optimisation of treatment flows, supporting regulatory compliance. Relocating the plant could introduce temporary risks to water quality during construction and commissioning.
- Stormwater Management: Additional stormwater storage can be integrated efficiently within the existing WWTP footprint. Alternative sites would require further stormwater management infrastructure, with potential impacts on nearby watercourses or previously undeveloped land.

Upgrading the existing WWTP provides the most sustainable environmental outcome, with neutral or beneficial effects relative to other potential locations. The Do-Something scenario at the current site delivers clear environmental advantages over hypothetical alternatives, including reduced land-take, lower construction impacts, improved resource efficiency, and continued regulatory compliance.

2.4.1.2 Alternative Construction Compound Arrangement

Alternative arrangements for the location of the temporary construction compound were considered as part of the development of the Proposed Development. The preferred construction strategy comprises a temporary construction compound located within the northern part of the existing WWTP site, which provides sufficient space to facilitate the construction works while maintaining segregation from the operational plant.

As part of the alternatives assessment, the potential use of lands adjacent to the south of the existing WWTP site as a temporary construction compound was also considered. The adjacent lands could provide additional construction space and operational flexibility during the construction phase. Accordingly, the EIAR includes an assessment of the potential environmental effects associated with this potential alternative for construction arrangement.

The assessment concluded that the Proposed Development can be delivered using the temporary construction compound within the northern part of the WWTP site. The adjacent southern compound has therefore been assessed as an alternative construction arrangement but does not form part of the Proposed Development for which consent is sought.

2.4.2 Regional Bioresource Centre

In line with the Uisce Éireann National Wastewater Sludge Management Plan (NWSMP, 2016), a number of potential locations were considered to identify the most suitable site for a Regional Bioresource Centre (RBC) capable of supporting sustainable sludge management in the southwest region. The NWSMP promotes a regionalised approach to sludge treatment and resource recovery, with site selection guided by factors such as transportation logistics, environmental constraints, and the availability of supporting infrastructure.

In September 2019, Uisce Éireann published the Site Selection Methodology Report (SSMR) – South Region and subsequently held a public consultation, inviting feedback from members of the public and stakeholders. Existing sludge hubs were assessed to identify potential infrastructure upgrades, and two sites were shortlisted as potentially suitable for RBC development: Limerick WWTP and Clonmel WWTP. The shortlisted sites were evaluated against technical, economic, and environmental criteria, as outlined in Table 2-1.

TABLE 2-1: CRITERIA USED IN THE SECTION OF A SHC LOCATION

CRITERIA	ASSESSMENT SUB-CRITERIA
Technical Criteria	Land Use
	Planning Policy
	Engineering & Design Constraints
	Existing Assets
	Access / Traffic
Economic Criteria	Capital & Operational Costs
Environmental Criteria	Ecology
	Cultural Heritage
	Landscape & Visual Impact
	Hydrology & Hydrogeology
	Soils & Geology
	Noise & Odour
	People & Communities

2.4.2.1 Technical Criteria

- Existing assets: Limerick WWTP has two operational mesophilic anaerobic digesters (MAD, 3,667 m^3 each), integral biogas storage, and a combined heat and power (CHP) system. Clonmel has two digesters (800 m^3 each), but only one is operational due to reduced inflows; hot water boilers provide supplementary heating.
- Land availability: Both sites have sufficient land within existing boundaries to accommodate the proposed RBC works and future expansion.
- Operational integration: Limerick offers the opportunity to incorporate existing AD infrastructure into the upgrade, reducing capital expenditure and leveraging existing operational experience.

2.4.2.2 Economic Criteria

- Whole-life costs: Limerick benefits from lower estimated capital and operational costs due to the availability of existing AD infrastructure and associated supporting systems. Clonmel would require more extensive upgrades to achieve equivalent capacity and performance.

