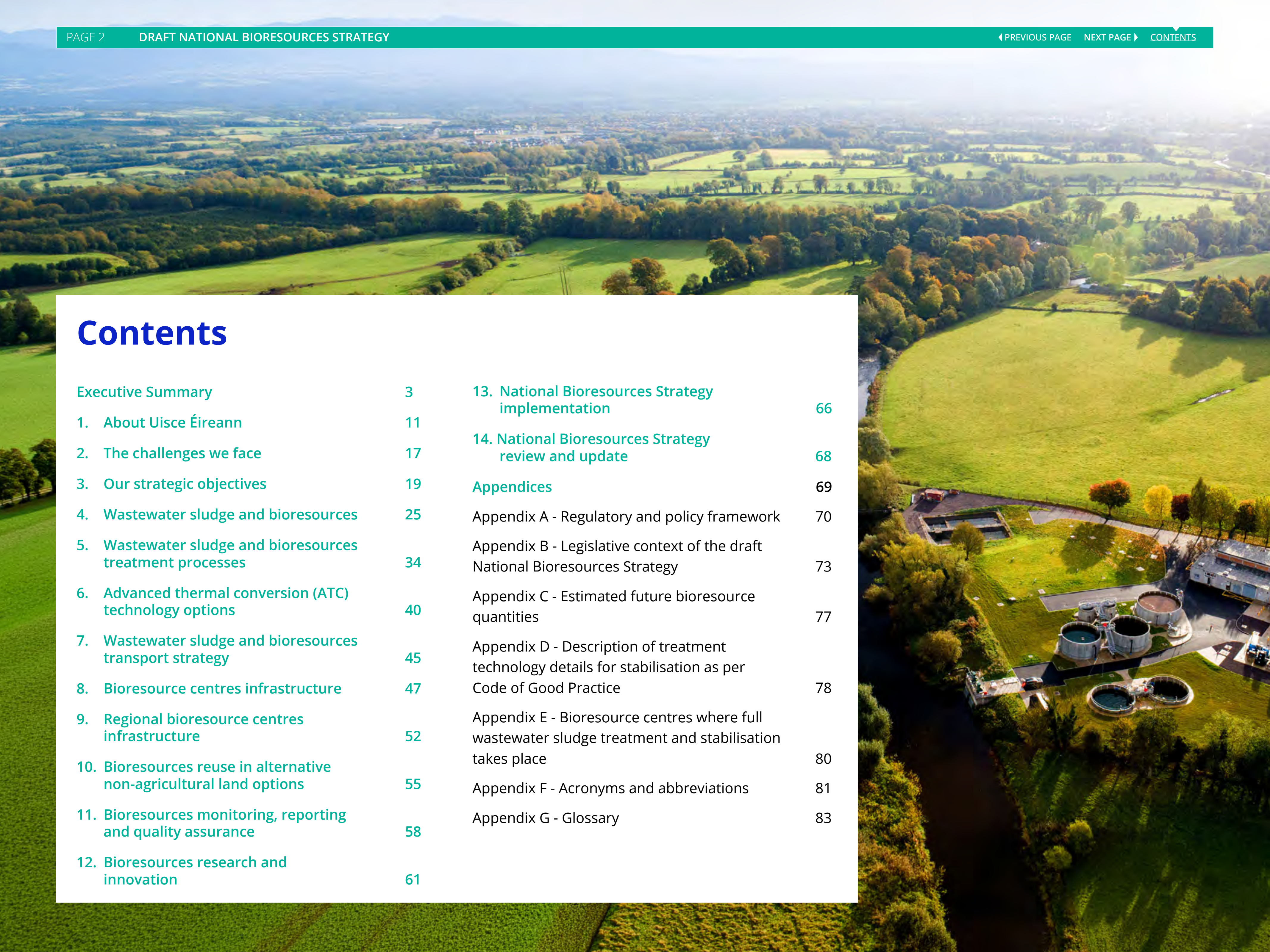
Draft National Bioresources Strategy



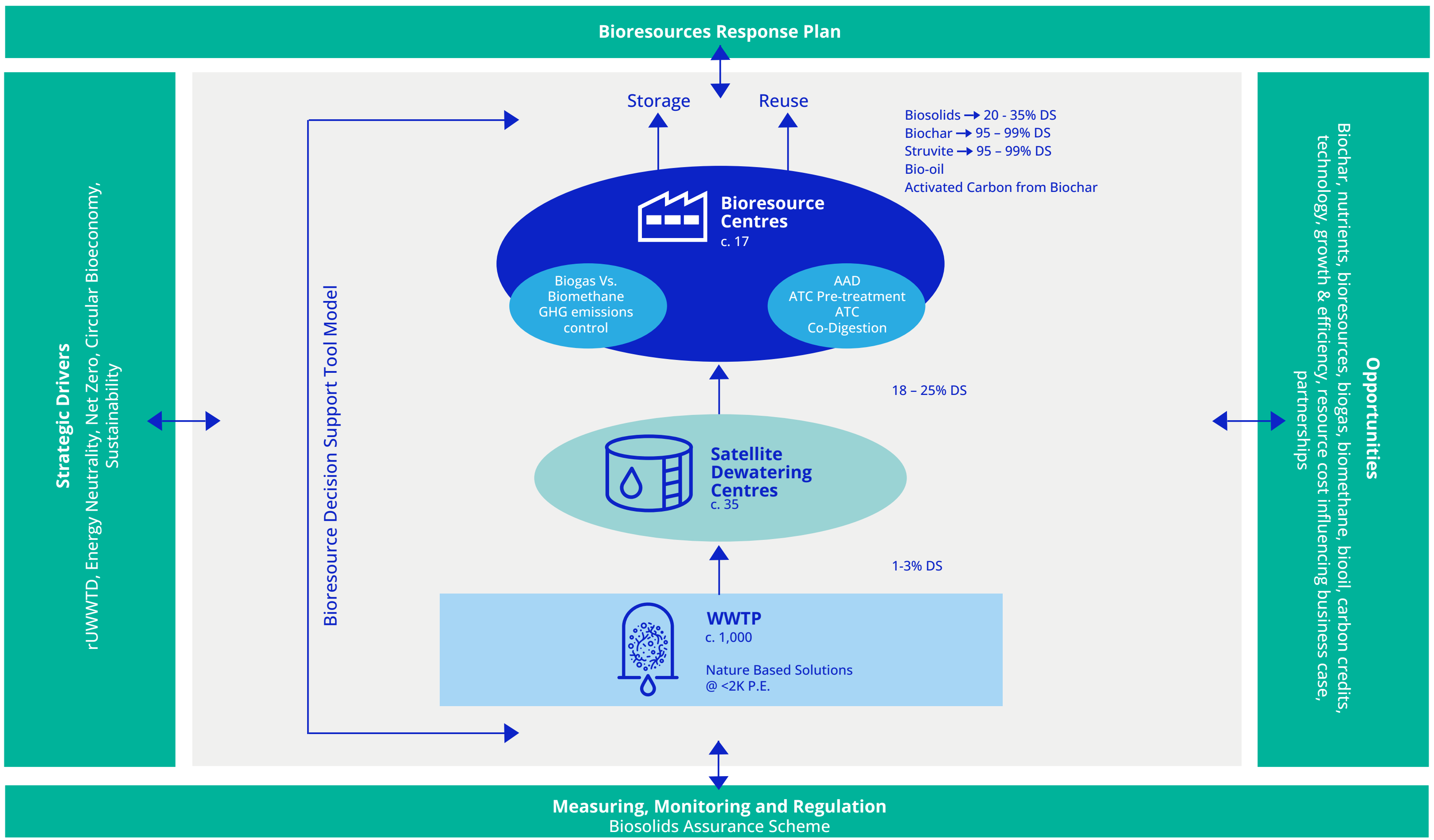
Contents

Executive Summary

The draft National Bioresources Strategy (NBioS) is a key document for Uisce Éireann (UÉ) that outlines our long term 25-year strategy to ensure a nationwide standardised approach for sustainably managing wastewater sludge and bioresources. It reviews and updates the existing National Wastewater Sludge Management Plan (NWSMP) published in 2016 and will ultimately replace the NWSMP once published.

Draft National Bioresources Strategy vision 2050

Wastewater sludge contains several valuable constituents such as energy and nutrients. Our aim is to treat our wastewater sludge effectively to recover bioresources for the economy, thus contributing to achieving a more sustainable, circular bioeconomy and assist us in meeting our net zero carbon ambitions. The recovery and reuse of available bioresources gives us the opportunity to minimise the use of finite natural resources, consequently minimising overall environmental impact. The draft NBioS vision is summarised below.



Wastewater sludge and bioresources challenges

Economic and population growth and more stringent wastewater treatment standards drive the increase in wastewater sludge and biosolids generation. Other wastewater sludge and bioresource management challenges include legislative and regulatory changes, sustainability ambitions, storage and transport logistics, emerging contaminants, and data and reporting.

All our treated bioresources are currently beneficially reused in agriculture, and this is completed in line with national and European legislative and regulatory requirements. However, we acknowledge that reliance on one outlet is susceptible to future policy, regulatory and/or compliance changes.

The recast Urban Wastewater Treatment Directive (rUWWTD) adopted in late 2024 will result in changes in the coming years such as enhanced monitoring, energy neutrality targets, and circular economy developments. Increased circularity is a key element of the rUWWTD, with new requirements to recover valuable components from wastewater sludge, like phosphorus, a critical raw material in the EU[1].

Revisions to the Sewage Sludge Directive (SSD) and the Code of Good Practice for use of Biosolids in Agriculture (Code of Good Practice) are also expected, in combination with the introduction of the proposed new EU Circular Economy Act. These legislative updates will result in changes to our approach to wastewater sludge and bioresources management.

Our Sustainability Framework outlines our sustainability ambitions such as net zero carbon by 2040, biodiversity net gain, greenhouse gas (GHG) emissions reduction, and consideration of circular solutions in all capital projects by 2026. The rUWWTD obligations in combination with our sustainability ambitions will result in multiple investment drivers and will require a review of longer term funding needs and prioritisation.

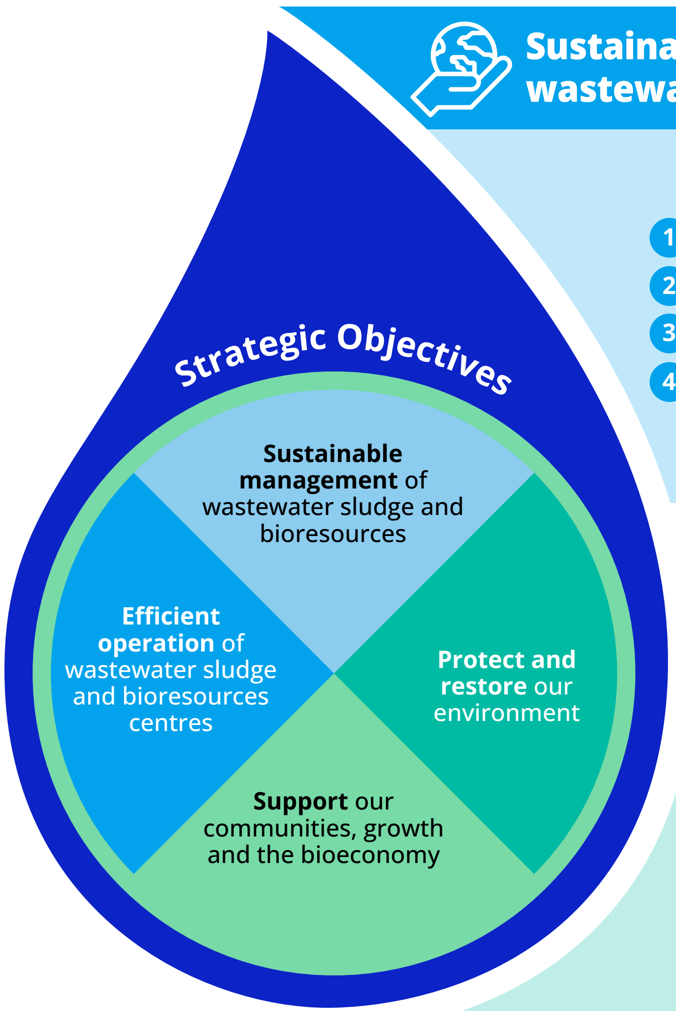
Our strategic response

In response to these challenges, we have developed strategic objectives and supporting actions to help us address our needs. We will continue to deliver sustainable and efficient wastewater sludge and bioresources management, whilst protecting the environment and supporting growth and the bioeconomy.

We have identified key actions that set out how we will achieve our strategic objectives and aims. These are presented in sections 3.1.1 to 3.1.4 of this draft Strategy. These actions build on the actions in the existing NWSMP and go further to ensure sustainable bioresources management.

[1] New rules for urban wastewater management set to enter into force - European Commission

Overall summary of aims and objectives



Sustainable management of wastewater sludge and bioresources

Strategic aims:

1. Achieving net-zero carbon
2. Adopting circular approaches
3. Gaining value from innovation
4. Securing long term funding

Protect and restore our environment

Strategic aims:

5. Contributing to positive biodiversity
6. Meeting our commitments under the rUWWTD and the Sewage Sludge Directive
7. Protecting our water and land environment

Support our communities, growth and the bioeconomy

Strategic aims:

8. Engaging with communities
9. Supporting the development of the circular bioeconomy
10. Providing for growth

Efficient operation of wastewater sludge and bioresources centres

Strategic aims:

11. Managing our assets
12. Ensuring efficient transportation
13. Implementing effective technologies

Our wastewater & bioresource services

Managing our wastewater sludge and bioresources

We treat circa 70,000 tds/yr of wastewater sludge and bioresources meeting environmental standards before beneficially reusing it in agriculture[2].

Wastewater sludge and bioresources transportation and storage

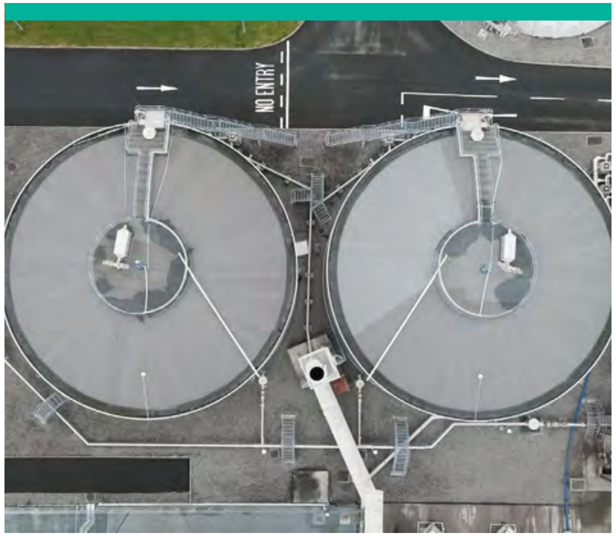
Transportation is a significant aspect of wastewater sludge and bioresources management in terms of environmental, social, and financial impacts. Our transportation strategy considers carbon footprint and potential impacts in terms of traffic, odour, and noise. We have a significant number of small WWTPs in our asset base; approximately 75% of WWTPs are less than 2,000 P.E. At our smaller WWTPs, transport accounts for a large proportion of the total costs associated with treatment.

Reducing treated sludge transport has benefits in terms of reducing greenhouse gas emissions due to reduced fuel, however this needs to be balanced against the lifecycle cost and environmental and social impacts of additional treatment infrastructure at a higher number of sites, and additional staff transportation required to operate and maintain equipment. Where practicable, bioresources are transported and spread on the nearest suitable spread lands to the WWTP.

[2] Reuse in non-food tillage agriculture

To optimise our bioresource transport, treatment and storage strategies we have developed a national bioresources strategic Decision Support Tool (DST) which enables us to evaluate and make informed decisions on our bioresources assets. We will continue to develop the decision support tool to optimise transport strategies and ensure lower carbon transport.

To ensure storage requirements are met nationally, we will provide additional storage facilities to facilitate the predicted increase in sludge as new and upgraded plants are completed. We will use the DST to identify strategic storage locations nationally, and these may be located at the bioresource centres (BCs) or at a separate storage facility.



Wastewater sludge and bioresource treatment

At some of our plants we recover energy via anaerobic digestion (AD). Digestion produces a methane rich biogas which is converted to heat and electricity and sustainably reused within our WWTPs. Some of our larger WWTPs have advanced anaerobic digestion (AAD) which enhances the digestion process resulting in a higher biogas yield, increased energy, and maximised sludge reduction quantity.

We are investing in renewable energy generation and will maximise the generation and use of biogas. Efficient energy generation and use is key, and we recognise the opportunity for optimising our biogas generation to fully realise its potential as a renewable energy resource. We have initiated a Biogas Optimisation Programme (BOP) with the aim to improve and optimise biogas production and usage, and to address common challenges across the digestion plants.

Whilst reusing the sludge bioresource through land application is the most circular and sustainable reuse route currently, we are looking at alternative pioneering options to the land application to ensure sustainable long-term resilience. To demonstrate increased resilience, and to meet our sustainability ambitions we are progressing alternative options such as advanced thermal conversion (ATC) technologies and alternative non-agricultural land outlets.

ATC technologies can both enhance the value of the circular economy and reduce risks of emerging contaminants. We will incorporate efficient thermal drying technology in parallel with ATC that require a dried sludge feedstock to optimise resource recovery. There are opportunities to optimise integration of ATC into the existing asset base with anaerobic digestion. We will develop energy and heat strategies and support heat recycling on-site. These technologies can be optimised to balance the benefits of each process to maximise energy and resource recovery whilst reducing the quantity.

As part of our Bioresources Strategy we will implement nature-based solutions such as sludge reed beds (SRBs). Aside from providing wastewater sludge treatment solutions, nature-based solutions have many additional benefits, including a reduction in sludge production and energy usage, positive biodiversity, and carbon sequestration. These are particularly beneficial in smaller remote WWTPs where the transport of sludge to a satellite dewatering site is unsustainable. We will implement sludge reed beds on smaller sites (less than 2,000 P.E.) where feasible and consider this approach on all capital projects.

Bioresource centres infrastructure

Bioresource centres (BCs) and satellite dewatering centres (SDCs) drive operational efficiencies and optimise the balance between treatment and transport costs by reducing wastewater sludge volume. Wastewater sludge from our rural WWTPs will be transported at circa 1-3% dry solids (DS) to intermediate satellite dewatering centres where it is dewatered to circa 18-25% DS prior to transfer to the bioresource centres for final treatment and stabilisation. Dewatering sludge reduces onward transport costs, transport carbon emissions and traffic movements.

This infrastructural approach allows for economies of scale and flexibility in the treatment process selection, particularly around energy and resource recovery technologies, and assists in terms of monitoring and quality control of the bioresource outputs. The decision support tool identified and prioritised circa 35 optimised SDC sites considering transport, logistics, emissions, and available capacity based on numerous strategic scenario assessments. We have circa 17 bioresource centres nationally and we are planning investment into developing 6 of these into future regional bioresource centres with advanced digestion and potentially advanced thermal conversion technologies.

We will develop a Bioresource Response Plan in case challenges lead to restrictions on agricultural land spreading. We will implement the alternative treatment and reuse options discussed within this Bioresources Strategy if there is a risk to land bank availability.

Bioresources monitoring and reporting

We carry out on-going regulatory monitoring, traceability pack system and Nutrient Management Plan (NMPs) reviews. We will ensure that all new regulatory requirements such as enhanced monitoring outlined in the rUWWTD are met. We are engaging with regulators and stakeholders in the revision of the Code of Good Practice, and we will implement a National Emerging Contaminants Monitoring Programme and carry out additional monitoring on emerging contaminants as required.

We will implement an independently audited quality system such as a Biosolids Assurance Scheme (BAS) for biosolids management activities. The development and implementation of a BAS will provide stakeholder reassurance on the protection of the environment. The BAS standard will enable full transparency and encompass all key aspects required of a

quality assurance system covering regulatory requirements, treatment, monitoring, recording, reporting and Standard Operating Procedure (SOP) implementation.

We have developed SOP's and control procedures to ensure that the wastewater sludge and bioresource treatment and reuse process is controlled and monitored. We will also develop an SOP that will set out best practice for the use of biosolids reuse on land which we will distribute to our contractors. This SOP will be dependent on collaboration with other key National Stakeholders and will reflect and not contradict the published data, regulations and national requirements for landspreading. We will implement and embed these SOPs for effective wastewater sludge and bioresource treatment assets.

Research and innovation

Ongoing research is being carried out internationally into options for resource recovery and valorisation of treated wastewater sludge and bioresources. Emerging and innovative technologies can provide new more efficient solutions for sustainable bioresources management. Research into new technologies that provide sustainable outlets with low-energy consumption, and energy and nutrient recovery can provide more sustainable options for bioresources management in Ireland.