- Transport efficiency: The central location of Limerick within the south-west region reduces the distance and frequency of sludge transport movements compared with Clonmel, supporting lower operational costs, reduced vehicle emissions, and improved sustainability.
- Operational efficiency: Incorporating existing infrastructure at Limerick minimises additional equipment needs and allows for continued use of established CHP and biogas systems, reducing ongoing energy and maintenance expenditures.
- Cost-effectiveness: Overall, the combination of lower construction costs, efficient integration with existing systems, and reduced transport and operational requirements makes Limerick the more economically advantageous option for the RBC.

2.4.2.3 Environmental Criteria

- Receiving water quality: Limerick WWTP discharges to the Shannon Estuary (Lower River Shannon SAC, "At Risk"); Clonmel discharges to the River Suir (Lower River Suir SAC, "Good").
- Flood risk: Clonmel is outside the 100-year fluvial/200-year coastal flood zones. Limerick is within the 200-year coastal flood zone, but flood defences mitigate the risk.
- Groundwater vulnerability: Minimal impact at both sites due to existing WWTP infrastructure.
- Odour and noise: Limerick shows minimal odour impact and only one minor noise exceedance. Clonmel had occasional odour and multiple noise exceedances (not attributable to WWTP).
- Proximity to sensitive receptors: Limerick has a more favourable separation distance to the nearest residential dwelling.

2.4.2.4 Recommendation

Considering technical feasibility, economic efficiency, and environmental performance, Limerick WWTP is identified as the preferred site for the Regional Bioresource Centre in the south-western sub-region.

The site requires no additional land take and retains sufficient space to accommodate future WWTP expansion. Existing anaerobic digestion infrastructure can be incorporated into the upgrade, reducing capital costs and leveraging established operational experience. Its central location within the south-west region optimises sludge transport logistics, reduces associated emissions, and enhances operational efficiency. The site is appropriately zoned for utility use, with surrounding lands designated for Enterprise, Employment, and Industrial purposes, ensuring compatibility with planning policy. Adequate separation from residential dwellings and public facilities minimises potential impacts on sensitive receptors. Environmental conditions are also favourable, with flood defences mitigating coastal risk, minimal odour and noise impacts, and low groundwater vulnerability.

The proposed RBC is consistent with the National Wastewater Sludge Management Plan, relevant local waste management policies, and the Limerick City Development Plan.

Limerick WWTP provides the most sustainable environmental and operational outcome for the Regional Bioresource Centre. The alternative location would likely result in greater environmental impacts, increased operational complexity, and reduced integration with existing infrastructure.

A comparison of Limerick WWTP versus alternative locations demonstrates the environmental advantages of the preferred site:

- Existing Site vs. Alternatives: Upgrading the existing Limerick WWTP avoids greenfield development, reducing land take, habitat disturbance, and construction-related environmental impacts.
- Operational Efficiency: Leveraging existing AD infrastructure reduces energy use, materials, and maintenance requirements compared with establishing a new facility.
- Water Quality and Compliance: Continuity of treatment and monitoring at Limerick supports regulatory compliance and safeguards receiving water quality.
- Transport Impacts: While sludge transport is required, the central location minimises overall travel distances, emissions, and operational complexity compared with the alternative site.

2.4.3 Stormwater Storage Tank

To ensure compliance with the Urban Waste Water Treatment Directive (91/271/EEC), the Recast Urban Waste Water Treatment Directive (2024/0423 COD), and Uisce Éireann's Technical Standards, additional stormwater storage capacity is required to reduce the frequency and volume of stormwater overflows (SWOs) from the Limerick agglomeration.

The proposed design capacity for the new stormwater storage tank is 12,500 m^3, corresponding to a structure approximately 30–40 m in diameter, installed 10–15 m below ground, with up to 3 m above ground to account for tidal variation.

Two primary location options were evaluated for the new tank, as outlined in the following sections.

2.4.3.1 **Option 1** – Construction within the Existing WWTP Site

Option 1 proposes constructing the 12,500 m^3 stormwater storage tank within the footprint of the existing Limerick WWTP. To accommodate the increased stormwater flows, the rising mains from Corcanree Pumping Station (PS) to the WWTP would require upgrading, and modifications to the WWTP's final effluent outfall would be needed to allow higher discharge volumes. On-site pumping arrangements would also need temporary adjustments to maintain continuous treatment during construction.

While technically feasible, this option would involve extensive groundworks within an active treatment site, including new wayleaves and temporary shutdowns of critical assets. Construction in a sensitive urban and tidal environment increases the risk of temporary impacts on water quality, noise, and odour. The limited available space on-site could constrain future WWTP expansion and create operational congestion during construction. Maintaining treatment continuity would require complex sequencing and temporary storage measures, adding operational and environmental risk. Although this option could deliver the required storage capacity, the scale and complexity of construction make it less environmentally and operationally favourable compared with the alternative location.

2.4.3.2 **Option 2** – Construction Adjacent to Corcanree PS

Option 2 proposes constructing the 12,500 m^3 stormwater storage tank on undeveloped land immediately east of Corcanree Pumping Station (PS). The two established rising mains from Corcanree PS would continue to convey flows to the WWTP with only minor upgrades to local pipework and pumping components. During storm events, the pumping station would continue to transfer flows to the WWTP, with any excess temporarily stored within the new tank until inflows subside. The existing 7,500 m^3 stormwater tank at the WWTP would remain in operation to manage flows above full treatment capacity, optimising the overall storage capacity across the network. The current WWTP outfall would continue to accommodate the combined flows from Corcanree and Mungret PS without requiring additional upgrades.

Locating the stormwater tank at Corcanree also provides future-proofing advantages, as it preserves valuable space at the main WWTP for potential expansion works that may be required to meet evolving treatment standards under the Recast Urban Wastewater Treatment Directive and other regulatory drivers. This approach minimises construction-related disturbance, reduces potential temporary impacts on water quality, noise, and odour, and supports operational efficiency. Overall, this option represents a more sustainable, cost-effective, and environmentally responsible solution for delivering the required stormwater storage capacity.

2.4.3.3 Recommendation

The preferred option for the new 12,500 m^3 stormwater storage tank is Option 2 – construction adjacent to Corcanree Pumping Station. This option provides the most environmentally sustainable solution, minimises construction disturbance, preserves space at the WWTP for future upgrades, and integrates efficiently with existing infrastructure. Option 1, while technically feasible, carries higher environmental risk, greater operational complexity, and potential constraints on future plant development.

A comparison of the options highlights the key environmental benefits of the preferred Corcanree site:

- Construction Disturbance: Locating the tank on undeveloped land avoids extensive excavation within the operational WWTP, reducing environmental disruption and operational complexity during construction.
- Water Quality Protection: Constructing away from active treatment processes reduces the risk of temporary water quality impacts associated with shutdowns and on-site works.
- Land Use and Future Capacity: Preserving space within the WWTP footprint safeguards the ability to accommodate future upgrades required to meet evolving treatment standards.
- Operational Continuity: Integration with existing rising mains and retention of the 7,500 m^3 stormwater tank ensures uninterrupted treatment and maintains system resilience.
- Resource Efficiency: Utilising existing rising mains, tank infrastructure, and outfall arrangements reduces energy demand and material use compared with modifications within the active plant.
- Noise and Odour Management: Separation from active WWTP operations limits temporary construction-related noise and odour effects.
- Flood Risk and Resilience: Although both sites have a high-water table and proximity to the Shannon, the excavation area does not interact with Flood Zone B, and no significant flood risk arises.

2.5 Alternative Technical Solutions

2.5.1 WWTP Capacity Upgrade Options

As part of the Feasibility Study Report (FSR), a range of technical options were evaluated for upgrading the biological treatment process at the Limerick WWTP. The objective of this assessment was to identify a sustainable and resilient treatment solution capable of accommodating projected increases in both organic loading and hydraulic capacity, in line with long-term population and industrial growth forecasts.