Research and innovation around bioresources management has accelerated significantly in recent years and continues to grow. Technologies that can reduce sludge volume and quantity whilst increasing resource recovery are of interest to us. Key areas of interest to gain further knowledge are around technologies and energy and resource recovery, emerging contaminants, and GHG emissions. We will demonstrate advanced thermal conversion (ATC) technologies to progress technology installation, and we will engage and support research on soil testing and land spreading.

National Bioresources Strategy implementation and review

The draft NBioS outlines our bioresources strategic objectives and aims and details a set of key actions we will undertake to meet our objectives. We are subject to monitoring and measurement to assess our performance and ensure we remain accountable to customers and stakeholders. We will produce an Implementation Plan with SMART[3] criteria to monitor and track the NBioS strategic actions.

The proposed mitigation and environmental monitoring programme required under the Strategic Environmental Assessment (SEA) Regulations will provide a basis for identifying significant environmental effects during the implementation of specific actions under the draft NBioS. The SEA monitoring will be integrated into the NBioS overall monitoring framework to ensure that environmental considerations are evaluated alongside other key performance measures.

We will carry out monitoring according to the SEA mitigation and monitoring requirements and will report monitoring and measuring data as required. The findings from the SEA monitoring will contribute to the five-yearly reviews of the final NBioS. This will ensure that the Strategy remains responsive to all relevant legislation and our commitment to environmental protection, sustainability, circular bioeconomy, and climate change mitigation and adaptation.

Regular monitoring of the strategy will support an adaptive planning approach in selecting specific options under each action during implementation of the strategy. The five-yearly assessment will be used to check that progress is being made towards meeting the NBioS objectives through implementation. If the five-yearly assessment finds that the objectives may not be achieved and/or a new approach is needed, actions in the strategy will be updated as needed.

[3] SMART – specific, measurable, achievable, realistic, timely.

1 | About Uisce Éireann

1.1 Our purpose and vision

Throughout Ireland, communities, businesses, the economy, and the environment depend on the delivery of safe, secure, and sustainable public water services. We are proud to take on the responsibility of transforming our water services to enable communities to thrive all over Ireland. We are committed to delivering safe, secure, and sustainable water services to our growing population and as a key enabler for investment in Ireland's future.

We have a vital job to do and many challenges and opportunities as we look ahead. Our 25-year overarching strategy, the Water Services Strategic Plan (WSSP) 2050 aims to give us clear direction for the journey ahead. Also, our Sustainability Framework outlines our sustainability commitments with four pillars; as shown below, and six key ambitions supporting initiatives which are embedded across the business and our supply chain.

OUR PURPOSE
We rise to the challenge of delivering transformative water services that enable communities to thrive.

OUR VISION
A sustainable Ireland where water is respected and protected, for the planet and all the lives it supports.

Environment Pillar

- **1. Net Zero 2040** (Carbon)
- **2. Net Gain across all new projects by 2030** (Biodiversity)
- **3. Achieve Sustainable Economic Levels of Leakage by 2034 in the Water Resource Zones that produce >10MLD*** (Customer)

Social Pillar

- **4. D, I & Equality Achieve inclusion index of 80% by 2030** (Employee)
- **5. Educate 1m people on the value of water by 2030** (Community)

Collaboration Pillar

- **6. Ensure circular solutions are considered at each phase in all UÉ capital projects by 2026** (Circular Economy)

1.2 Draft National Bioresources Strategy background

Our existing National Wastewater Sludge Management Plan (NWSMP) published in 2016 set out our 25-year strategy to ensure a nationwide standardised approach for managing wastewater sludge. Almost 10 years later, we have reviewed and updated the existing NWSMP to provide a progress update on the objectives in the existing NWSMP and to what extent they have been achieved.

It is proposed to rename the existing NWSMP to the "National Bioresources Strategy" to reflect recent regulatory changes such as the rUWWTD and to align with principles of the circular economy, net zero carbon, and sustainability. It also reflects developments across the industry in the approach to the management of wastewater sludge and bioresources and aligns with the approach taken by the UK utilities. The recommendations of the draft NBioS will be used to inform future capital and operational activities in relation to sustainable bioresources management in Ireland.

In the draft NBioS, the term bioresources refers to stabilised wastewater sludge (biosolids) and associated by products such as biogas/biomethane. There are also a wide range of bioresources from the wastewater effluent stream, however, this Strategy is only focussed on the bioresources associated with wastewater sludge. The term wastewater sludge refers to both liquid and cake sludge prior to stabilisation.

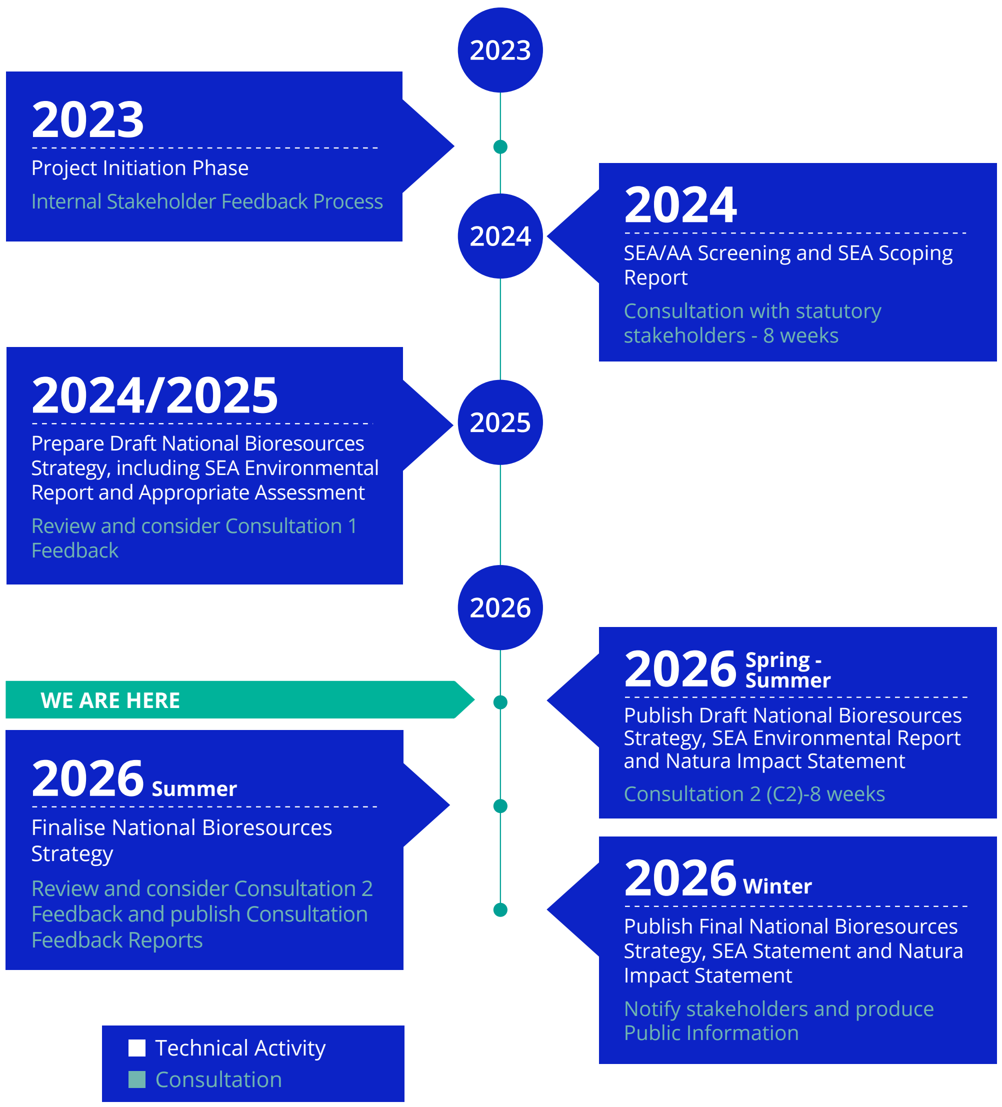
1.3 Draft National Bioresources Strategy roadmap

The road map outlines the key stages and project delivery timeline associated with the draft NBioS. The map illustrates the opportunities for public and stakeholder participation in the development of the draft NBioS. The process involves two periods of focused consultation.

- Consultation 1 (C1) – SEA scoping and statutory consultation with the designated environmental authorities
- Consultation 2 (C2) – consultation on the draft NBioS.

The consultations provide an opportunity for statutory bodies, interested parties and members of the public to provide feedback on the draft strategy and the associated environmental reports.

National bioresources strategy roadmap



Our regulatory and policy framework

Key regulations, policies and guidance documents relating to wastewater sludge and bioresources management in Ireland are shown below and further details can be found in Appendix A.

Key legislation:

The Sewage Sludge Directive

Directive 86/278/EEC of 12 June 1986 on the protection of the environment, and in particular of the soil, when sewage sludge is used in agriculture

The recast Urban Wastewater Treatment Directive

Directive (rUWWTD) 2024/3019/EU of the European Parliament and of the Council of 27 November 2024 concerning urban wastewater treatment (recast)

The Nitrates Directive

Directive 91/676/EEC concerning the protection of waters against pollution caused by nitrates from agricultural sources

The Waste Framework Directive

Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives

The Industrial Emissions Directive

Directive 2010/75/EU concerning industrial emissions (integrated pollution prevention and control).

Key policies:

With an increasing focus on climate change and drive to reduce greenhouse gas (GHG) emissions and achieve net zero at EU and National level and across the Water Industry, the following National Government plans are critical for us to work towards to contribute to meeting National targets:

- **National Energy and Climate Plan (NECP)** 2021-2030 incorporated all policies and measures that were identified up to the end of 2019.
- **Climate Action Plan (CAP)** 2025 sets an action plan to meet its international and EU climate commitments. The plan aims to achieve a target of reducing GHG emissions by 51% (from a 2018 baseline) by 2030, and to get to net-zero emissions by 2050. The CAP specifically sets a national biomethane production target of 5.7TWh by 2030.
- **National Biomethane Strategy and Bioeconomy Action Plan** 2023-2025 seeks to support and develop jointly with the circular economy with key focus on sustainability, circularity, and enhanced natural resources. The strategy, co-developed by the Department of the Climate, Energy and the Environment (DCEE) & the Department of Agriculture, Food and Marine (DAFM), outlines measures to support the development of the Anaerobic Digestion (AD) & Biomethane Industry.

The Code of Good Practice for the use of Biosolids in Agriculture (1999) provides detailed information on good practice for treatment, reuse and monitoring.

Legislative and regulatory developments

The Sewage Sludge Directive (SSD) allows the use of treated sludge and biosolids in agriculture subject to specified technical requirements, without the need for a specific waste authorisation. The SSD sets out limit values for heavy metals and nutrients application to land. The SSD and the Industrial Emissions Directive (IED) have been proposed for review and are expected to be updated in the coming years.

The Urban Wastewater Treatment Directive (UWWTD) aims to protect human health and the environment through obligations for collection and treatment of urban wastewater. The recast Urban Wastewater Treatment Directive (rUWWTD) adopted in late 2024 outlines new obligations which will be introduced on a phased basis at our larger plants[4]. Some key obligations relating to wastewater sludge and bioresource management include energy and climate neutrality targets of 20% by 2030 and 70% by 2040 and increasing monitoring to include microplastics and greenhouse gas (GHG) emissions. Increased circularity is also an important element, with new requirements introduced to recover valuable components from wastewater sludge, like phosphorus, a critical raw material in the EU[5].

The rUWWTD also sets out requirements for quaternary treatment for the removal of emerging contaminants and micropollutants at the larger sites, and other sites on a risk basis. The new regulation introduces the 'polluter pays principle' whereby producers of pharmaceuticals and cosmetics must cover at least 80% of additional costs for treating wastewater through an extended producer responsibility (EPR) scheme[6].

The Code of Good Practice (CoGP) provides detailed information on best practice for the treatment, reuse, and monitoring of treated biosolids. We treat and monitor all wastewater sludge and biosolids to meet the requirements of the CoGP. A multi stakeholder working group including UÉ was set up in 2024 to review and update the Code of Good Practice to consider developments in monitoring requirements and technologies.

In July 2024 it was announced in the guidelines for the next European Commission (EC) (2024-2029) that work on a *'Circular Economy Act'* had begun. The purpose of this proposed Circular Economy Act[7] is to help creating market demand for secondary materials and a single market for waste, notably in relation to critical raw materials. We will continue to work with key stakeholders such as EurEau regarding the development of the proposed EU Circular Economy Act.

As noted in the EurEau paper on 'Resource and Nutrient Recovery from Wastewater Sludge'[8] , the future Circular Economy Act should have a broad scope that includes the full potential of wastewater and sludge in terms of resource recovery. The paper included a summary of the current challenges and strategic opportunities to improve the circularity of nutrient and resource management from wastewater and sludge, thus contributing to circular economy and competitiveness in the internal market.

We will endeavour to meet all the new regulatory and policy change requirements in the coming years relating to wastewater sludge and bioresources such as enhanced monitoring, energy neutrality, and circular economy.

[4] Larger plants are those treating a load of 10,000 P.E. or more

[5] New rules for urban wastewater management set to enter into force - European Commission

[6] https://www.consilium.europa.eu/en/press/press-releases/2024/01/29/urban-wastewater-council-and-parliament-reach-a-deal-on-new-rules-for-more-efficient-treatment-and-monitoring/

[7] Ursula von der Leyen calls for a more circular and resilient economy | European Circular Economy Stakeholder Platform

[8] October 2024, Eureau paper 'Resource and Nutrient Recovery from Wastewater Sludge' (Note: Eureau members including UÉ contributed to).

Draft National Bioresources Strategy legislative context

The draft NBioS is subject to Strategic Environmental Assessment (SEA) and Appropriate Assessment (AA), including public consultation. A detailed overview of the legislative context of the draft NBioS is presented in Appendix B including details on the European Union (EU) SEA Directive (2001/42/EC) and Appropriate Assessment (under the Birds and Habitats Directive).

Further to our commitments in our Biodiversity Action Plan (BAP), and in recognition of wider issues relevant to protection of biodiversity, that are not covered under the Habitats Directive, for example ecological networks, disturbance of habitats and species, we will ensure that whilst carrying out bioresources management activities that they will comply with the obligations under the Birds and Natural Habitats Regulations 2011-2016 and the mitigation and monitoring requirements within the SEA Environmental Report.

1.5 Progress since 2016

Since the publication of the National Wastewater Sludge Management Plan in 2016, we have made significant progress on a number of key measures to address the management of wastewater sludge and bioresources in Ireland.

We are developing 5 Regional Bioresources Centres nationally and **5** Satellite Dewatering Centres (SDCs), with a further **3** SDCs in development.

We have completed assessments of alternative outlets, as well as a National Thermal Treatment Study.

We have constructed a **Regional Biosolids Storage Facility.**

We have installed a **Phosphorus Recovery facility** in Ringsend WWTP.

Continued participation in National and **European Research & Innovation initiatives.**

We implemented an **online reporting traceability system** and continue to carry out auditing of third-party sludge framework contractors.

We have worked on the development and implementation of a number of measures including:

- The National Bioresources Decision **Support Tool**
- **Standard Operating Procedures** for Bioresource Management
- **Technical Specifications** relating to Bioresource Management
- **Biogas Optimisation Programme.**

We continue to participate in relevant **National and European Working Groups** e.g. the EurEau 2 Sludge Task Force.

We have installed **sustainable circular nature-based solutions** such as Sludge Reed Beds.

2 | The challenges we face

We will face many challenges over the coming years. At a macro level, these include climate change, growing population and economy, environmental and biodiversity crises, ageing infrastructure, legislation and economic conditions. Some of these challenges are shown below and further details can be found in the WSSP 2050.

In addition to these overarching challenges, we face other challenges that are specific to wastewater sludge and bioresource management.

Wastewater sludge and bioresources challenges

Legislation & regulatory changes
The recast Urban Wastewater Treatment Directive (rUWWTD) adopted in late 2024 will result in changes in the coming years such as enhanced monitoring, energy neutrality targets, and circular economy developments. Revisions to the Sewage Sludge Directive (SSD) and the Code of Good Practice for use of Biosolids in Agriculture are also expected. These legislative updates will result in changes to our approach to wastewater sludge and bioresources management.

Sustainability ambitions
Our Sustainability Framework outlines our sustainability ambitions such as net zero carbon by 2040, biodiversity net gain, GHG emissions reduction, and consideration of circular solutions in all capital projects by 2026. The rUWWTD obligations in combination with our sustainability ambitions will result in multiple investment drivers and will require a review of longer term funding needs and prioritisation.

Storage
There is a need for storage during winter months as required by the Code of Good Practice for the use of Biosolids in Agriculture. In recent years the period of land spreading availability has decreased due to heavier rainfall events and waterlogged land. These conditions have resulted in challenges around bioresources management and operational pressures on storage capacity.

Transport logistics
We need to reduce the volume for transportation whilst ensuring optimisation of our transport logistics. We have developed a National Bioresources Strategic Decision Support Tool (DST). We will continue to develop the DST to optimise transport strategies and ensure lower carbon transport.

Emerging contaminants
Wastewater sludge contains many valuable elements such as organic matter and nutrients. However, it can also contain emerging contaminants which originate from various sources, including domestic, agricultural, industrial, and leachate. The impact of emerging contaminants and nutrient management requirements could potentially restrict the current land availability for sustainable reuse.

Data & reporting
There are a range of stakeholders responsible for reporting. Reporting requirements are becoming more extensive such as the recent EU Commission Spatial Data Request for biosolids spreading across all Member States. Compliance with GDPR can impact availability of data for reporting.

All our treated bioresources are currently beneficially reused in agriculture. Reliance on one outlet is susceptible to policy, regulatory, and/or compliance changes and therefore this strategy looks at possible alternatives for the future. There is a need for storage facilities during periods when application of biosolids to land is not allowed during winter months as required by the Code of Good Practice. In recent years the period of land spreading availability has decreased due to changing climate conditions and heavier rainfall events leading to waterlogged land. These conditions have resulted in challenges around bioresources management and operational pressures on storage capacity.

Wastewater sludge contains many valuable elements such as organic matter and nutrients. However, it can also contain contaminants of concern such as heavy metals, pathogens, organic and emerging contaminants. These can originate from various sources, including domestic, agricultural, industrial, leachate, and illegal or non-compliant discharges to the WWTP.

The rUWWTD adopted in late 2024 once transposed will result in changes in the coming years such as enhanced monitoring, energy neutrality targets, and circular economy requirements. Revisions to the Sewage Sludge Directive (SSD) and the Code of Good Practice (CoGP) are also expected, in combination with the introduction of the proposed EU Circular Economy Act. These legislative updates will result in changes to our approach to wastewater sludge and bioresources management.

Our Sustainability Framework outlines our sustainability ambitions such as net zero carbon by 2040, biodiversity net gain, GHG emissions reduction, and ensure circular solutions are considered in all capital projects by 2026.

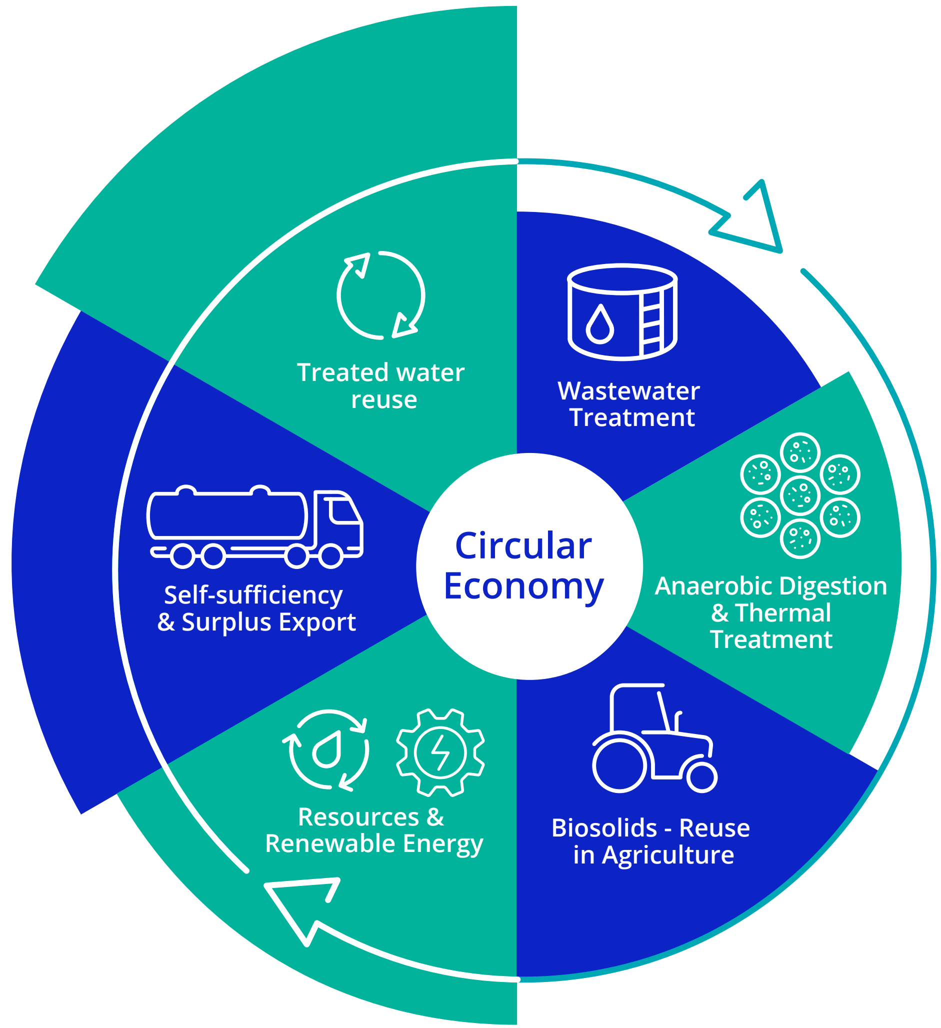
3 | Our strategic objectives

Whilst the WSSP 2050 sets out our long-term overarching objectives and strategic direction, more detail is provided in our Tier 2 plans and supporting strategies on how we aim to achieve our objectives. As shown below there are a range of Tier 2 supporting strategies including the draft NBioS.

The draft NBioS objectives and aims summarised below, and described in more detail in Section 3.1, closely align with the WSSP 'Sustainable Services fit for the Future' strategic aim. Achieving net zero carbon and adoption of circular approaches is key. Also, ensuring we embrace and gain value from innovation is an important factor in our draft NBioS.

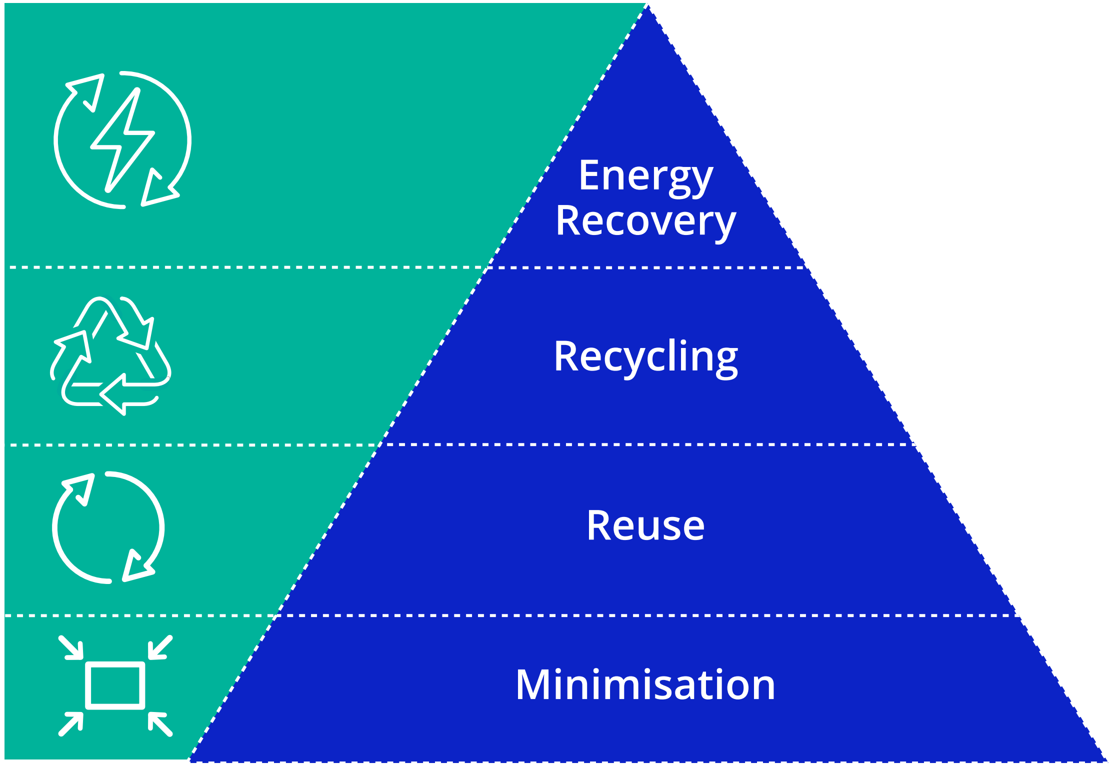
3.1 Draft National Bioresources Strategy actions

We manage our assets to maximise resource recovery and resource efficiency and minimise waste. We treat all wastewater sludge to meet the requirements of the Code of Good Practice. We continue to work with stakeholders and industry to develop alternatives for the beneficial reuse of bioresources and the recovery of energy and/or bioresources in a sustainable and economically viable manner.



The draft NBioS supports the hierarchy of waste management by minimisation of wastewater sludge volume and organic stabilisation (Section 5) followed by reuse, recycling, and resource recovery. Since 2020 we have stopped disposal to landfill as it is not an environmentally or economically sustainable option.

Hierarchy of waste management



Sections 3.1.1 to 3.1.4 set out the draft NBioS key actions to achieve our strategic objectives. These actions build on the actions in the existing NWSMP and go further to ensure sustainable bioresources management. The final NBioS will undergo regular reviews, at least every five years, to ensure it remains appropriate and fit for purpose. The reviews will allow us to adapt to changing circumstances and evolving needs.

3.1.1 Sustainable management of wastewater sludge and bioresources

STRATEGIC OBJECTIVE	STRATEGIC AIM	Action		Refer to Section for more details
1 - Sustainable management of wastewater sludge and bioresources	Achieving net zero carbon	1.1	Implement Biogas Optimisation Programme and incorporate methane emissions monitoring and control into biogas producing sites.	Section 4.4
		1.2	Development of heat strategies and support heat recovery.	Section 6.3
	Adopting circular approaches	1.3	Continue to develop potential opportunities for Co-Digestion in line with development of National Policy or Legislation.	Section 4.4
		1.4	Implement resource recovery technologies.	Section 4.4
		1.5	Maximise circularity and valorisation of circular bioeconomy.	Section 4.4
		1.6	Increase understanding of alternative outlets, market demand and specification requirements for these outlets.	Section 7.0
	Gaining value from innovation	1.7	Carry out demonstration on advanced thermal conversion (ATC) technology, and based on outcome implement ATC technology.	Section 12.3
		1.8	Continue to support current and future bioresources research projects, monitor specific evidence based findings and incorporate into risk assessment method.	Section 12.3
		1.9	Invest in renewable energy optimisation and generation.	Section 4.4
	Securing long-term funding	1.10	Quantify long term investment needs for our bioresource assets.	Section 9.0

3.1.2 Protect and restore our environment

STRATEGIC OBJECTIVE	STRATEGIC AIM	Action	Refer to Section for more details
2 - Protect and restore our environment	Contributing to positive biodiversity	2.1 Implement nature based solutions such as sludge reed beeds (SRBs) on smaller sites (<2K P.E.), and SRBs are considered on all capital projects.	Section 5.4
		2.2 Manage our assets to ensure biodiversity 'net gain'.	Section 2.0
		2.3 Implement actions from our 'Biodiversity Action Plan' in delivery of bioresources projects.	Section 1.4
	Meeting our commitments under the recast UWWTD (rUWWTD) and the Sewage Sludge Directive	2.4 Manage wastewater sludge and bioresources throughout the asset lifecycle to meet our existing regulatory requirements.	Section 11.0
		2.5 Ensure all new regulatory requirements of the rUWWTD are met e.g. enhanced monitoring, energy neutrality, and circular economy.	Section 11.1
		2.6 We are engaging with Regulators and Stakeholders regarding the development of a revised Code of Good Practice for the Use of Biosolids in Agriculture.	Section 11.1
		2.7 Implement National emerging contaminants monitoring programme and carry out additional analysis as needs emerge.	Section 11.1
	Protecting our water and land environment	2.8 Continue on-going regulatory monitoring and UÉ traceability data collection.	Section 11.1
		2.9 Implement a National Biosolids Assurance Scheme.	Section 11.3
		2.10 Engage with key stakeholders and consult on PFAS limits.	Section 4.6
		2.11 Implement alternative uses if needed.	Section 4.6
		2.12 Bioresources response plan to be reviewed and further developed to manage land outlet.	Section 4.6
		2.13 Promote source control management, advocating legislation around source control and improving wastewater sludge quality.	Section 4.6
		2.14 Carry out risk assessments for industrial / pharmaceutical effluent discharging into our wastewater treatment plants.	Section 4.6
		2.15 Provide storage facilities for treated bioresources Nationally.	Section 8.2

3.1.3 Support our communities, growth, and the bioeconomy

STRATEGIC OBJECTIVE	STRATEGIC AIM	Action		Refer to Section for more details
3 - Support our communities, growth and the bioeconomy	Engaging with communities	3.1	Develop a culture of acceptance and community education & awareness regarding quality assurance and circularity of bioresources.	Section 11.3
	Supporting the development of the circular bioeconomy	3.2	Engage with EU, Regulators and key stakeholders regarding the development of the proposed new EU Circular Economy Act.	Section 1.3
	Providing for growth	3.3	Embed growth and demand analysis capability to forecast and plan for future investment requirements.	Section 4.3
		3.4	Engage and collaborate with key stakeholders to support local, regional and national planning policy.	Section 4.3

3.1.4 Efficient operation of wastewater sludge and bioresources centres

STRATEGIC OBJECTIVE	STRATEGIC AIM	Action		Refer to Section for more details
4 - Efficient operation of wastewater sludge and bioresources centres	Managing our assets	4.1	Phase out leachate acceptance at our wastewater treatment plants in consultation with Regulators, Local Authorities and waste operators.	Section 3.0
		4.2	Continue to utilise licenced waste transport operators and auditing of contractors to ensure compliance with Standard Operating Procedure (SOP).	Section 7.0
		4.3	Review dry solids monitoring on all new and upgraded wastewater sludge treatment assets to improve dewatering quality.	Section 5.1
		4.4	Review and update Standard Operating Procedures (SOPs) for wastewater sludge and bioresource treatment assets.	Section 11.1
	Ensuring efficient transportation	4.5	Continue to develop a National Bioresource Decision Support Tool, optimising low carbon transport.	Section 7.2
	Implementing efficient technologies	4.6	Implement sustainable efficient pre treatment drying technology in parallel with ATC to optimise Resource Recovery.	Section 6.3

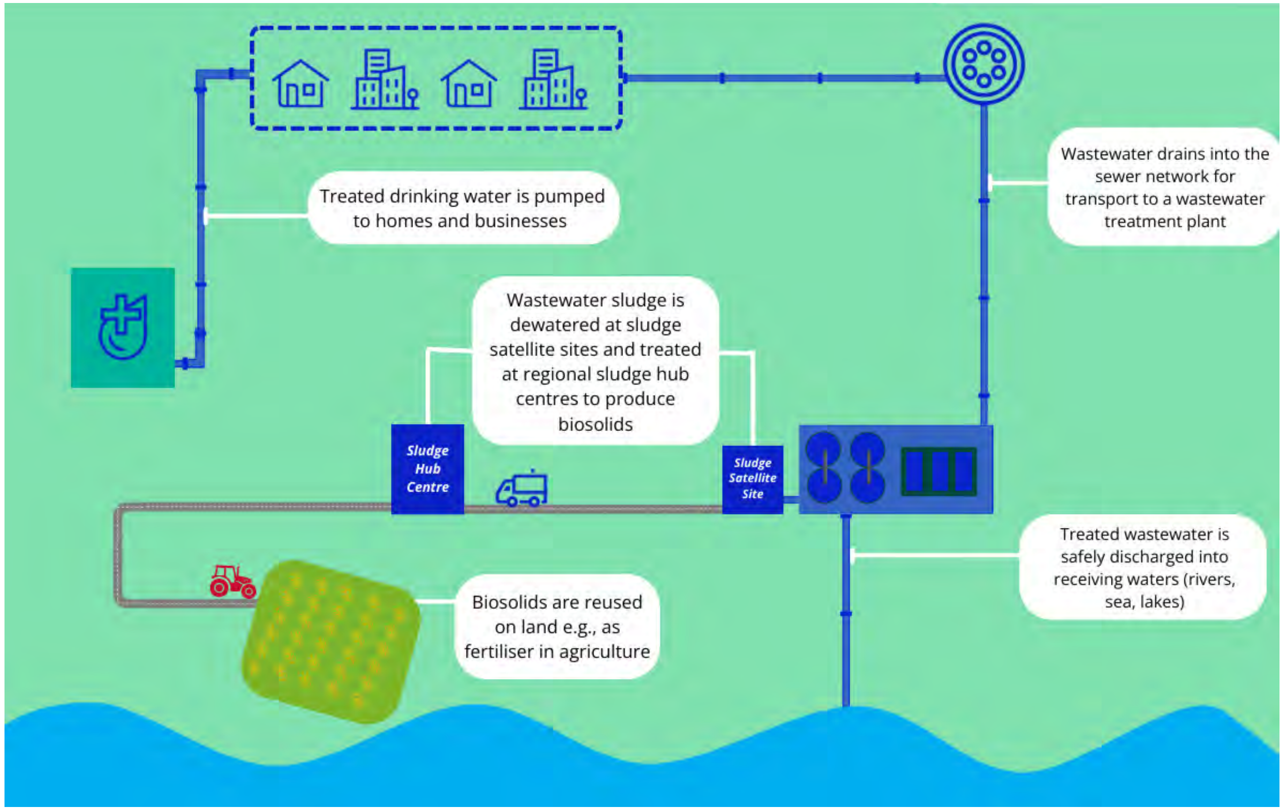
4 | Wastewater sludge and bioresources

4.1 What is wastewater sludge and how is it managed?

Wastewater sludge is recovered from the wastewater treatment process. The treated wastewater sludge becomes a bioresource which is rich in organic matter and nutrients, and it can be reused in various beneficial ways such as fertiliser and as a soil conditioner. We treat all our wastewater sludge to produce a treated biosolids bioresource, which is beneficially reused in agriculture.

Sludge from WWTPs is primarily the organic by-product of the biological treatment of wastewater, and comprises the solids removed during the treatment processes. WWTPs operate biologically active processes, and sludge is the natural product of this process. When appropriately treated and managed it does not present a risk to the environment or human health and it can be safely recycled to provide a benefit to society and the environment. It can be particularly beneficial as a soil conditioner and source of nutrient enrichment (fertiliser).

Wastewater sludge from the wastewater treatment process is normally separated from the treated effluent using gravity settlement. This produces a liquid wastewater sludge with a solids concentration in the range 1 – 3% dry solids (DS). This sludge is further treated using mechanical, biological or chemical processes, or a combination of these processes, prior to recycling. These processes are aimed at removing water, hence reducing sludge volume, and stabilising the organic matter. Further details on this are included in Section 5.



4.2 Bioresource quantities and outlets

All the treated sludge bioresources produced at our WWTPs, circa 70,000 tds/yr, is currently beneficially reused in agriculture in accordance with the Code of Good Practice. Every year we provide sludge data to the Environmental Protection Agency (EPA). The graph below summarises the national sludge data from 2016 to 2024.

Although reusing the sludge bioresource through land application is the most circular and sustainable reuse route currently, we are looking at alternative pioneering options to the land application to ensure sustainable long-term resilience. More details on sustainable alternatives are detailed in Sections 6 and 10.

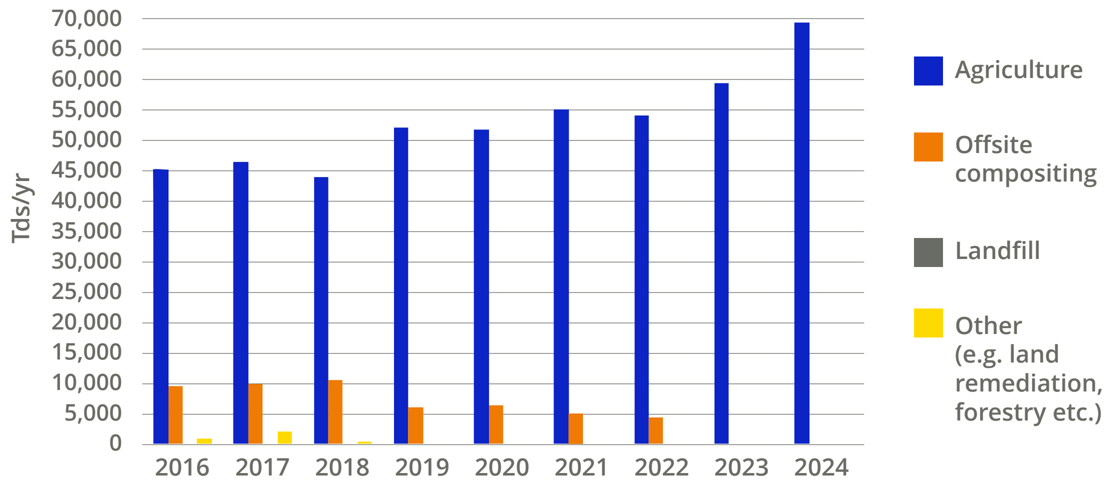
4.3 Estimated future bioresource quantities

As new WWTPs and upgrades occur, the level of compliance will increase, and the actual sludge load will increase to the predicted quantities as shown in Appendix C. These projections are based on the published draft revised National Planning Framework (NPF) and 2022 Census population figures.

Variations can occur between the predicted and reported sludge quantities for several reasons such as uncertainty on accuracy of reported population growth rates and operational (for example higher sludge age, desludging frequency at smaller plants, increasing compliance with emission limit values (ELVs), or dry solids concentrations used in calculations measured infrequently).

We embed growth analysis capacity to forecast and plan for our future investment requirements. We will continue to engage with key stakeholders to support local, regional, and national planning policies.

Reported sludge loads and outlets



4.4 Valorisation of wastewater sludge for the bioeconomy

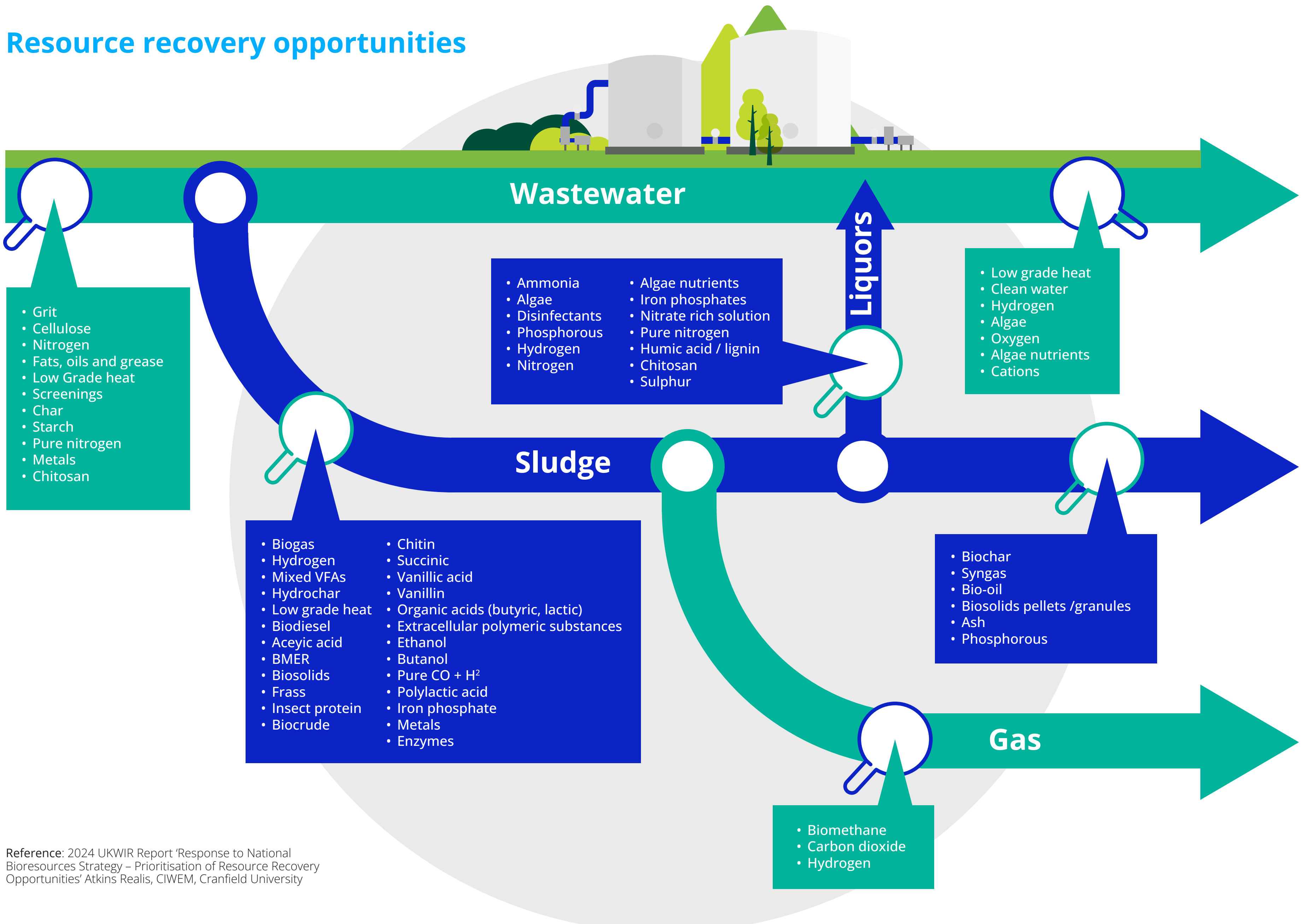
Wastewater sludge contains several valuable constituents such as energy and nutrients that can provide bioresources for the economy, thus contributing to achieving a more sustainable, circular bioeconomy and assisting us in meeting our net zero carbon ambitions. The recovery and reuse of available bioresources gives us the opportunity to minimise the use of finite natural resources, consequently minimising the overall environmental impact.