The proposed upgrade concept retains the existing biological treatment process stream while constructing a new, additional process stream off-line within the WWTP site. Once completed, the new process stream will operate in parallel with the existing system, with flow being evenly split between the two. One of the two existing 900 mm rising mains from Corcanree Pumping Station will be redirected to a new inlet works designed to serve the upgraded process stream.

The FSR examined the following four technical options for the new process stream, each with different implications for treatment efficiency, operational complexity, site footprint, and long-term compliance:

- Installation of Ballasted Settling (BioMag);
- Mixed Liquor Vacuum Degassing (MLVD);
- Conventional Activated Sludge (CAS); and
- Aerobic Granular Sludge (AGS) Process.

2.5.1.1 Installation of Ballasted Settling (BioMag)

The BioMag process involves adding ballast to the activated sludge process to increase the specific gravity of biological flocs, enabling them to settle more rapidly. This enhanced settling allows the system to treat higher hydraulic loads through the same clarifier while producing higher-quality effluent from the Final Settlement Tanks (FSTs). However, the FSR determined that the incorporation of the BioMag process would only increase the plant's biological capacity to approximately 316,000 PE, which falls short of the 325,000 PE design target for the phased upgrade approach. Consequently, while BioMag offers some process improvements, it does not provide sufficient long-term treatment capacity.

2.5.1.2 Mixed Liquor Vacuum Degassing (MLVD)

The MLVD process improves sludge settling by removing micro-sized gas bubbles from the mixed liquor, thereby reducing flotation and improving clarifier performance. It also helps control filamentous organisms that can cause bulking and scum formation. Despite these benefits, MLVD is a complex process requiring careful monitoring to prevent excessive oxygen stripping or other operational issues. Similar to BioMag, MLVD was found to be limited in its ability to accommodate projected +25-year population growth and was therefore not considered a viable long-term option.

2.5.1.3 Conventional Activated Sludge (CAS)

The Conventional Activated Sludge process relies on aeration to support microbial oxidation of organic matter, with biomass flocculation and settling occurring in secondary clarifiers. This process is currently employed at the Limerick WWTP; however, to achieve the future biological loading requirements, a second CAS stream of comparable scale would need to be developed. The FSR concluded that this approach would be space-intensive, requiring significant civil infrastructure and operational duplication, leading to higher capital and lifecycle costs. As a result, CAS was considered less favourable due to its spatial and economic constraints.

2.5.1.4 Aerobic Granular Sludge (AGS) Process

The AGS process represents an advanced biological treatment technology that promotes the formation of compact, dense microbial granules capable of simultaneously removing organic matter, nitrogen, and phosphorus. This process minimises the need for chemical dosing and results in reduced sludge generation compared to CAS systems. The AGS process stream would operate in parallel with the existing CAS system, offering a more compact footprint, lower energy consumption, and reduced greenhouse gas emissions. The technology also allows for higher volumetric loading rates and shorter settling times, providing a flexible and sustainable solution well-suited to the existing site constraints.

2.5.1.5 Initial Recommendation

Following evaluation of the alternative biological treatment technologies, the Aerobic Granular Sludge (AGS) process is identified as the preferred option for the WWTP capacity upgrade. While BioMag, MLVD, and Conventional Activated Sludge (CAS) offer incremental process improvements, they either fail to achieve the required long-term design capacity or would result in greater land take, operational duplication, and lifecycle environmental impacts.

The AGS process represents the most sustainable and future-proof technical solution for the Limerick WWTP capacity upgrade. It minimises land take, energy consumption, sludge generation, and lifecycle environmental impacts while ensuring compliance with future regulatory standards. Integration of AGS alongside the existing CAS stream provides a resilient, efficient, and environmentally responsible upgrade pathway for the projected design horizon.