A recent UK Water Industry Research (UKWIR) study (July 2024)[10] carried out a detailed review of all the sludge constituents which are or can be used to create bioresources for beneficial reuse. A total of 79 bioresources were identified as being deemed viable for recovery. A Resource Recovery Prioritisation Tool was developed as part of the project which allows us to review prioritisation of resource recovery options[11].

[10] UKWIR Study entitled 'Response to the National Bioresources Strategy – Prioritisation of Resource Recovery Opportunities'

[11] Reference: 2024 UKWIR Report 'Response to National Bioresources Strategy – Prioritisation of Resource Recovery Opportunities' Atkins Realis, CIWEM, Cranfield University

Resource recovery opportunities



Reference: 2024 UKWIR Report 'Response to National Bioresources Strategy – Prioritisation of Resource Recovery Opportunities' Atkins Realis, CIWEM, Cranfield University

4.4.1 Resource recovery at our plants

We are already recovering some of these identified priority bioresources at our WWTPs, and we will continue to review opportunities and implement resource recovery technologies. We will maximise circular bioeconomy benefits and increase valorisation of the bioeconomy where feasible. Treated biosolids are beneficially reused in agriculture where they provide nutrient content in terms of phosphorus and nitrogen, and levels of potassium, sulphur, magnesium, and micronutrients. In addition, the organic content can improve the overall soil quality.

We will maximise circular bioeconomy benefits and increase valorisation of the bioeconomy where feasible.

At some of our plants we recover energy via the anaerobic digestion (AD) processes. Digestion produces a methane rich biogas which is converted to heat and electricity and sustainably reused within the WWTPs. Furthermore, some of our larger WWTPs have advanced anaerobic digestion (AAD) which incorporates pasteurisation or the thermal hydrolysis process (THP) which enhances the digestion process resulting in a higher biogas yield, increased energy, and enhanced sludge quantity reduction.

We are investing in renewable energy generation and optimisation. Efficient energy generation and use is key, and we recognise the opportunity for optimising our biogas generation to fully realise its potential as a renewable energy resource. We have initiated the biogas optimisation programme (BOP) with the aim to improve and optimise biogas production and usage, and to address common challenges across digestion plants for example, ensure biogas usage, data and reporting on biogas quantities and quality (including methane emissions monitoring and control), biogas cleaning and implementation of innovative biogas technologies where appropriate.

Case study – Ringsend Wastewater Treatment Plant phosphorous recovery

We have applied innovation and advanced technology at our largest wastewater treatment plant at Ringsend, to recover phosphorous from wastewater. This is Ireland's first ever facility to recover phosphorous fertiliser from wastewater.

The Ringsend Wastewater Treatment Plant takes 40% of the country's wastewater load and discharges treated wastewater into the Lower Liffey Estuary. The application of this innovative technology applies the principles of the circular economy to create a valuable resource for agriculture and other sectors.

The new facility is part of a €500 million investment to upgrade Ringsend Wastewater Treatment Plant and make it compliant with European standards. The facility can produce over 4,000 tonnes of fertiliser per year and recover 1.3 tonnes of phosphorous per day.

The BOP is needed to help us meet our circular economy, reduction in greenhouse gas (GHG) emissions, and net zero carbon ambitions. Furthermore, the rUWWTD has new requirements such as energy neutrality and circular economy that we will aim to meet in the coming years. If we achieve self-sufficiency, any surplus biogas could be upgraded to biomethane at some of our larger sites, and this could help to meet the Climate Action Plan (CAP) National biomethane target of 5.7Twh by 2030.

There is the potential for us to develop opportunities with producers of wastes that are suited for co-digestion facilities. Food waste is one of the key focuses detailed in the National Waste Policy 'Waste Action Plan for a Circular Economy' (WAPCE)[12]. The policy was developed from the Circular Economy Strategy[13] (published in 2021) and it aims to fulfil the commitments to waste planning and management over the coming years and help Ireland move towards achieving a circular economy. Food waste is recognised as a global and national problem.

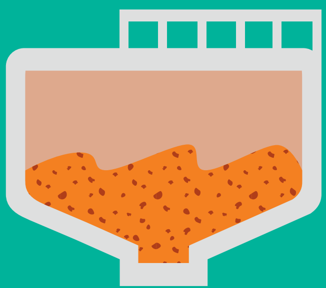
We carried out a feasibility study to investigate the potential for co-digestion of wastewater sludge and food waste at our digestion sites. Co-digestion involves digesting wastewater sludge with other highly degradable organic wastes to generate additional biogas and therefore more renewable energy. Food waste is an attractive substrate to co-digest due to its high methane yield, fast digestion kinetics and local availability.

Co-digesting sewage sludge and food waste at our digestion sites would result in increased renewable energy generation, which would align with the national policy to achieve a circular bioeconomy. However, there are key legislative changes required before we could implement co-digestion at our sites.

[12] gov.ie - Waste Action Plan for a Circular Economy
[13] gov.ie - Whole of Government Circular Economy Strategy 2022 – 2023 'Living More, Using Less'

4.5 Wastewater sludge types

We produce various sludge types in our WWTPs including primary, biological secondary, and sludge generated from phosphorus removal.

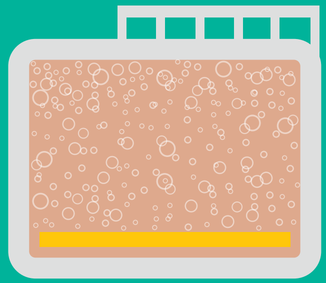


Primary sludge

Primary sludge is formed during the primary treatment stage.

Primary sludge is produced by gravity when heavier organic matter and solid particles in the wastewater settle. It is the first solid produced at a wastewater treatment plant and contains a lot of organic matter.

At our sites primary sludge is produced at very small (<1,000 PE) and very large (>10,000 PE) wastewater treatment plants. At the larger plants primary settlement is normally included with Anaerobic Digestion as it has a high energy content and biogas production can be optimised.



Biological sludge

Biological sludge is formed during the secondary treatment stage. It is produced most commonly by the activated sludge process, but other processes include biological filters, rotating biological contactors, and trickling filters.

The activated sludge process uses microorganisms and air to biologically breakdown the organic matter and solids.

The quantity of biological sludge produced depends on the sludge age and level of treatment required. The quantity of sludge decreases as the sludge age increases. The sludge age required for nitrogen removal is approximately 10 days whereas the sludge age required for BOD removal only is 3-4 days.

Biological sludge is produced at approximately 80% of our wastewater treatment plants.

Sludge from phosphorus removal

Chemicals such as ferric sulphate or ferric chloride are used to remove phosphorus to ensure the treated effluent is safely discharged into the receiving waters.

The removal of phosphorus from wastewater using chemical dosing leads to an increase in sludge production by up to 25%.

Biological phosphorus removal is in place in a small number of WWTP's. Due to the additional process control and infrastructure required, chemical removal is generally favoured. However, the number of WWTP's with biological phosphorus removal may increase due to the cost of chemicals and higher sludge production associated with chemical dosing.

4.6 What makes up our wastewater sludge?

Wastewater sludge contains many valuable elements such as organic matter, nutrients, and energy. However, it can also contain contaminants of concern such as heavy metals, pathogens, organic and emerging micropollutants such as persistent organic pollutants (POPs), PFAS, pharmaceuticals, personal care products, and microplastics.

These micropollutants can originate from various sources, including domestic, agricultural, industrial, leachate[14], and non-compliant discharges to the WWTP. We consider source control a preferable management option to end-of-pipe treatment to minimise the risk of specific contaminants of concern in the treated biosolids and we target source control as part of our strategy for protecting the water environment. We will carry out risk assessments for industrial / pharmaceutical effluent discharging into our WWTPs.

Furthermore, the rUWWTD sets out requirements for quaternary treatment for the removal of micropollutants at the larger sites and introduces the 'polluter pays principle' whereby producers must cover at least 80% of additional costs for treating wastewater through an Extended Producer Responsibility (EPR) scheme. We recognise the need to monitor source control to protect wastewater sludge quality and welcome increase legislation to reduce the risks of micropollutants.

The licence holder carries out monitoring at the industry discharge points, and we carry out regular monitoring at our WWTP's on influent and effluent, and on leachate accepted for treatment. Monitoring is also carried out on treated biosolids before reusing in agriculture in accordance with the requirements in the Code of Good Practice. This monitoring includes for nutrients (nitrogen, phosphorus, potassium), pathogens, heavy metals, and POPs. Also, Nutrient Management Plans (NMPs) manage the application rates of nutrients.

There has been increasing monitoring and research around emerging contaminants of concern in recent years, particularly PFAS and microplastics. The Chemical Investigations Programme (CIP) set up by the UK Water Industry Research (UKWIR) investigates and monitors these contaminants to gain a better understanding of their occurrence, behaviour, and management. The programme runs in phases and CIP4 which started in 2024[15] builds on previous monitoring and includes investigations into PFAS and microplastics in biosolids. We participate in EPA research projects on emerging contaminants in biosolids such as Terrachem and Safewaste and will also be implementing a National emerging contaminants monitoring programme.

An EU funded study[16] on levels of POPs in sludge were generally significantly below the limits set in relation to EC Regulation 850/2004[17]. A review of international research in relation to organic contaminants, noted that most risk assessments demonstrate that use of treated biosolids does not place human health at risk from the organic contaminants studied. It was recommended that this is reviewed on an ongoing basis to ensure the long-term sustainability and security of the beneficial agricultural route for biosolids management[18].

[14] Leachate from landfill or from recycling centres

[15] Introducing the next phase of the Chemical Investigations Programme (CIP) (ukwir.org)

[16] Occurrence and Levels of Selected Compounds in European Sewage Sludge Samples JRC 2012

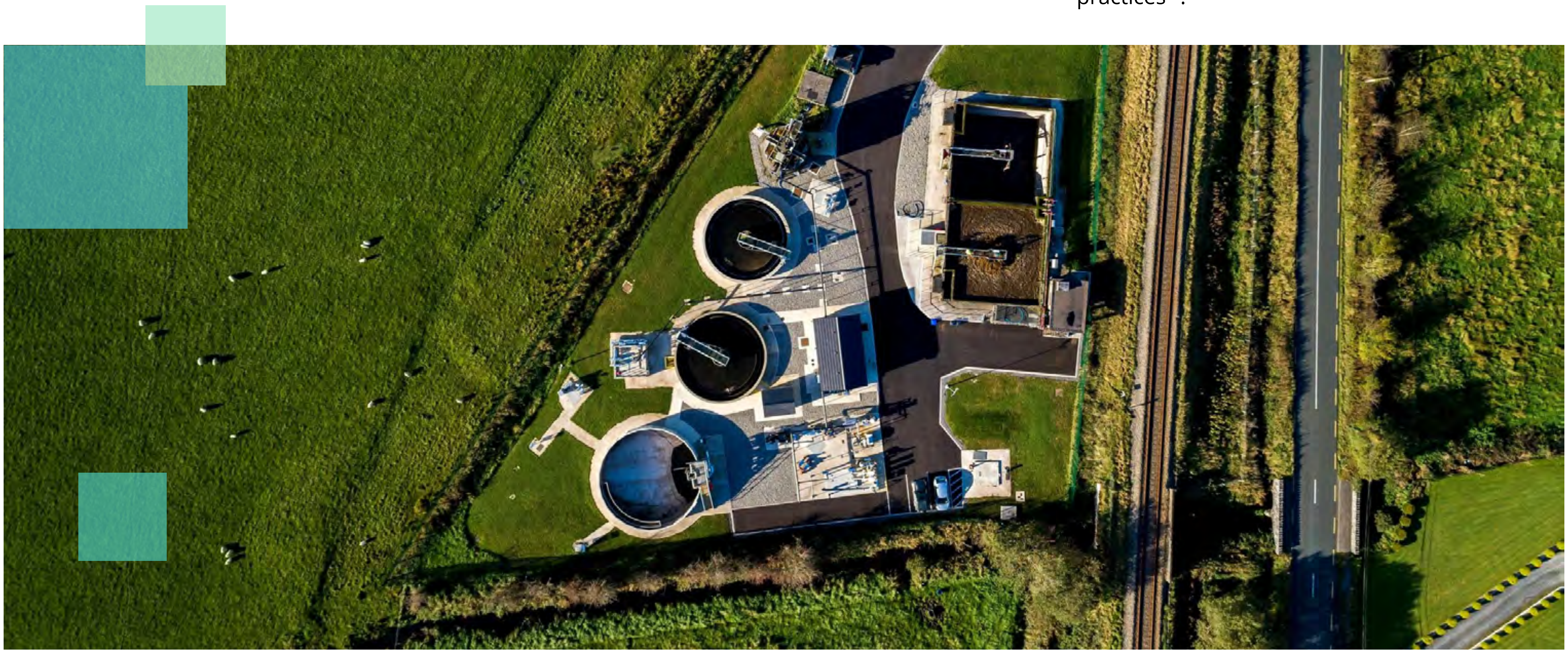
[17] Regulation (EC) No. 850/2004 of the European Parliament and of the Council on persistent organic pollutants and amending Directive 79/117/EEC

[18] Clarke BO, Smith SR. Review of 'emerging' organic contaminants in biosolids and assessment of international research priorities for the agricultural use of biosolids. Environmental International, 2011.

There are currently no limits for levels of organic pollutants specifically relating to treated biosolids used in agriculture. It is proposed that research and recommendations in this area are reviewed regularly, and we will undertake additional analysis as needs emerge to mitigate against any risk to soils or health.

We welcome the review of the Code of Good Practice which will review monitoring and limits for organic pollutants and likely make recommendations for additional monitoring to mitigate against potential risks. We are working with a multi stakeholder working group on this review and we will consult on new emerging contaminants limits such as PFAS.

We will develop a Bioresources Response Plan and will implement alternative uses such as those described in Section 10. Also, outputs from ATC technologies, as discussed in Section 6, such as biochar or hydrochar could provide an alternative for the beneficial re-use of organic materials on land. It should be noted that both outputs are in the initial stages of building a regulatory, scientific and market proposition for deployment rather than being established practices[19].



[19] 2022: Converting Sewage Sludge to Biochar: a review of options and feasibility (AtkinsRéalis, Cranfield University)

5 | Wastewater sludge and bioresources treatment processes

Treated effluent is safely discharged into receiving waters. The byproduct of the wastewater treatment process is **liquid sludge**

Sometimes sludge undergoes a **Sludge Thickening** process using:

- A sludge storage tank with decanting,
- A picket fence thickener, or
- A drum thickener

The output of sludge thickening processes is **thickened liquid sludge (1-3%)**

The **Sludge Dewatering** process reduces the volume of liquid sludge, making it more efficient to transport. There are several sludge dewatering processes including:

- Centrifuge
- Belt press
- Screw Press
- Mobile dewatering
- Sludge reed bed (SRB)

The output of Sludge Dewatering processes is **Sludge Cake (18-25% DS)**

Sludge Treatment Processes turn sludge cake into **bioresources** (biosolids, biogas). There are many treatment options including:

- Anaerobic Digestion (AD) and Microbial or Thermal Hydrolysis or Pasteurisation (Advanced AD)
- Digestion & Hydrolysis
- Composting
- Lime Stabilisation
- Efficient Thermal Drying

Advanced Thermal Conversion of wastewater sludge allows for additional resource recovery (energy / heat / biochar).
Examples include:

- Hydrothermal Carbonisation
- Gasification
- Pyrolysis

Biosolids can be **reused on land:**

- In agriculture
- In forestry
- On energy crops
- For land remediation

Biochar can be reused in agriculture, construction aggregates, micropollutant removal, or fuel source.

5.1 Wastewater sludge volume and quantity reduction

It is important to reduce the sludge volume and quantity to optimise transport and storage efficiencies. The extent of volume and quantity reduction depends on the size and location of the WWTP, and the technology type. Various thickening and dewatering technologies used to reduce the volume. We will incorporate dry solids monitoring to improve quality and to ensure optimal operations.

The balance between the capital and operating costs of thickening and dewatering versus the cost of transportation need to be considered. At smaller plants containerised or mobile dewatering units can be used to reduce volumes where a permanent dewatering installation is not economically justified. In such cases the quantity and quality of the return liquor must be monitored.

Some stabilisation technologies, discussed in Section 5.3, can also reduce the volume and quantity. For example, efficient thermal drying substantially reduces the volume by evaporation of water and produces a microbiologically safe and stabilised product. Digestion when carried out with pasteurisation or hydrolysis is called advanced anaerobic digestion (AAD), and this process reduces the quantity of sludge and produces a stabilised product.

5.2 Wastewater sludge stabilisation

We use several treatment processes to provide pathogen reduction to ensure treated biosolid bioresources are suitable for reuse in agriculture. These processes outlined in the Code of Good Practice are listed in Table 5.1.

Further details on these technologies and how they operate can be found in Appendix D. These treatment processes have all been demonstrated to achieve 99.9999% (or 6 log) reduction in indicator pathogens and are therefore acceptable. New technology and processes which are proven to achieve the same levels of reductions will be considered.

Table 5.1: Code of Good Practice treatment processes

Process	Description
Mesophilic anaerobic digestion with pre- or post-pasteurisation	Mean retention period of at least 12 days primary digestion in temperature range 35°C +/- 3°C or of at least 20 days primary digestion in temperature range 25°C +/- 3°C. Pasteurisation phase must achieve a retention period of at least 1 hour at a temperature of greater than or equal to 70°C or for 2 hours at a temperature of greater than or equal to 55°C.
Thermophilic anaerobic digestion	Mean retention period of at least 48-72 hours in temperature range 50-55°C. Must include a retention period of at least 1 hour at a temperature greater than 70°C followed by a minimum retention period of at least 2 hours at a temperature of greater than or equal to 55°C or of at least 4 hours at a temperature greater than or equal to 50°C.
Thermophilic aerobic digestion	Mean retention period of at least 7 days. All sludge to be subject to a temperature of greater than or equal to 55°C for at least 4 hours. Must achieve a reduction of volatile solids of greater than or equal to 38%.
Composting	Windrows: To be held at 55°C for at least 15 days, during which time a temperature of greater than or equal to 55°C must be maintained over 5 turnings of the windrow. Static Pile or In-vessel: A temperature of greater than or equal to 55°C must be achieved and maintained uniformly for at least 3 days.
Alkaline stabilisation	Addition of lime to raise pH to greater than 12.0 with an accompanying rise in temperature to 70°C for 30 minutes. Addition of lime to raise pH to greater than 12.0 and to maintain pH above 12 for 72 hours and to achieve a temperature of greater than or equal to 52°C for at least 12 hours. At the end of the 72-hour period, air dry to a dry solids content of greater than or equal to 50%.
Thermal drying	Drying by direct or indirect contact with hot gases. Moisture content of the dried biosolids to be less than or equal to 10%. Either the temperature of the biosolids should be greater than 80°C or the wet bulb temperature of the gas in contact with the biosolids leaving the drier should be greater than 80°C.

Total Stabilised Sludge in 2024 (tonnes dry solids)

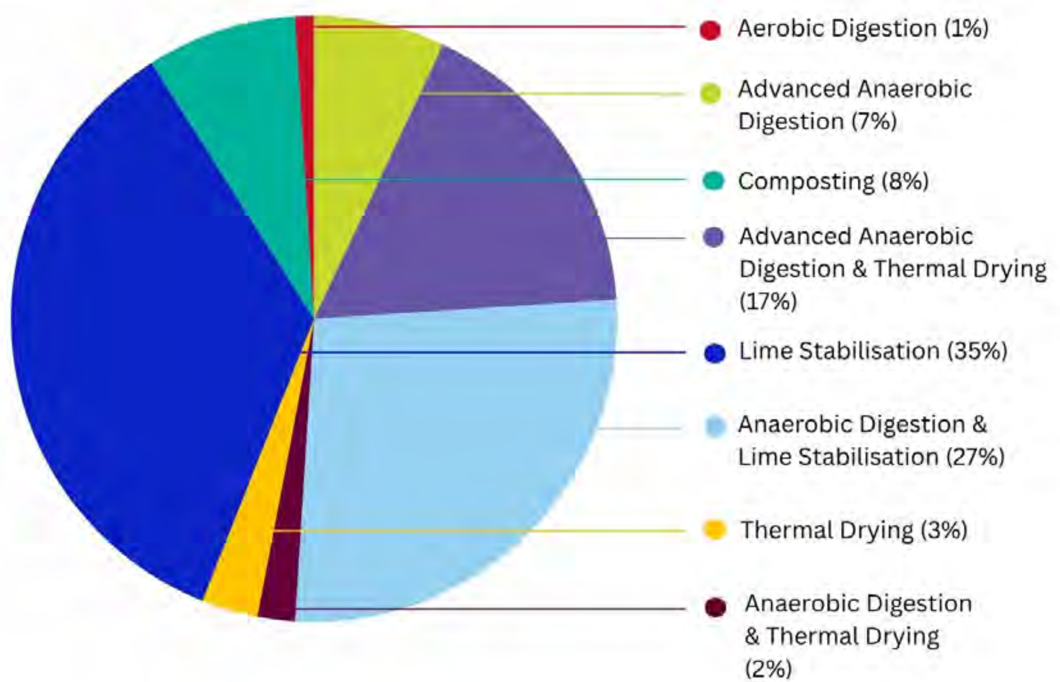


Figure 5.1: The proportion of wastewater sludge being treated and stabilised by each of the treatment processes based on 2024 sludge returns data.

Based on 2024 sludge returns data anaerobic digestion and lime stabilisation are our main wastewater sludge stabilisation methods. The proportion of thermal drying has decreased in recent years as a significant number of the dryers were turned off due to high operational energy requirements and other reasons outlined in Section 6.3.

5.3 Advanced anaerobic digestion (AAD)

Anaerobic digestion (AD) is very effective at reducing solids and producing energy from primary sludges, however the level of solids reduction on secondary sludges is lower. That's why we implement pretreatment advanced digestion at some of our sites to optimise the digestion process and boost biogas and energy production. As the biodegradability of primary sludge is much higher than secondary sludge, pretreatment is often only carried out on secondary sludges. Some examples of advanced digestion are:

- Thermal Hydrolysis process (THP)
- Microbial Hydrolysis
- Enhanced Enzyme Hydrolysis
- Thermophilic Digestion
- Pre or post Pasteurisation

The thermal hydrolysis process (THP) uses heat and pressure at the hydrolysis stage to breakdown the wastewater sludge into more soluble compounds, which are more easily converted to energy during digestion. This is a widely used technology with operational facilities internationally and in Ireland. Advanced digestion with thermal hydrolysis has been selected as a viable technology for some of our regional bioresource centres (Section 8). This will ensure optimised digestion, increased biogas, and energy generation at these sites.

New advanced digestion process configurations such as intermediate THP are being researched and implemented as it has shown additional advantages such as reduced THP plant capacity, increased volatile solids reduction (VSR) and biogas yields, higher dewaterability of final cake, lower digestate volumes, and less steam required for the biosolids line, however a larger digester volume is required. Other pretreatment technologies to improve digestion and boost biogas and energy are based on mechanical, lysing centrifuge, ozonation, ultrasound, biological and chemical methods.

Further to above, we are optimising conventional digestion processes where feasible. Anaerobic digestion was conventionally operated in parallel but more recently plug flow operation is preferred to optimise the digestion process. By operating the tanks in-series there is reduced short circuiting, resulting in greater digestion of all the sludge, reduction digested sludge mass, and more biogas production. In addition, there is better biogas capture as the tanks are covered and managed for gas collection, while in the parallel configuration the secondary digesters were not usually covered.

5.4 Nature-based solutions

Nature-based solutions utilise nature and healthy ecosystem processes to deliver more sustainable solutions for society. Employing nature-based solutions helps protect, restore, and enhance water quality; improves climate resilience; increases biodiversity; and has significant potential to deliver more sustainable solutions. As part of our Bioresources Strategy we encourage and promote the identification of opportunities for the incorporation of sludge reed beds (SRBs) and other nature-based solutions into wastewater treatment sites to ensure we contribute to positive biodiversity.

Aside from providing wastewater sludge treatment solutions, nature-based solutions have many additional benefits, including a reduction in sludge production, energy usage, carbon sequestration, and biodiversity benefits. Sludge reed beds are particularly beneficial in smaller remote WWTPs (with an inlet screen) where the cost of transport of sludge to a satellite dewatering centre is unsustainable.

We operate SRBs according to our SOPs for optimal operation, and we monitor the biosolids product according to the Code of Good Practice to demonstrate the product is suitable for sustainable reuse. The management and reuse of the treated product occurs every 10 years.

Case study –Sludge reed beds, Carlow

In partnership with Carlow County Council, we successfully completed an €800,000 pilot programme to install innovative sludge reed beds (SRBs) at five Co. Carlow wastewater treatment plants. These eco-friendly projects in Clonegal, Fenagh, Ballon, Myshall, and Raheendoran use natural processes for treating wastewater sludge. The SRB system offers a nature-based solution for treating wastewater sludge.

The reed beds increase biological activity that helps to absorb nutrients like nitrogen and phosphorous from the wastewater. The natural drying system also reduces sludge production, energy use, greenhouse gas emissions and costs, compared with traditional methods. Additionally, the reed beds help to support biodiversity by creating a valuable habitat for birds, insects, and other animals.

We will continue to invest in SRBs as a sustainable natural process for treating wastewater sludge where feasible to ensure biodiversity net gain.

Sludge reed beds are particularly beneficial in smaller remote WWTPs where the transport of sludge to a satellite dewatering site is unsustainable. We will implement sludge reed beds on smaller sites (less than 2,000 P.E.) where feasible and consider sludge reed beds on all capital projects.

6 | Advanced thermal conversion (ATC) technology options

The existing NWSMP included a commitment to review alternative outlets and approaches. To demonstrate increased resilience, and to ensure we meet our sustainability ambitions and alignment with Ireland and EU targets for climate change, energy security, and circular bioeconomy, we have reviewed and are progressing alternative bioresource treatment options such as ATC technologies and alternative non-agricultural land outlets. Further details on alternatives can be found below and in Section 10.

We undertook a feasibility study to assess thermal treatment options and how these might provide an alternative approach to manage the risks and meet net zero ambitions. The study outputs are presented in Section 6.1. We are also progressing with ATC technology alternative options to ensure sustainable long-term resilience to our agricultural land reuse outlet.

6.1 Thermal sludge treatment feasibility study 2019

As part of the feasibility study, site surveys were carried out in 2019 at fourteen of our sludge dryer sites. The assessment identified the operational status, performance, and viability of continued use of the conventional thermal dryers. Of the fourteen sites surveyed, seven were in operation, two were temporarily off awaiting repairs, three were not in operation but were routinely activated to demonstrate their operability and readiness if needed, and two were decommissioned. Due to the age and high maintenance requirements of some of the dryers, it was concluded that if future ATC technology options required a dried sludge, then several of the dryers would need to be refurbished and brought back into operation or replaced with new more sustainable efficient driers.

A 'longlist' of potential thermal technologies was assessed including established conventional technologies and other advanced thermal technologies that were in various stages of development (from pilot to demonstration scale). At the time of the study a shortlist of four technologies covering different technology types and scales were technically more viable for Ireland and these were taken through to a more detailed assessment. The shortlist of technologies was as follows:

- Mono-incineration (wastewater sludge incineration (SSI)
- Co-incineration in cement plants
- Hydrothermal carbonisation (HTC)
- Pyrolysis

Each shortlist technology option was assessed for the three regions. The assessment included technical, environmental, and economic analysis.

The review concluded that the use of sludge in cement plants was the least costly solution which provided a reasonable level of resilience and recovery of value from sludge (though in the form of cement rather than more valuable forms). However, this option did not perform well on environmental grounds due to the reliance on fossil fuels for heating dryers (higher carbon emissions) on our sites and lack of valuable resource P recovery. Incineration was considered to score well against the resilience criteria although it was more expensive than the cement plant option.

The hydrothermal carbonisation (HTC) option appeared expensive at larger scale (East Midlands and South regions) compared to the other options. In terms of resource recovery and environmental objectives the option performed reasonably well though it was relatively less proven as demonstrated by its low resilience score.

At the time of the study in 2019 pyrolysis did not perform well against economic and resilience objectives and only similarly to HTC in terms of resource recovery and environmental objectives. Based on the above it was considered prudent to continue planning based on either use of cement plants or SSI. Formal consultation with the cement plant operators was recommended to confirm their potential interest for receiving wastewater sludge. It was advised to continue to follow development of pyrolysis in case further development resulted in an enhanced and more cost-effective version of the technology in the short to medium term.

6.2 Advanced thermal conversion technology (ATC) overview

Advanced thermal conversion technologies use heat to convert wastewater sludge into alternative products with different potential outlets.

Conventional thermal incineration requires sludge to be dewatered to a minimum of 25 to 35% dry solids for the process to be self-sustaining which means no external heat input is required after start- up. Fuel is always required during start-up and is normally required intermittently as the solids content and calorific value of the feed varies. 65% to 75% of the wastewater sludge is combustible.

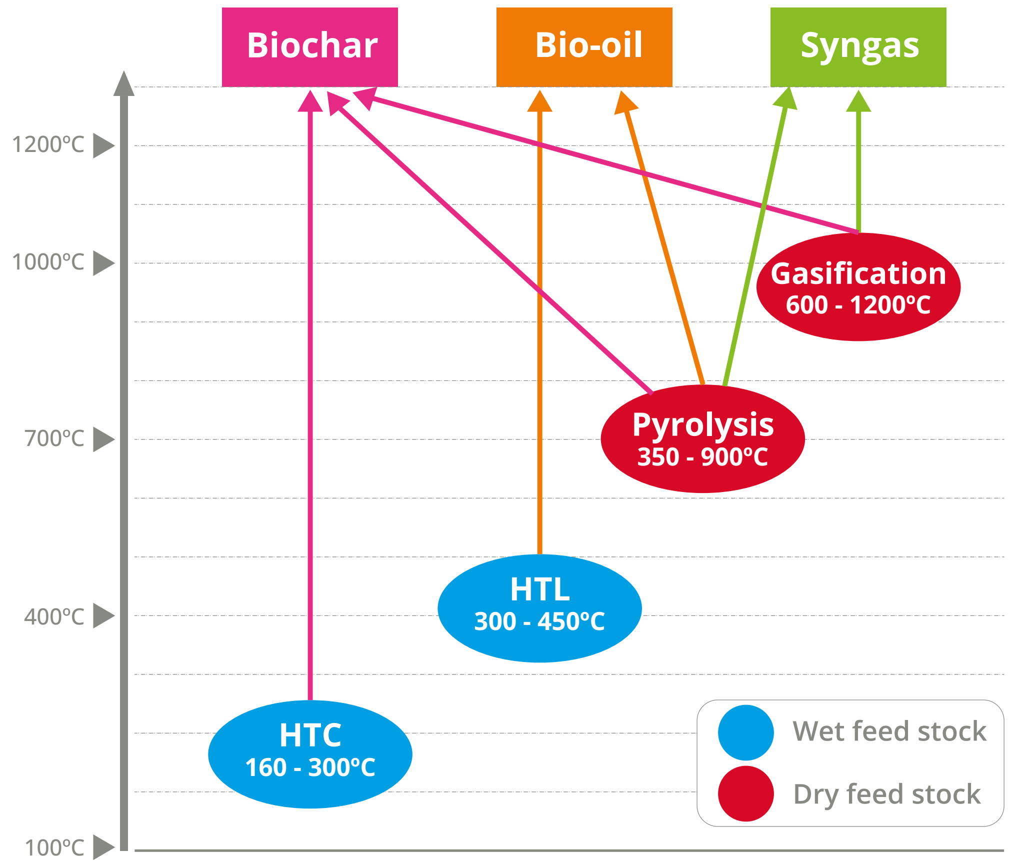
There is a potential for recovery of struvite from the ash. However, this is normally only viable in large-scale installations with mono-incineration of wastewater sludge only. Incineration has high capital and operating costs with limited energy recovery. A recent review by United Utilities in the UK concluded that energy recovery is optimised by using advanced digestion upstream of incineration rather than incineration of raw sludge. The possibility of co-incineration with other waste forms can also be considered.

Advanced thermal conversion technologies, all currently at varying levels of technology readiness levels (TRLs), development and deployment include the following:

- Gasification
- Pyrolysis
- Hydrothermal Carbonisation (HTC)
- Hydrothermal Liquefaction (HTL)
- Hydrothermal Gasification (HTG)
- Supercritical Water Oxidation (SCWO)
- Wet air Oxidation (WAO)

These processes have a range of feedstock phases, feedstock dry solids concentrations, operating temperatures, thermodynamics, and outputs.

Process ranges of ATC Technologies and Potential Outputs



(Reference: UKWIR AtkinsRéalis, Sewage Sludge to Biochar Report, 2022)

Gasification

Gasification thermally converts the organic matter by partial oxidation in a reducing atmosphere in the presence of steam at high temperatures to convert the feedstock to a synthesis gas (syngas), and some biochar. Gasification occurs at elevated temperatures normally more than 800°C; however, gasification occurs best at higher temperatures of more than1000°C.

Pyrolysis

Pyrolysis is the thermal conversion of organic matter at elevated temperatures in the absence of oxygen. The feedstock needs to be dried before pyrolysis, and both raw sludge and digestate are compatible feed stocks for pyrolysis. The process converts organic matter into bioresources such as biochar, bio-oil, and a synthetic gas (syngas). The type and quantity of each resource is dependent on the operating temperature, which can be tailored to maximise production of the desired bioresource.

Slow pyrolysis operates at lower temperatures (less than 450°C) and higher hydraulic retention times (HRT), and the biochar is maximised. A large proportion of the carbon, hydrogen and volatiles are fixed in the biochar and there is the potential to recover Phosphorus from the biochar. There is a high dry solids feedstock requirement at 90% DS[20].

Fast pyrolysis takes place at higher temperatures. At mid-level temperatures between (450-550°C) the bio-oil is the main product with a small amount of biochar produced. Bio-oil can be combusted to produce heat, steam, or electricity, or it could be upgraded to produce a renewable transport fuel. The feedstock dry solids (DS) requirement is between 50-80% DS. At higher temperatures (more than 600°C) and lower HRT the syngas is the main product with a small quantity of biochar also produced. The dry solids requirement for higher temperature process is between 50-66% DS.

Hydrothermal Carbonisation (HTC)

HTC is the hydro-chemical conversion of organic feedstock into a hydrochar at temperatures in the range of 200-500°C, at 15-270 bar pressure in an aqueous state. The process is like the natural conversion of organic material into coal over millions of years. Hydrochar is a similar material to coal in that it can be used as a solid fuel. An advantage of this over other advanced thermal conversion processes is that drying is not required up-stream and the feedstock DS can range from 5-30% DS.

HTC processes can also be enhanced by the addition of catalysts into the reactor. Process water or liquor is produced which is rich in organic and inorganic salts, and there are possibilities to recover nitrogen or phosphorus

There is potential to upcycle the biochar to activated carbon which can be used as a filter material for reuse in tertiary or quaternary wastewater treatment. Once the activated carbon has been fully utilised it can be regenerated in the pyrolysis plant for reuse in the filtration unit. Making use of biochar as an activated carbon filter for quaternary wastewater treatment not only ensures circularity and maximisation of resource recovery, but it will also assist us in meeting upcoming quaternary treatment and increasing circularity requirements in the rUWWTD.

[20] 2022: Converting Sewage Sludge to Biochar: a review of options and feasibility (Atkins, Cranfield University)
[21] 2022: Converting Sewage Sludge to Biochar: a review of options and feasibility (Atkins, Cranfield University)
[22] 2022: Converting Sewage Sludge to Biochar: a review of options and feasibility (Atkins, Cranfield University)

from the liquor streams back to the digestion process to enhance biogas production. HTC produces a small quantity of gas composed mainly of carbon dioxide with smaller quantities of carbon monoxide[21]. Depending on quantities produced there could be potential to recover bio carbon dioxide for reuse.

Hydrochar is produced at lower operating temperatures than biochar and therefore does not promise the same benefits of total elimination of contaminants such as PFAS compared to pyrolysis or gasification. However, it does have the ability to be dewatered without requiring thermal drying and therefore could be seen as an alternative to biosolids for land application[22].

6.3 Current status of thermal drying and efficient drying options

Since the thermal sludge treatment study was carried out in 2019 (Section 6.1) a significant number of the sludge dryers at our sites are not in operation due to high operational energy requirements, high maintenance requirements, poor asset condition, ATEX[23], operational issues (odour, sludge consistency) and/or asset failure.

There is a synergetic relationship between efficient thermal drying and advanced thermal conversion technologies. We will incorporate efficient low temperature thermal drying as a pre-treatment with ATC technologies that require a dried sludge feed to optimise resource recovery and promote valorisation of the bioeconomy.

There are opportunities to optimise integration of efficient drying and ATC technologies into the existing asset base with digestion. We will develop energy and heat strategies and support heat recycling on-site. These technologies can be optimised to balance the benefits of each of the technology processes to maximise energy and resource recovery whilst reducing the volume.

Examples of efficient low energy thermal drying options:

- Low temperature air belt dryers
- Application of rapid heat through initial stages of composting
- Infrared drying
- Solar-Regenerative Dryers utilise solar energy as well as low-temperature heat
- Contact disc dryers
- Thin film sludge dryers
- Solar sludge drying based on combined solar drying and bio-drying in a greenhouse under continuous ventilation with dry air
- Air drying supplemented with waste heat drying indoors.

[23] ATEX (Atmospheres Explosive)

6.4 More recent developments and studies on ATC technologies

Since the existing NWSMP was adopted a lot of research and development has been carried out on advanced thermal conversion technologies in the water sector with some examples noted below. Technology readiness levels have advanced and there are full scale technologies in operation at WWTPs. Pyrolysis technology is available and installed at medium scale WWTP facilities (circa 200,000 P.E.) currently.

Given the challenges we face and recent regulation changes such as the rUWWTD requirements, we will progress an advanced thermal conversion (ATC) demonstration and implement ATC technology at our larger sites. Installing such technologies can assist us in meeting new energy and climate neutrality targets and increased circularity by recovering valuable components from wastewater sludge.

To ensure we follow all new developments we participate as project steering group members on UKWIR desk-based research studies such as:

- **2022:** Converting Sewage Sludge to Biochar: a review of options and feasibility[24]
- **2023:** Biosolids to Land: Carbon Emissions and Carbon Capture[25]
- **2024:** Response to National Bioresources Strategy – Prioritisation of Resource Recovery Opportunities[26]

We also keep up to date with progress and studies and alternative approaches to biosolids reuse options through reviewing studies and reports such as 2023: 'Developing a Long-term Strategy for Bioresources in England[27]', and 2025 UKWIR CIP4 Microplastics and Advanced Thermal Conversion Phase 1 project. These more recent studies show how advanced thermal conversion technology research within the water sector has advanced in recent years, and research and technology developments are on-going. Further details on research and innovation around bioresources management is detailed in Section 12.

[24]https://ukwir.org/converting-sewage-sludge-to-biochar-a-review-of-options-feasibility-0 (Atkins, Cranfield University)

[25]https://ukwir.org/eng/final-report-for-biosolids-to-land-carbon-emissions-and-carbon-capture (RSK ADAS Ltd., WRc)

[26]https://ukwir.org/response-to-national-bioresources-strategy-prioritisation-of-resource-recovery-opportunities (AtkinsRéalis, CIWEM, Cranfield University)

[27]'Developing a Long-term Strategy for Bioresources in England' (Water UK, CIWEM, Atkins)

7 | Wastewater sludge and bioresources transport strategy

Transportation is a significant aspect of wastewater sludge and bioresources management in terms of environmental, social, and financial impacts. The transportation strategy must be sustainable, considering carbon footprint and potential impacts in terms of traffic, odour, and noise.