A comparison of the alternatives demonstrates the environmental advantages of the AGS process:

- Treatment Capacity and Compliance: AGS achieves the required 325,000 PE design capacity and provides resilience for projected long-term growth, whereas BioMag and MLVD do not provide sufficient capacity uplift.
- Land Use and Site Footprint: AGS offers a more compact process footprint, avoiding the significant civil expansion required for a second CAS stream and reducing pressure on the existing site.
- Energy Consumption and Greenhouse Gas Emissions: AGS operates with lower energy demand and reduced greenhouse gas emissions compared to a duplicated CAS system.
- Sludge Production and Chemical Use: AGS reduces sludge generation and minimises chemical dosing requirements relative to conventional systems, resulting in lower material use and associated environmental impacts.
- Operational Complexity and Resilience: AGS provides a flexible and efficient treatment solution capable of handling higher volumetric loading rates and shorter settling times, supporting long-term operational stability within existing site constraints.

2.5.2 Regional Bioresource Centre

The technical options appraisal for the proposed Regional Bioresource Centre (RBC) at Limerick WWTP was undertaken in accordance with Uisce Éireann’s National Wastewater Sludge Management Plan (NWSMP), which promotes the regionalisation of sludge treatment and the production of a Class A biosolid. This standard is achieved through a combination of Anaerobic Digestion (AD) and heat treatment processes.

The integration of Advanced Anaerobic Digestion (ADD) at the Limerick site allows for increased generation of biogas, a renewable energy source that is used on-site to produce both electrical power and heat required to sustain the WWTP processes. In addition to producing renewable energy, AAD reduces the volume of sludge solids through biological decomposition, thereby decreasing the amount of biosolids requiring transport and land spreading, and contributing to Uisce Éireann's circular economy objectives.

The heat treatment stage ensures the complete sanitisation of the digested sludge and the production of a stabilised Class A biosolid. Three shortlisted combinations of AD and heat treatment processes were identified for detailed evaluation, including pasteurisation, thermal hydrolysis, and pyrolysis. Each process was assessed for energy efficiency, process reliability, cost-effectiveness, and alignment with national sludge management policy.

2.5.2.1 Anaerobic Digestion with Pasteurisation

This process combines biological stabilisation through anaerobic digestion with a subsequent heat pasteurisation stage to ensure pathogen destruction and the production of a Class A biosolid suitable for agricultural reuse.

Under this scenario, the existing mesophilic anaerobic digesters at the Limerick site could be retained and integrated with the new process. While this option allows reuse of existing infrastructure, the pasteurisation process requires a larger footprint extending northward into undeveloped lands at the site. It also demands increased sludge storage volumes to accommodate residence times for the heat treatment phase.

From a performance perspective, AD and pasteurisation were determined to be inferior to Thermal Hydrolysis in terms of solids reduction, biogas yield, and long-term scalability. The limited potential for energy recovery and higher ongoing operational costs mean this option is not considered practicable for the projected regional capacity. Consequently, it was discounted at detailed design stage.

2.5.2.2 Anaerobic Digestion with Thermal Hydrolysis Process (THP)

The combined AD + Thermal Hydrolysis Process (THP) represents the preferred technical option and the solution most consistent with the NWSMP. THP is a pre-treatment stage that breaks down complex organic matter under high temperature (≈160°C) and pressure (>7 bar), accelerating hydrolysis and significantly improving sludge digestibility during subsequent anaerobic digestion.

The configuration provides a biogas production rate of approximately 12,900 m^3/day, equivalent to a potential electrical generation capacity of ~1.2 MW. The recovered biogas will power both process heating and site electrical demand, with excess energy offsetting imported grid electricity.

The THP system achieves greater pathogen destruction and reduced sludge volumes, halving the required digester volume compared with conventional AD. It also reduces transport requirements for biosolids and delivers improved energy efficiency through internal heat recovery loops.

Uisce Éireann's operational experience with both batch and continuous THP systems at other regional sites provides a proven technical basis for deployment.