We have a significant number of small WWTPs in our asset base; approximately 75% of WWTPs are less than 2,000 P.E. At our smaller WWTPs, transport accounts for a large proportion of the total costs associated with treatment. We use licenced waste transport operators with full traceability and have standard operating procedures to optimise desludging and liquid sludge removal.

7.1 Existing sludge transportation

The total volume of sludge from our WWTPs is circa 1,000,000 m3/yr[28]. The volume of sludge varies depending on the treatment type and the use of thermal drying facilities. The transport costs can vary depending on the WWTP location.

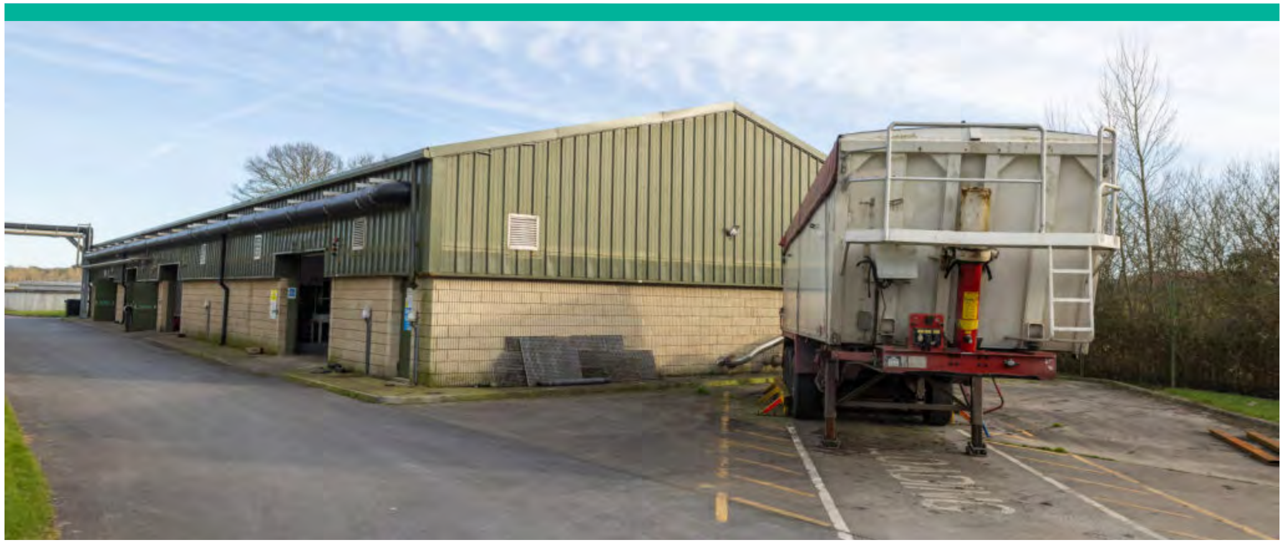
UÉs Sludge Framework contractors carry out all elements of the works related to the transportation of sludge in accordance with current legislation, regulations and the requirements set out within the Code of Good Practice. Further details on key legislation relating to transport can be found in Appendix A.

7.2 Wastewater sludge and bioresources transport strategy

Reducing treated sludge transport has benefits in terms of reducing greenhouse gas emissions due to reduced fuel, however this needs to be balanced against the lifecycle cost and environmental and social impacts of additional sludge infrastructure at a higher number of sites, and additional staff transportation required to operate and maintain equipment.

Where practicable, bioresources are transported and spread on the nearest suitable spread lands to the WWTP. This needs to be supported by suitable strategic storage for periods when land spreading is not allowed. Storage could be accommodated at Bioresource Centres or at dedicated storage facilities.

To optimise our Bioresource transport and treatment strategies we have developed a National bioresources strategic Decision Support Tool (DST)*. The tool will enable us to evaluate and make informed decisions on our National bioresources assets. We will continue to develop this to optimise transport strategies and ensure low carbon transport.



[28]Wet tonnes based on 6% DS

*In collaboration with Business Modelling Applications

The decision support tool includes all our wastewater sludge treatment and bioresource centre assets and it gives us the following capabilities:

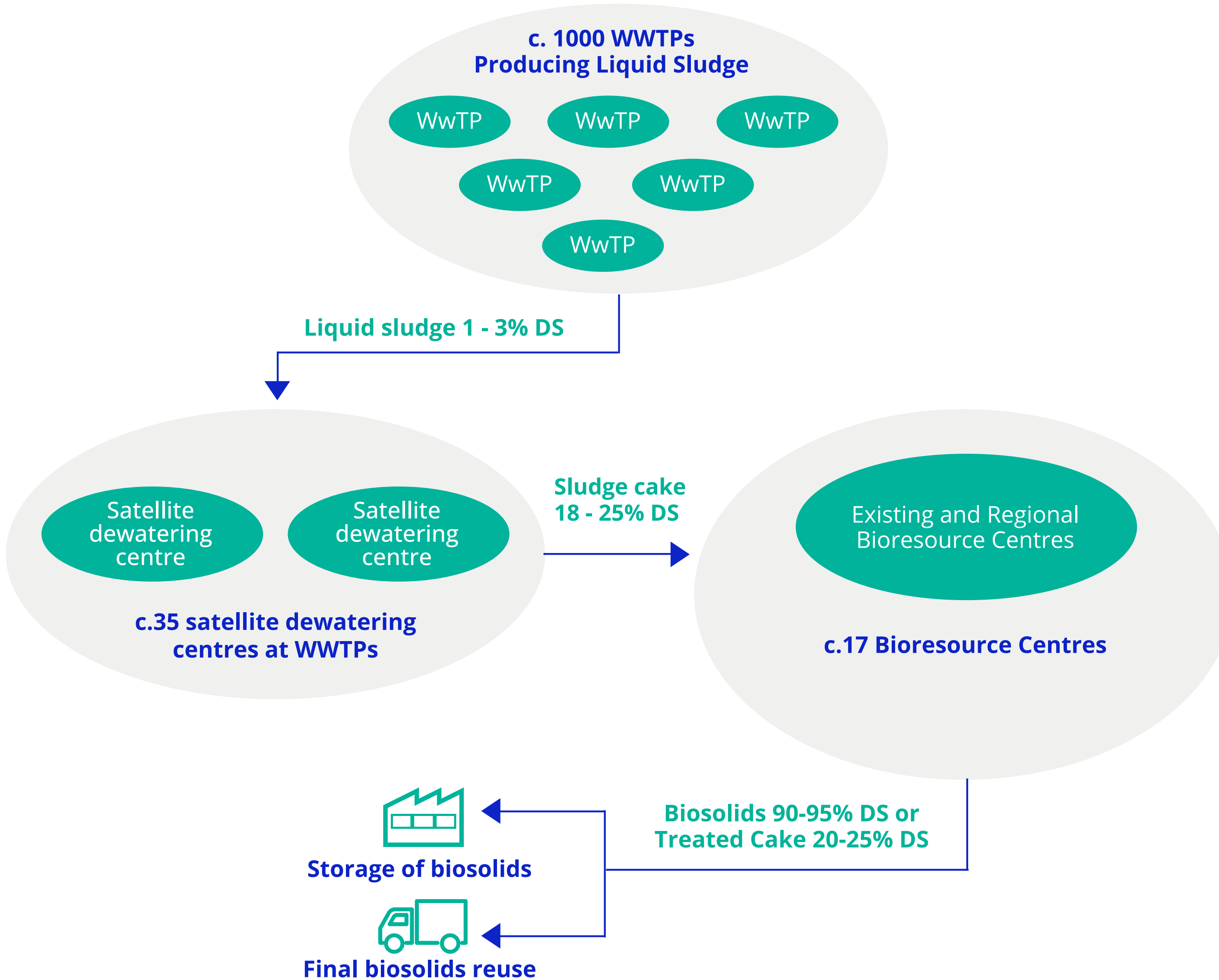
- Represent the end-to-end bioresources value chain
- Generate multiple strategic and operational scenarios to enable adaptive planning
- Energy, Carbon and Net Zero assessment
- Represent impact of time on critical factors (growth, increasing standards, emission factors, energy costs, transport costs)
- Optimise investment decisions including new assets, upgrades, or decommissioning against multiple key performance indicators
- Evaluate impact of new technologies such as ATC
- Assess and optimise transport and storage requirements
- Demonstrate holistic asset management approach

National bioresources decision support tool (Business Modelling Applications Interface)

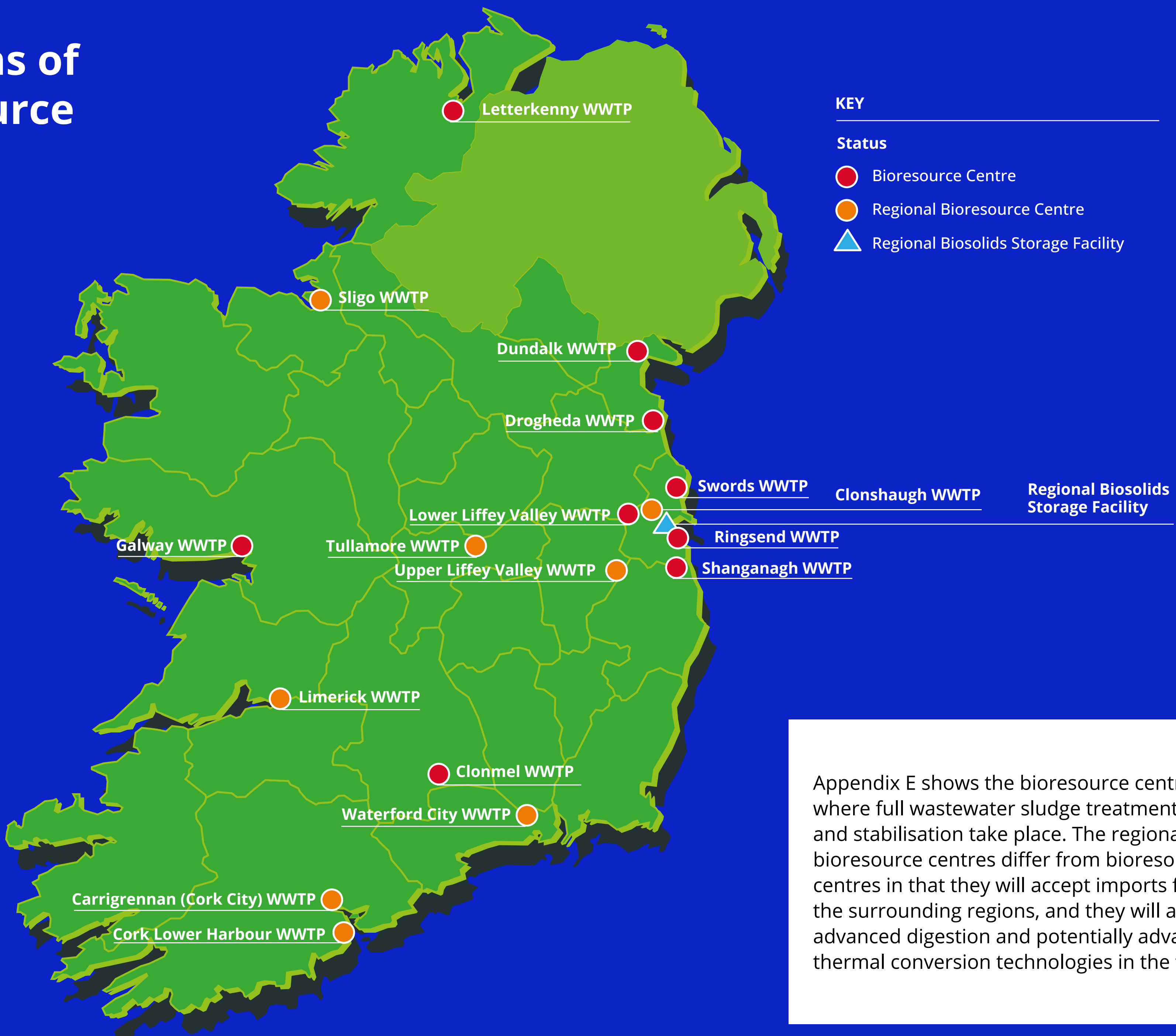
8 | Bioresource centres infrastructure

Bioresource centres (BCs) and satellite dewatering centres (SDCs) drive operational efficiencies and optimise the balance between treatment and transport costs by reducing wastewater sludge volume. Wastewater sludge from our rural WWTPs is transported at circa 1-3% dry solids to intermediate SDCs where sludge is dewatered to circa 18-25% dry solids prior to transfer to the bioresource centres for final stabilisation and treatment. Dewatering sludge reduces onward transport costs, transport carbon emissions and traffic movements.

This infrastructural approach allows for economies of scale and flexibility in the treatment process selection, particularly around energy and resource recovery technologies, and assists in terms of monitoring and quality control of the bioresource outputs.



Locations of Bioresource Centres



Appendix E shows the bioresource centres where full wastewater sludge treatment and stabilisation take place. The regional bioresource centres differ from bioresource centres in that they will accept imports from the surrounding regions, and they will all have advanced digestion and potentially advanced thermal conversion technologies in the future.

8.1 Satellite dewatering centre infrastructure

Liquid sludge from smaller WWTPs and septic tank sludge from private contractors is imported to our satellite dewatering centres. Some WWTPs have sludge acceptance facilities with screening and storage facilities. A sludge acceptance screen is needed where acceptance of sludge occurs from septic tanks or smaller WWTPs without fine screens.

Satellite Dewatering Centres require suitable reception facilities for importation of liquid sludge. This includes as a minimum:

- Screening and screenings handling
- Flow measurement of imported sludge
- Sludge balancing tank
- Capacity for mechanical thickening of imported sludge
- Dewatering facilities with sufficient capacity
- Tanker unloading bays with a tanker turning circle
- Odour control equipment

BCs and larger SDCs may require additional facilities including additional tanker unloading bays, sludge blending tank, or a weighbridge. To reduce risks on final effluent or sludge quality, all sites accepting sludge imports use standard operating procedures to control the quantity and type of sludge imported.

8.2 Bioresource storage facilities

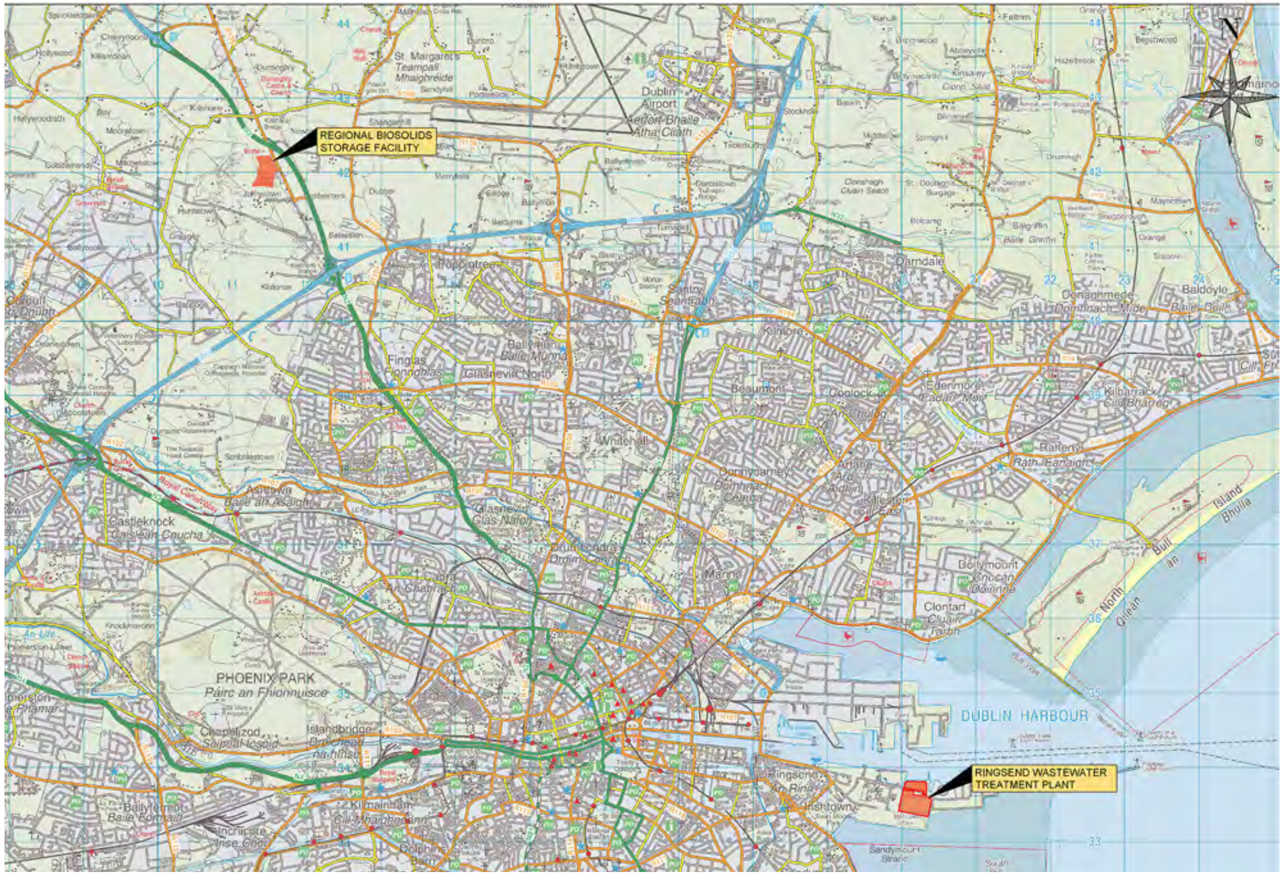
There is a need for storage facilities during periods when application of biosolids to land is not allowed during winter months from October to February as required by the Code of Good Practice. In recent years the period of land spreading availability has decreased due to changing climate conditions and heavier rainfall events leading to waterlogged land. These conditions have resulted in challenges around bioresources management and pressures on storage capacity.

To ensure storage requirements are met nationally, we will provide additional storage facilities to facilitate the predicted increase in sludge as new and upgraded plants are completed. We will identify strategic storage locations nationally, and these may be located at the BCs or at a separate facility.

The need for additional storage capacity was identified during the planning stages of the Ringsend WWTP upgrade programme and the planning of the Greater Dublin Drainage (GDD) project. To meet this need for storage capacity, the Regional Biosolids Storage Facility (RBSF) was designed and granted planning permission by An Bord Pleanála as part of the planning consent for the Ringsend WWTP project. Phase 1 (Storage Building A) of the project is complete, and Phase 2 (Storage Building B) is due to be completed in December 2026.

The storage facility is designed to serve Dublin for the next 25 years and is an example of how we will achieve efficiencies over the long term. The RBSF is located in North Dublin, near the junction of the N32 and M50.

Location of the Regional Biosolids Storage Facility



The storage facility (when both Phase 1 and Phase 2 are completed) will include 2 no. 5,250m2 biosolids storage buildings with associated site facilities and provision for expansion. Each odour-controlled storage building will consist of 12 storage bays to allow separation of varieties of biosolids, loading and unloading facilities, and an administration building providing office and welfare facilities.

The location and size of any additional storage facilities nationally will require detailed site assessment including AA. The site selection process and assessment of potential environmental impacts will be undertaken in line with regulations and biosolids storage facilities must be registered in accordance with S.I. No. 32/2010 - Waste Management (Registration of Sewage Sludge Facility) Regulations, 2010. Storage at a WWTP or a waste licenced facility is excluded from this requirement for registration.

Regional Biosolids Storage Facility during the construction phase

9 | Regional bioresource centres infrastructure

The existing NWSMP considered upgrades and investment based on Local Authority area Sludge Management Plans (SMPs) as a starting point. Circa 25 treatment centres were identified across Ireland. We have reviewed and quantified the long-term investment needs for our bioresource assets and will work to secure funding to meet our needs.

9.1 Future approach and adaptive planning

Using a combination of approaches, we considered the long-term future scenarios and challenges and through an adaptive planning approach we have identified 6 preferred regional bioresource centres for investment and development nationally.

A feasibility study was carried out to review and select suitable regional bioresource centre locations. The site selection methodology and outputs are summarised in Section 9.2.