In summary, AD with THP:

- Maximises energy recovery;
- Reduces sludge export volumes and transport costs;
- Is fully compliant with NWSMP and circular economy principles; and
- Provides the required scalability for future regional sludge loads beyond 2030.

2.5.2.3 Anaerobic Digestion with Pyrolysis

The pyrolysis process involves the thermal decomposition of dewatered sludge (typically >90% DS) in the absence of oxygen, producing three co-products: biochar, syngas, and bio-oil. The syngas can be used as a fuel for process heating or power generation, while the biochar is a carbon-rich, inert material that can potentially be used as a soil conditioner, construction additive, or long-term carbon sink.

From an environmental perspective, pyrolysis offers several benefits, including:

- Permanent destruction of microplastics and organic contaminants;
- Net carbon sequestration potential via biochar reuse;
- Minimal odour and reduced GHG emissions compared with conventional thermal drying; and
- Potential for energy self-sufficiency through recovery of syngas for combustion.

However, the technology remains emerging in the wastewater sector in Ireland and across the EU. Large-scale regulatory approval for agricultural reuse of biochar derived from sewage sludge is still under assessment at European level. Furthermore, the process requires very high dry solids feed (≥90%), necessitating an upstream thermal drying phase, which adds capital and energy demand.

While pyrolysis represents a promising long-term technology for energy-positive sludge management, it is not yet sufficiently proven for integration within the immediate RBC development timeframe. Its inclusion within future phases may be revisited as part of Uisce Éireann's long-term innovation and decarbonisation strategy.

2.5.2.4 Initial Recommendation

Following detailed technical and environmental evaluation of the shortlisted sludge treatment technologies, Anaerobic Digestion with Thermal Hydrolysis (AD + THP) is identified as the preferred option for the Regional Bioresource Centre at Limerick WWTP. While Anaerobic Digestion with Pasteurisation and Anaerobic Digestion with Pyrolysis each present specific advantages, neither provides the same level of energy efficiency, operational certainty, scalability, and policy alignment as the AD + THP configuration.

Anaerobic Digestion with Thermal Hydrolysis represents the most sustainable, technically robust, and policy-aligned solution for the Limerick Regional Bioresource Centre. It maximises renewable energy recovery, minimises sludge volumes and transport requirements, enhances resource efficiency, and provides a proven, scalable platform capable of meeting long-term regional growth and regulatory requirements.

A comparison of the alternatives demonstrates the environmental advantages of the preferred option:

- Energy Recovery and Renewable Generation: AD + THP maximises biogas production (approximately 12,900 m^3/day), supporting on-site renewable electricity generation (~1.2 MW) and reducing reliance on imported grid electricity. Pasteurisation provides lower energy recovery, while pyrolysis requires significant upstream energy input for thermal drying.
- Sludge Volume Reduction and Transport: THP significantly improves sludge digestibility and reduces final biosolid volumes, halving required digester volume compared with conventional AD and reducing export and transport requirements. Pasteurisation achieves lower solids reduction, and pyrolysis requires high dry solids content prior to treatment.
- Resource Efficiency and Circular Economy: The AD + THP configuration supports internal heat recovery, reduces chemical and material inputs, and aligns fully with the objectives of the National Wastewater Sludge Management Plan and circular economy principles.
- Environmental Emissions and Odour: THP improves pathogen destruction and stabilisation, producing a sanitised Class A biosolid with reduced odour potential. While pyrolysis offers potential carbon sequestration benefits, it remains dependent on high-energy drying stages.
- Technical Certainty and Scalability: AD + THP is a proven and operational technology within Uisce Éireann's portfolio, providing reliability and scalability for projected regional sludge loads beyond 2030. Pasteurisation offers limited scalability, and pyrolysis remains an emerging technology with evolving regulatory acceptance.

2.5.3 Combined Processes Appraisal

In identifying the most appropriate technology for the new process stream, it was recognised that the biological and sludge treatment systems must operate as an integrated unit. The biological process determines both the quality and composition of the sludge produced, while the downstream sludge treatment technology influences overall plant efficiency, energy balance, and environmental performance. The combined configuration must therefore optimise hydraulic and organic load management while maximising renewable energy recovery and producing a sustainable Class A biosolid in line with Uisce Éireann's National Wastewater

Sludge Management Plan (NWSMP).

The technical appraisal focused on assessing combinations of biological and sludge treatment processes capable of meeting both current and future performance requirements, while remaining feasible within the site's physical constraints.

2.5.3.1 Conventional Activated Sludge (CAS) with Pasteurisation

The baseline upgrade option for Limerick WWTP considered expansion of the existing CAS process, combined with sludge pasteurisation upstream of the Anaerobic Digestion (AD) system. This approach represents the conventional treatment pathway, with well-understood performance and operational reliability.

However, the expansion of CAS requires a significant physical footprint to accommodate new primary settlement, aeration, and final clarification tanks. This scale of development would extend beyond the existing process area and require additional land, presenting environmental constraints.

From a sludge treatment perspective, pairing CAS with pasteurisation is technically compatible, particularly where the sludge stream contains a high proportion of primary sludge. Pasteurisation ensures pathogen reduction and facilitates production of a Class A biosolid suitable for land application. Nevertheless, compared to thermal hydrolysis, the process offers lower solids destruction efficiency, limited opportunities for heat recovery, and reduced potential for energy generation.

Overall, while technically feasible, this option is considered less sustainable and less space-efficient, with lower energy recovery potential and higher long-term operational costs.

2.5.3.2 Conventional Activated Sludge (CAS) with Thermal Hydrolysis Process (THP)

This option involves expanding the existing CAS system in parallel with the addition of THP for sludge pre-treatment. While CAS is a proven and reliable biological treatment process, its expansion would require substantial additional infrastructure — including new primary and secondary tanks — and therefore a larger land footprint than the AGS-based alternative.

The incorporation of THP in this configuration would improve sludge digestion and biogas yield compared to pasteurisation, but the overall energy balance and land efficiency would still be less favourable than the AGS + THP combination. CAS inherently produces higher volumes of mixed primary and secondary sludge, which demands greater digester capacity and higher heating requirements during hydrolysis.

Consequently, although this option performs well in terms of treatment reliability and Class A biosolid production, it presents higher capital costs, greater space constraints and reduced overall efficiency when compared with AGS + THP.

2.5.3.3 Aerobic Granular Sludge (AGS) with Pasteurisation

Pasteurisation was not considered a suitable pairing with the AGS process due to the nature of the sludge it produces. AGS systems primarily generate Surplus Activated Sludge (SAS), which has a lower proportion of readily biodegradable organic matter compared to the mixed primary and secondary sludge produced by conventional activated sludge systems. Since pasteurisation is a heat-based sanitisation process rather than a pre-treatment for enhanced digestion, it does not increase biodegradability or biogas potential. When applied to AGS sludge, pasteurisation would therefore deliver minimal additional energy recovery, reduced overall process efficiency, and higher operational energy demand, making the combination technically and economically infeasible.

2.5.3.4 Aerobic Granular Sludge (AGS) with Thermal Hydrolysis Process (THP)

The AGS process represents an advanced biological treatment technology that combines compact design with high treatment efficiency. AGS reactors form dense microbial granules that allow for simultaneous nitrification, denitrification, and phosphorus removal in a single tank, significantly reducing reactor volume and site footprint compared to CAS systems. Coupling AGS with Thermal Hydrolysis (THP) maximises the breakdown of solids and enhances energy recovery through anaerobic digestion.