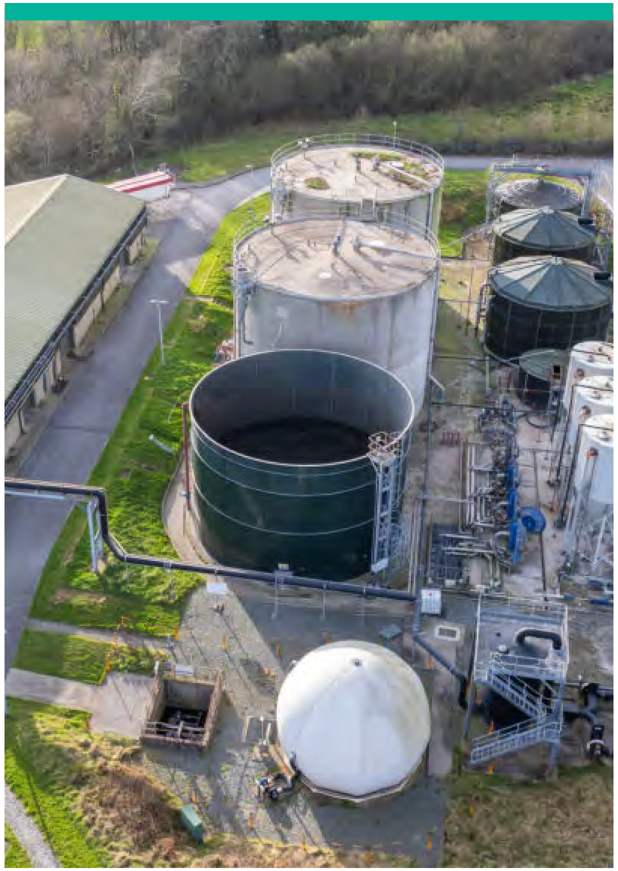
Further to this study we used the decision support tool to run strategic scenarios to check and support our key strategic decision-making framework, considering investment planning. The tool allows us to develop internal adaptive planning capabilities, giving us the means to consider uncertainty and to create a more agile decision-making process.

9.2 Regional bioresource centre feasibility study overview

The study focused on WWTPs in three defined areas (Northwest, South, East) for the site selection of the regional bioresource centres. The site selection methodology considered technical, environmental, planning, and financial criteria. A review of other constraints such as an existing operational contract was also considered. Site characteristics such as restricted access, risk to Natura 2000 Sites, impacts on receptors, availability of space and economic feasibility were considered in the final site selection. The assessments involved desktop studies and visual surveys and, were carried out on a standalone basis for each site initially. A comparative assessment was then carried out for all sites for each criterion.

The selection of the preferred site was based on advantages and disadvantages of the potential sites, relative to each other in accordance with the defined assessment criteria. This comparative assessment assigned either more favourable, less favourable, or neutral classifications to each site for the criteria identified. For each of the criteria, a qualitative approach was applied in determining selection indicators. The selection of the final preferred site(s) was based on a cumulative consideration of the selection indicators.

Following the comprehensive technical, environmental, and economic comparative assessment's, Cork, Limerick, Waterford, Tullamore, and Sligo WWTPs were selected as regional bioresource centres.



Regional bioresource centres feasibility study conclusions

Feasibility Study Areas

South | East | Northwest

↓

Multi Criteria Analysis

Technical	Land availability; Load & capacity; Imported sludge capacity; Treatment process capacity; Energy efficiency; Discharge authorisation requirements; Service & utility connections; Site access.
Environmental	Biodiversity receptors; Site biodiversity; Geology & hydrogeology; Hydrology; Odour; Noise.
Planning	Land use zoning; Core strategy; Adjoining land use.
Financial	Financial appraisal.

↓

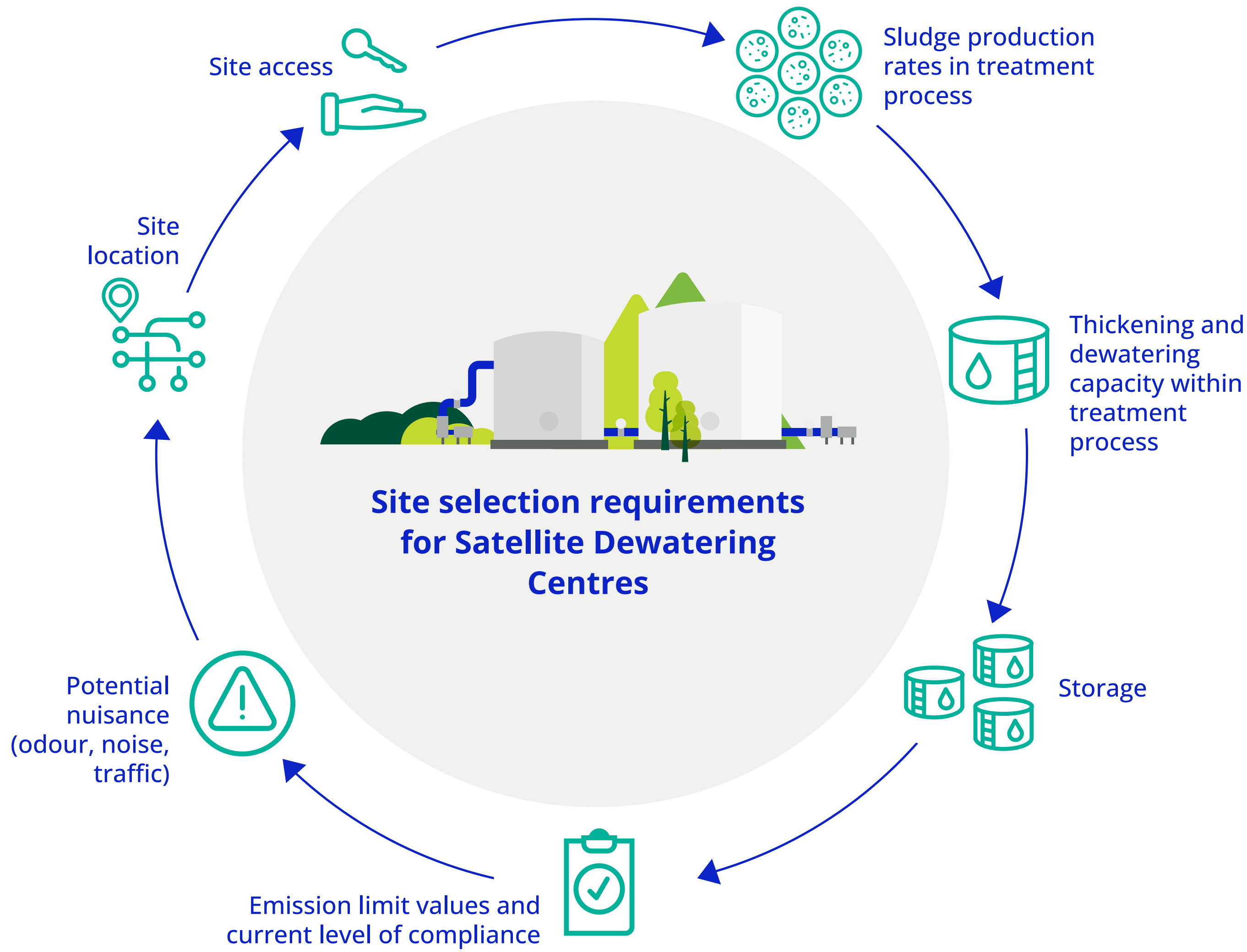
Cork WWTP | Limerick WWTP | Waterford WWTP | Tullamore WWTP | Sligo WWTP

9.3 Investment in satellite dewatering centres (SDCs)

The existing NWSMP identified potential satellite dewatering centres across Ireland to be developed within the 2040 horizon timeline. Some of the planned infrastructural upgrades were to be carried out in phases, and the satellite dewatering centre upgrades are at various stages of development.

Since the existing NWSMP we now utilise adaptive planning and the decision support tool (DST) to identify and prioritise optimised SDC site selection considering transport, logistics, emissions, and available capacity. We have run numerous strategic scenario assessments within the decision support tool, and it selected circa 35 SDCs for prioritisation.

Site selection requirements



10 | Bioresources reuse in alternative non-agricultural land options

All our treated biosolid bioresources are reused in agriculture. Alternative options to this include ATC technologies, reuse in Industry, reuse in non-agricultural land options or export[30]. To demonstrate increased resilience, mitigate risk of reduced agricultural land bank availability, and to meet our sustainability ambitions we have reviewed and are progressing alternative options such as ATC technologies and alternative non-agricultural land outlets. A Bioresources Response Plan will also be developed to mitigate risk of reduced land bank availability, and we will implement alternative uses if there is a change to the current reuse outlet.

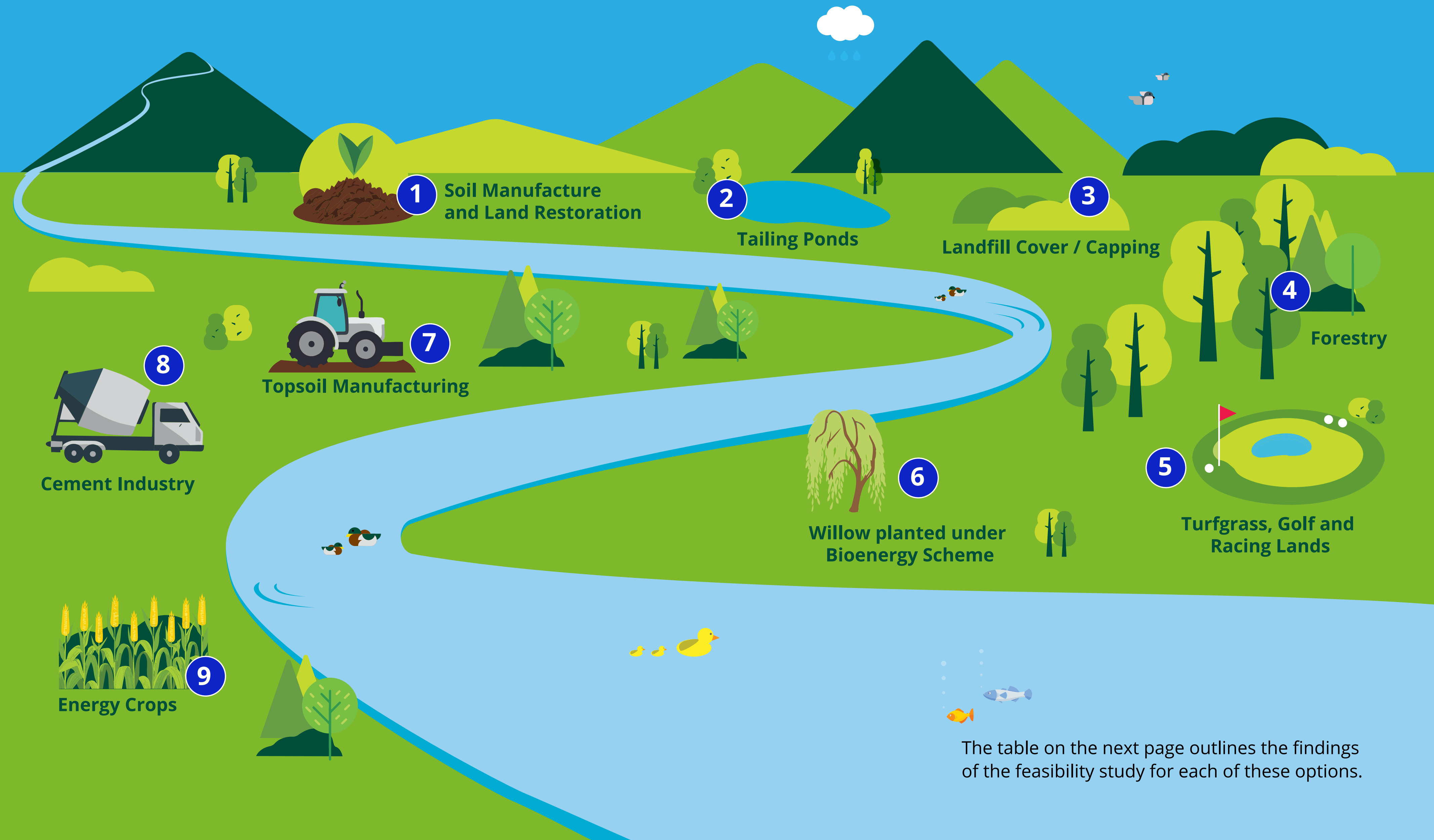
10.1 Feasibility study on reuse in non-agricultural land

Bioresources from wastewater sludge have several re-use options on non-agricultural lands. A feasibility study of alternative non-agricultural land use options for biosolids reuse was carried out to identify and quantify potential alternative land use outlets. The study assessed the availability and suitability of several land-use categories.

[30] Export outside of the Country will only be considered as a short-term emergency option if all other outlet options are exhausted.

Non-agricultural land-use options for bioresources

Bioresources from wastewater sludge have several re-use options on non-agricultural lands



The table on the next page outlines the findings of the feasibility study for each of these options.

Bioresources re-use options on non-agricultural lands

	Land types	Potential reuse options
1	Soil manufacture and land restoration	Brownfield lands and or contaminated land, including mines restoration, landfill capping and Irish bog restoration.
2	Tailing ponds	Tailing ponds restoration are incorporated into a soil mix, limed stabilised biosolids could form a proportion of the topsoil depending on soil conditions and quality, plant tolerances and manufacturer recommendations.
3	Landfill cover/capping	Biosolids could form part of the topsoil required for capping, depending upon soil conditions and quality, plant tolerances, and manufacturer recommendations.
4	Forestry	Potential biosolids use during planting to sapling growth, canopy closure, weed reduction via mulching effects and act as a substitute fertiliser during crop rotation stages.
5	Turfgrass, golf and racing lands	Applications of turfgrass, golf and racing lands would be very site-specific.
6	Willow planted under bioenergy scheme	Short rotation coppice crops, maybe suitable for biosolids applications.
7	Topsoil manufacturing	Topsoil manufacturing blends soils with other organic or inorganic materials to produce soil for a specific site or market. Topsoil manufacture can be applicable in end uses such as in woodland and grassland establishment, energy crop production, general landscaping, housing and mixed-use development, and recreation and sports turf.
8	Cement industry	Act as a substitute ingredient.
9	Energy crops	Energy crops are typically low maintenance, high yielding plants grown for biomass to use as a source of energy. Some crops are burned as a fuel source for electricity or heat production. Grass and maize are digested for biogas generation. Energy crops have been flagged as a high-potential sector.

We are at varying stages of progressing these alternative outlets. It should be noted that some outlets can take a significant amount of time to develop and key drivers are policy, legislation, and testing requirements.

11 | Bioresources monitoring, reporting and quality assurance

We manage all our wastewater sludge and bioresources throughout the asset lifecycle to meet our regulatory requirements. Monitoring and reporting is required for each step of the treatment process to ensure a quality biosolids bioresource product. There are several statutory requirements for monitoring and reporting of sludge management activities which we undertake as described below.

11.1 Bioresources monitoring requirements

We will continue our on-going regulatory monitoring, traceability pack system and nutrient management plans (NMPs) review. We will also ensure that all new regulatory requirements are met, such as enhanced monitoring outlined in the rUWWTD. We are engaging with regulators and stakeholders regarding the development of a revised Code of Good Practice for the Use of Biosolids in Agriculture, and we will implement a national emerging contaminants monitoring programme and carry out additional monitoring on emerging contaminants as needs emerge.

We have developed SOPs and control procedures to ensure that the wastewater sludge and bioresource treatment and reuse process is controlled and monitored. We will develop an SOP that will set out best practice for the use of biosolids reuse on land which we will distribute to our contractors. We will implement and embed these SOPs for effective wastewater sludge and bioresource treatment assets.

11.2 Bioresources reporting requirements

Every year, we report on treated wastewater sludge and bioresource quantities and information as part of the annual sludge returns data returned to the EPA. The data reported includes site name, quantity, treatment type, monitoring results, and final reuse location. We have developed an online reporting system for all sludge data, and all data is also reported in the EPA Annual Environmental Reports (AERs) for all licenced WWTPs.

11.3 Quality assurance

We have completed a feasibility study identifying key stakeholders, operating costs and on how a quality assurance scheme would be implemented. To ensure that the risks are adequately addressed, we will implement an independently audited quality system such as a Biosolids Assurance Scheme (BAS) for biosolids bioresource management activities. The development and implementation of a BAS will provide stakeholder reassurance on the protection of the environment and increase the acceptability of biosolids recycling to agricultural land. We will develop a culture of acceptance, community education and awareness regarding quality assurance and circularity of bioresources.

The BAS Standard will enable full transparency and encompass all key aspects required of a quality assurance system covering regulatory requirements, treatment, monitoring, recording, reporting and SOPs implementation.

Biosolids Assurance Scheme

The benefits of implementing a biosolids assurance scheme include:

- Providing satisfactory stakeholder reassurance that biosolids recycling is safe and sustainable;
- Increasing the acceptability of biosolids recycling to agricultural land;
- Enabling biosolids to be sustainably recycled to agricultural land;
- Enabling investment in treatment and biosolids recycling to agricultural land;
- Enabling the most cost-effective route with the lowest carbon footprint;
- Conformance with the scheme should imply regulatory compliance providing reassurance to the regulators;
- Providing environmental protection;
- Sequestering carbon into soil and improving soil health.

11.4 Auditing

Compliance with the Code of Good Practice is currently a requirement for our bioresource management contractors. To ensure that all sludge treatment and reuse complies with this, auditing of contractor's activities is carried out. The timing of this is planned to allow auditing of activities during land spreading periods.

11.5 Biosolids mapping

The Department of Agriculture Food and Marine (DAFM) has rolled out an online organic nutrient movements system designed to address requirements under the Nitrates Regulations. This new portal will help record organic nutrient movements across farmlands, and the IT infrastructure is being upgraded to capture information on spreading lands where stabilised biosolids are reused on agricultural land. We will support and feed data into the online reporting portal as it is developed and will ensure all necessary information on spreading lands is provided as needed.

Uisce Éireann are working with the EPA on spread land mapping. As part of UÉ engagement with DAFM and the EPA a map will be produced which identifies sensitive lands and their suitability for land spreading.

Recently, an amendment to the Sewage Sludge Directive (SSD)[31] included a requirement for Member States to report the geographic location or geometry to identify the places where biosolids are reused on land. We will work closely and collaborate with the Department of Housing, Local Government and Heritage (DHLGH) to assist with this European spatial data request.

[31] Regulation (EU) 2019/1010 of the European Parliament and of the Council of 5 June 2019 on the alignment of reporting obligations

12 | Bioresources research and innovation

Ongoing research is being carried out internationally into options for resource recovery and valorisation of treated wastewater sludge and bioresources. As mentioned in Section 4 wastewater sludge contains valuable resources such as energy and nutrients that can provide bioresources for the bioeconomy and assist us in meeting our sustainability ambitions.

Emerging and innovative technologies can provide new cost-efficient and efficient solutions for sustainable bioresources management. Research into new technologies that provide sustainable outlets with low-energy consumption and energy, and nutrient recovery can provide more sustainable options for bioresources management in Ireland.

12.1 Research and innovation actions

The research and innovation actions will provide a focus for reviewing, trialling, and testing innovation within our bioresources assets in:

1. energy reduction and recovery;
2. treatment processes to achieve compliance;
3. nutrient recovery and reuse;
4. infrastructure rehabilitation or upgrade;
5. monitoring and automation;
6. climate change adaptation or infrastructure resilience.

Research and innovation will be delivered through collaboration with:

- Academic institutions (for example DCU, UCD, NUIG, MTU, DIT, UL, NUIA),
- National research bodies (for example EPA, Teagasc, Enterprise Ireland (EI), Science Foundation Ireland (SFI), The Greenway)
- Other research organisations (for example WRc plc, UKWIR, Ofwat, Aqua Publica Europea),
- Participating in EU Networks/Action Groups, EU Horizon 2020 and INTERREG funding programmes to pursue research and innovation opportunities and
- Engaging with other water utilities (including Scottish and Northern Ireland (NI) Water) to develop research and innovative bioresources technologies, processes, or systems.

12.2 Bioresource research areas of interest

Research and innovation around bioresources management has accelerated significantly in recent years and continues to grow.

Technologies that can reduce sludge volume and quantity whilst optimising resource recovery are important. Key areas of interest for UÉ to gain further knowledge in are as follows:

Treatment Technologies

ATC, AD & AAD (e.g., THP, MHP, BH, pasteurisation), efficient thermal drying, dewatering and nature-based solutions.

Bioresources

Nutrients – Phosphorus, Ammonia, Nitrogen, Struvite, Biosolids, Biochar. Energy: Biogas, Biomethane, Hydrogen, CO2, Bio-oil, Energy (heat and electricity), Others: VFAs, Enzymes, Metals.

Emerging contaminants of concern

PFAS, PFOS, Microplastics.

GHG and Process Emissions

CO_2, N_2O, CH_4.