The THP pre-treatment process heats sludge to approximately 160°C under pressure, breaking down cell structures and increasing sludge biodegradability. This results in higher biogas production, improved pathogen destruction, and reduced sludge volumes for export. In combination, AGS and THP provide a compact, energy-positive solution with a smaller physical footprint, enhanced odour control, and strong alignment with circular economy principles.

This configuration achieves the required treatment capacity for the Limerick agglomeration and provides flexibility for future regional sludge management under the proposed Regional Bioresource Centre (RBC) model.

2.5.3.5 Combined Process Recommendation

Following evaluation of the shortlisted biological and sludge treatment combinations, the Aerobic Granular Sludge (AGS) with Thermal Hydrolysis Process (THP) configuration is identified as the preferred integrated treatment solution for the Limerick WWTP upgrade. While expansion of Conventional Activated Sludge (CAS) systems remains technically feasible, the combined appraisal demonstrates that the AGS + THP configuration provides superior environmental performance, space efficiency, energy recovery, and long-term sustainability.

When assessed against technical feasibility, economic efficiency, environmental performance, and policy alignment, AGS with THP represents the most sustainable and future-proof solution. The combination optimises treatment performance and hydraulic capacity while minimising land take, reducing carbon emissions, maximising renewable energy recovery, and producing a high-quality Class A biosolid in accordance with national sludge management objectives.

A comparison of the combined alternatives highlights the advantages of the preferred option:

- Land Take and Footprint: AGS significantly reduces reactor volume and eliminates the need for separate primary and secondary clarification infrastructure required under CAS expansion. This minimises additional land requirements and reduces associated construction-related environmental impacts.
- Energy Balance and Renewable Generation: When paired with THP, AGS enhances sludge biodegradability and maximises biogas yield during anaerobic digestion. CAS-based systems generate larger sludge volumes, increasing digester heating demand and reducing overall energy efficiency. Pasteurisation options provide limited additional energy recovery.
- Sludge Production and Transport: AGS produces a more concentrated surplus activated sludge stream, and when combined with THP, achieves substantial solids reduction. This reduces final biosolid volumes requiring transport and land application compared with CAS-based configurations.
- Operational Efficiency and Carbon Emissions: The integrated AGS + THP configuration reduces aeration demand, infrastructure requirements, and overall process energy intensity. Lower sludge volumes and improved energy recovery contribute to reduced greenhouse gas emissions over the operational life of the facility.
- Technical Robustness and Future Scalability: AGS offers high treatment efficiency within a compact footprint, providing flexibility to accommodate future load increases. Coupled with THP, the system aligns with long-term regionalisation objectives under Uisce Éireann’s National Wastewater Sludge Management Plan and supports the operational model of the proposed Regional Bioresource Centre.

2.6 Conclusion

Following a systematic assessment of reasonable alternatives, the Proposed Development has been designed to deliver the most environmentally responsible, technically robust, and sustainable solution for Limerick WWTP and regional sludge management. The evaluation of wastewater treatment technologies, sludge treatment processes, Regional Bioresource Centre location, and stormwater storage options allowed the project team to identify solutions that minimise land take, reduce operational and construction impacts, safeguard receiving water quality, and maximise energy efficiency and resource recovery.

Environmental considerations were central to the selection process. The preferred option, Aerobic Granular Sludge with Thermal Hydrolysis for the WWTP, the siting of the Regional Bioresource Centre at Limerick, and the Corcanree location for stormwater storage, demonstrate reduced construction disturbance, lower greenhouse gas emissions, improved treatment resilience, and alignment with circular economy principles. These choices also preserve future expansion potential, maintain continuity of operations, and limit impacts on sensitive receptors.

The alternatives appraisal has directly informed the design of the Proposed Development, ensuring that it represents the best balance between environmental protection, operational efficiency, and long-term sustainability. This process demonstrates compliance with the EIA Directive requirement to consider reasonable alternatives and provides a clear, transparent rationale for the selection of the preferred solution.

2.7 Difficulties encountered in Compiling Information

There were no difficulties encountered in compiling this information.

2.8 References

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