Research themes

Carbon capture, net zero, circular economy, biodiversity, resilience and efficiency, land and soil, energy, climate change, sustainability.

Advanced Digital Technologies

Digitisation, process modelling, AI, decision support tools, risk assessment modelling.

Efficient and relevant bioresource technologies that have been trialled, proven and subsequently developed to commercial scale can be considered for use on our sites.

12.3 Bioresource research projects involvement

We are involved in many bioresource research and innovation projects to support advancements in the sector.

Previous research projects involvement

Innovation project title	Strategic theme
Wastewater Sludge Treatment Reedbeds - Carlow County Council No.5	Environment Biodiversity
Nutrient removal (phosphorus and ammonia) at WWTPs	Resilient and Efficient Services
Converting sewage sludge to biochar - a review of options and feasibility	Circular Economy
Biosolids to land - carbon emissions and carbon capture	Circular Economy
Response to National Bioresources Strategy - prioritisation of opportunities	Circular Economy
Urban Bio-Waste Workshop (UrBioPro)	Circular Economy

Current research projects involvement

Innovation project title	Strategic theme
Terrachem	Emerging Contaminants
Safewaste	Emerging Contaminants

Future research projects involvement

Innovation project title	Strategic theme
Proving the concept sewage sludge pyrolysis	Circular Economy
Biopolymers in the circular economy (BICE)	Circular Economy
Using heat of WWTP to generate district heating	Energy
Transforming bioresources: The benefits of biochar	Circular Economy
Sewage sludge gasification	Climate
Biochar application in SRBs: potential for increased treatment efficiency and sustainability	Resilient and Efficient Services
Ecosystem-scale multi-omics to explore hidden biodiversity, evolution, and function	Environment Biodiversity

Key research and innovation area - advanced thermal conversion technology pyrolysis

Case study – Advanced thermal conversion research study Visit

We carried out a research study visit to an operational pyrolysis plant in at Fårevejle Municipal WWTP, Denmark in 2023 to review its integration into an existing WWTP site. The AquaGreen technology is an integrated drying and pyrolysis process that operates at 650°C. The unit has a design capacity of 1,000 tds/y equating to 50,000 P.E. (e.g. Tullamore 45,000 P.E.) and produces approximately 400 t/y of biochar. The biochar produced contains 5 – 6 % P-total and 2 – 3 % N-total. The process integrates steam drying of the wastewater sludge (feed stock approximately 22% – 25% DS) which is heated from burning the pyrolysis gas.

The pyrolysis process is operated to minimise condensate oil production, and the oil is burnt directly with the pyrolysis gas. A ceramic gas burner with gas scrubber ensures low atmospheric emissions (Nox <limit values). Energy is used to heat the sludge dryer (so generating steam), with excess energy recovered at 80°C by steam condensation for district heating (estimated 2000 kWh heat per year at Fårevejle). The unit at Fårevejle is expected to bring approximately 1,500 tCO2-e carbon credits (1,000 – 1,500 for district heating, 400 for carbon sequestered in the biochar), as well as reducing methane and N2O emissions and emissions from saved on reduced volumes to transport (saving 2,000 tCO2e).

Analytical tests carried out on the biochar produced from Fårevejle pyrolysis plant showed removal of PFAS, PAH, pharmaceuticals, and pesticides. PFAS was reduced from 52 µg/kg-PFAS4 in incoming sludge to non-detectable in the biochar, off gas scrubber water and condensate from the dryer. PAH in biochar's produced is c. 0.2 mg/kg (an order of magnitude lower than the 6 mgPAH16/kg limit in the EU Fertilising Products Regulation CMC14).

It was noted in the 'Converting Sewage Sludge to Biochar' report[32] that smaller scale WWTPs can benefit from pyrolysis technologies to produce biochar, thus reducing sludge volume and transportation needs. Also, the bio-oil or syngas can be combusted, and process heat recycled back to the pyrolysis plant in an auto-thermal process. However, if the driver is to produce high-quality syngas or bio-oil products, it is likely that economies of scale will influence implementation at larger sites due to safety related requirements to ensure safer operation at higher temperatures, syngas or bio-oil separation and upgrading technology requirements.

Following recent developments, pyrolysis technology is deployable and scalable. It is a mature technology with a technology readiness level (TRL) 9. Several technology providers have demonstration and operational reference facilities at WWTPs. Examples of plants in continuous operation exist in Germany, Czech Republic, Denmark and Sweden while demonstration plants are operated in, Germany, Italy, Australia, and USA. These plants have capacity within the range of 50,000 P.E. to 200,000 P.E. Higher treatment capacities can be achieved by installing several modular units in parallel. This size range is suitable and scalable within our asset base, particularly within our bioresource centres. However, for a very large scale WWTP the scalability and feasibility of pyrolysis would need to be reviewed based on the currently available capacities on the market. As the technology and research advances the scalability for larger sites will likely be addressed.

Biochar produced from wastewater sludge is excluded from the EU Fertilizing Products Regulation 2019/1009[33] due to uncertainty about elimination of contaminants of concern. However, Article 42 of the Regulations allow for the possibility of amending Annexes I to IV to align with technical progress and scientific evidence that the contaminants do not present a risk to the environment.

In recent years several EU member states have authorised the agricultural use of sludge biochar's in their national regulations under certain conditions for example, Denmark, Czech Republic, Italy, and Sweden[34]. Other non-EU examples include Norway and Australia. The EU countries allowed authorisation by either setting up a regulation that includes biochar or by proving the compliance of biochar with existing national policies.

On-going research and development, in combination with these full-scale operational examples and data from on-going testing and monitoring of biochar's, can feed into a review and potential adaptation of the EU regulations, and drive policy change. As there is potential for gasification or pyrolysis to provide net energy recovery, there is a potential for a lower carbon footprint than other ATC technologies. In the context of critical drivers such as contaminants of concern removal, Net Zero, reducing GHG emission, and increasing circular economy ambitions, ATC technologies such as pyrolysis and gasification, could offer viable sustainable treatment options in Ireland.

To ensure we are prepared for ATC technology implementation we will progress a trial to demonstrate and test ATC to determine its suitability and technical and economic feasibility. The demonstration will also measure the impact in terms of resource recovery and valorisation of the circular economy, sustainability, GHG emission reduction, Net Zero and treatment of emerging contaminants. The demonstration will also help us to navigate through the challenges such as licencing and regulations and end-of-waste status.[35]

[32] https://ukwir.org/converting-sewage-sludge-to-biochar-a-review-of-options-feasibility-0 (Atkins, Cranfield University)

[33] https://eur-lex.europa.eu/EN/legal-content/summary/safe-and-effective-fertilising-products-on-the-eu-market.html

[34] https://nutrient-platform.org/scope-in-print/scopenewsletter/2250-november-2022-scope-144

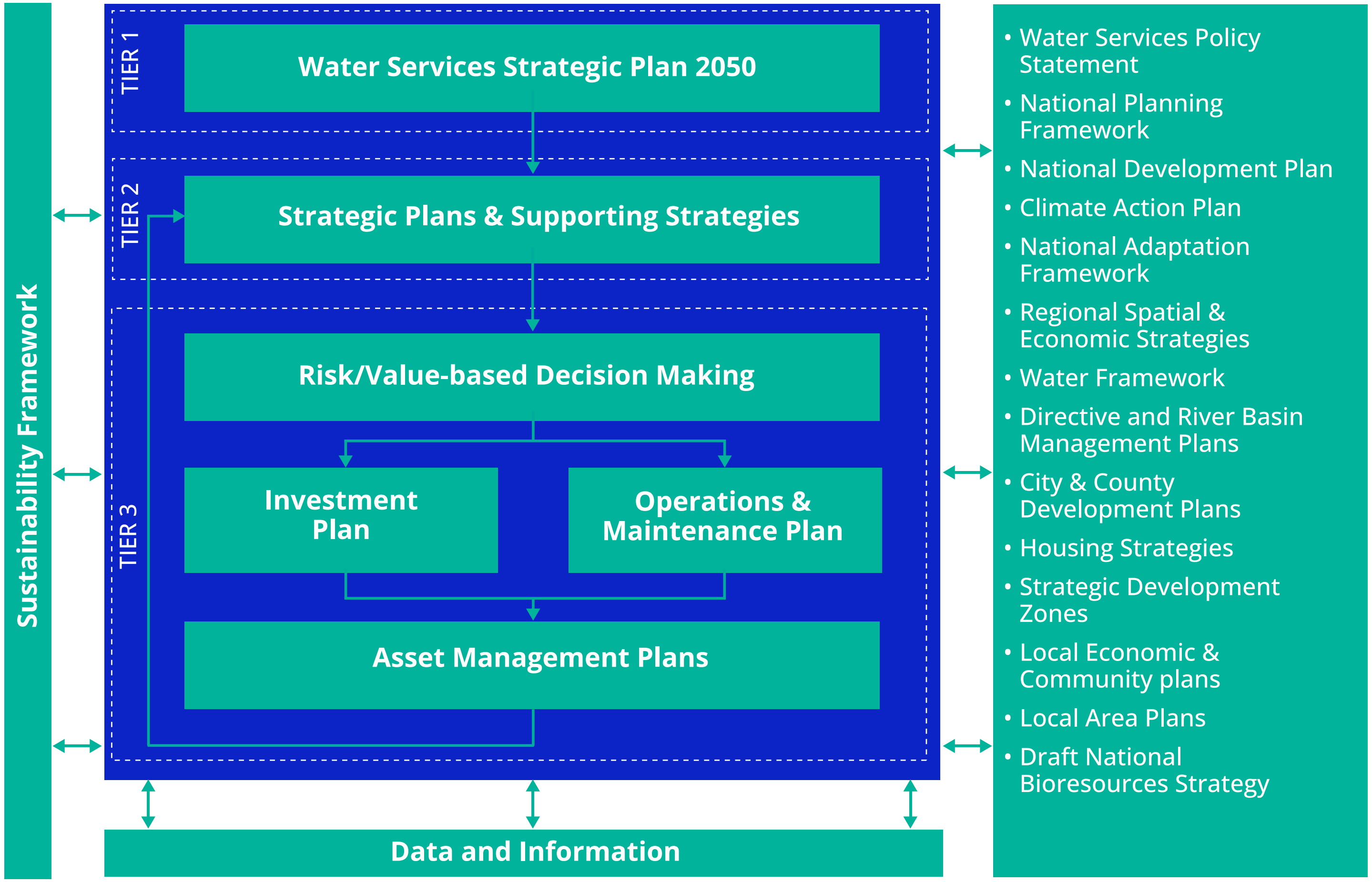
[35] Achieving end-of-waste status for a material means it can cease to be classified as waste which assists in developing opportunities for beneficial applications of waste-derived materials. This mechanism is included in Article 28 of the European Communities (Waste Directive) Regulations 2011.

13 | National Bioresources Strategy implementation

13.1 How we will deliver our objectives

The draft National Bioresources Strategy is a Tier 2 supporting strategy that sits under our overarching Tier 1 Water Services Strategic Plan 2050. The draft NBioS outlines our bioresources strategic objectives and aims and details a set of key actions we will undertake to meet our objectives. The draft NBioS is subject to SEA and AA, including statutory and public consultation.

The WSSP 2050 and our Tier 2 supporting strategies form the basis for our Tier 3 plans that we prepare for each regulatory control period, which is typically 5 years in duration. As the investment needs across the asset base will always exceed the available funding (for the foreseeable future), prioritisation is carried out as part of the investment planning process to ensure alignment with the Government's priorities as set out in the Water Services Policy Statement (WSPS).



The current WSPS covers the period from 2024 to 2030. UÉ prepares a Strategic Funding Plan (SFP) which sets out the funding envelope that we consider necessary for the following regulatory control period. Following approval of the funding plan by the Minister, we then prepare our regulatory submissions, including the Capital Investment Plan for submission to the Commission for the Regulation of Utilities (CRU). In preparing Capital Investment Plan, we are required to consult with the EPA, the regional assemblies, and the local planning authorities. We then finalise the Investment Plan for submission to the CRU and they carry out a public consultation on the plan, prior to setting the allowed revenue for UÉ.

13.2 How we will measure progress

We are subject to monitoring and measurement to assess our performance and ensure we remain accountable to customers and stakeholders. The DHLGH monitors performance in the water sector including UÉ's performance. We are regulated by two regulators. The CRU is our economic regulator which oversees our operational expenditure and capital investment. The Comptroller and Auditor General (CAG) carry out audits on expenditure. The EPA is our environmental regulator.

Our Capital Investment Plan (CIP) is subject to a statutory stakeholder engagement process, undertaken by UÉ, and a public consultation process undertaken by the CRU. We report progress on our CIP throughout each regulatory cycle across a range of metrics, which in turn, the CRU publishes reports on in its assessment of our performance.

The EPA ensures our environmental compliance, and we engage and provide reports to the EPA on a regular basis including the annual sludge reporting returns. We report on sustainability and energy metrics to the Sustainable Energy Authority of Ireland (SEAI). In 2026, the first reporting under the Corporate Sustainability Reporting Directive (EU 2022/2464) ('CSRD'), for the financial year 2025 will occur. The CSRD requires companies to provide information on how sustainability matters affect the company and the impact of the company's activities on the environment and people.

We will produce an Implementation Plan with SMART criteria to monitor and track the NBioS actions.

13.3 Environmental monitoring and reporting

A monitoring plan is required under the Strategic Environmental Assessment (SEA) Regulations to provide a basis for identifying significant environmental effects during the implementation of specific actions under the draft NBioS. This is required to review the impacts of the draft Strategy predicted by the SEA and to assess whether the recommended mitigation measures are adequate to address the identified environmental concerns and that beneficial outcomes supporting SEA objectives can be achieved.

The proposed SEA mitigation measures and environmental monitoring programme are provided in Tables 9-1 and 9-2 of the SEA Environmental Report and can also be found in Appendix B in the draft NBioS. The proposed measures will be updated following consultation on this draft NBioS and the SEA Environmental Report. It will form part of the SEA statement to be published with the NBioS. The SEA monitoring will be integrated into the NBioS overall monitoring framework to ensure that environmental considerations are evaluated alongside other key performance measures.

This process will involve assessing the environmental impacts of the Strategy implementation, with a focus on the sustainability and the protection of environment. The findings from the SEA monitoring will contribute to the five-yearly reviews of the final NBioS. This will ensure that the Strategy remains responsive to all relevant legislation and our commitment to environmental protection, sustainability, circular bioeconomy, and climate change mitigation and adaptation.

We will carry out monitoring according to the SEA mitigation and monitoring requirements and will report monitoring and measuring data as required.

14 | National Bioresources Strategy review and update

The draft NBioS is a key document that outlines our long term 25-year strategy to ensure a nationwide standardised approach for sustainably managing wastewater sludge and bioresources. Critically the draft NBioS aligns with principles of the circular economy, net zero carbon, and sustainability. It also reflects developments and current thinking across the industry in the UK and Europe in the approach to the sustainable management of wastewater sludge and bioresources.

The draft NBioS sets out our strategic objectives and how we plan to achieve them in the context of the challenges we are likely to face in the coming years. The recommendations of the final National Bioresources Strategy will be used to inform future capital and operational activities in relation to sustainable bioresources management in Ireland. The final NBioS will undergo regular reviews, at least every five years, or as required by legislation. These reviews will allow us to adapt to any changing circumstances or needs.

Updates to the final NBioS will be informed by any upcoming changes in relevant legislation or government policy. The challenges outlined in Section 2 of the draft NBioS could likely impact our objectives. We will continue to monitor these challenges and check progress against each action. Regular monitoring of the final Strategy will support an adaptive planning approach in selecting specific options under each action during implementation of the Strategy. The five-yearly assessment will be used to check that progress is being made towards meeting the final National Bioresources Strategy objectives through implementation. If the five-yearly assessment finds that the objectives may not be achieved and/or a new approach is needed, actions in the strategy will be updated as needed.

When a change to the final National Bioresources Strategy is needed, it will be evaluated for environmental impact according to SEA and AA regulations. Consultations with the EPA and government departments are part of this process, as mandated by EU regulations. If the change is deemed to have a significant environmental impact, an SEA will be conducted. Additionally, an AA will be performed if the change could significantly affect European sites, unless it’s essential for site management and no significant effects can be scientifically ruled out. The final NBioS will continue to capture the strategic objectives necessary for efficient and sustainable bioresources management.

Appendices

Appendix A – Regulatory and policy framework

There are five European Directives which impact the management of wastewater sludge as follows:

1. Council Directive 86/278/EEC of the European Parliament and of the Council of 12 June 1986 on the protection of the environment, and of the soil, when sewage sludge is used in agriculture. Referred to in this document as the Sewage Sludge Directive (SSD).
2. Council Directive 91/676/EEC of the European Parliament and of the Council on the protection of waters against pollution caused by nitrates from agricultural sources. Referred to in this document as the Nitrates Directive.
3. Council Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste. Referred to in this document as the Waste Framework Directive.
4. Council Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control). Referred to in this document as the Industrial Emissions Directive (IED).
5. Council Directive (EU) 2024/3019 of the European Parliament and of the Council of 27 November 2024 concerning urban wastewater treatment (recast). Referred to in this document as the recast Urban Wastewater Treatment Directive (rUWWTD).

The Sewage Sludge Directive (SSD)

The SSD facilitates the use of sludge in agriculture subject to specified technical requirements, without the need for a specific waste authorisation. This directive has been transposed into Irish legislation by S.I. No. 148 of 1998 — Waste Management (Use of Sewage Sludge in Agriculture) Regulations, 1998, as amended by the SI No. 267 of 2001. The main restrictions for reuse of wastewater sludge in agriculture are set out in terms of limit values for heavy metals and nutrients. The maximum annual rates of application of parameters in wastewater sludge are summarised in Table A.1. The maximum levels of parameters in soil are listed in Table A.2.

Table A.1: Maximum annual rates of application of parameters in wastewater sludge

Parameter group	Parameter name	Limit value (kgs per hectare per year)	Legislation
Heavy Metals	Cadmium	0.05	SI 267 of 2001
Heavy Metals	Copper	7.50	SI 267 of 2001
Heavy Metals	Nickel	3.00	SI 267 of 2001
Heavy Metals	Lead	4.00	SI 267 of 2001
Heavy Metals	Zinc	7.50	SI 267 of 2001
Heavy Metals	Mercury	0.10	SI 267 of 2001
Heavy Metals	Chromium	3.5	SI 267 of 2001
Nutrients[1]	Nitrogen	0-225	SI 31 of 2014
Nutrients[1]	Phosphorus	0-125	SI 31 of 2014

Notes: [1] Nutrient application rates are dependent on land use and nitrogen and phosphorus indices as detailed in S.I. 34 of 2014

Both the SSD and the IED have been proposed for review and are expected to be updated in the coming years.

The recast Urban Wastewater Treatment Directive (rUWWTD)

The UWWTD has been updated and recast on November 27th, 2024. Items within the recast specially related to wastewater sludge include Article 20 entitled 'Sludge and Resource Recovery' (formerly Article 14). Article 20 has been updated to include the following:

1. Member States shall encourage the recovery of valuable resources and take the measures necessary to ensure that sludge management conforms to the waste hierarchy provided for in Article 4 of Directive 2008/98/EC. Such sludge management shall:
   (a) maximise prevention;
   (b) prepare for reuse, recycling and other recovery of resources, in particular phosphorus and nitrogen, taking into account national or local valorisation options; and
   (c) minimise the adverse effects on the environment and human health.

Table A.2: The maximum levels of parameters in soil

Parameter	Limit Value mg/kg of dry matter in a representative sample[1]	Legislation
Heavy Metals		
Cadmium	1	SI 148 of 1998
Copper	50	SI 148 of 1998
Nickel	30	SI 148 of 1998
Lead	50	SI 148 of 1998
Zinc	150	SI 148 of 1998
Mercury	1	SI 148 of 1998

Notes: [1] Values applicable to soil with a pH from 5 to 7. Where the pH of the soil is consistently higher than 7, the values set may be exceeded by not more than 50%, if there is no resulting hazard to human health, the environment or, in particular, ground water.

2. The Commission is empowered to adopt delegated acts in accordance with the procedure referred to in Article 27 to supplement the recast UWWTD by specifying a combined minimum reuse and recycling rate for phosphorus from sludge and from urban wastewater not reused under the derogation of Article 15(1), taking into account available technologies, resources and the economic viability of phosphorus recovery as well as the phosphorus content of the sludge and the level of saturation of the national market with organic phosphorus from other sources while ensuring that there is safe sludge management and no adverse impact on the environment or human health. The Commission shall adopt those delegated acts by 2 January 2028[36].

[36] Directive - EU - 2024/3019 - EN - EUR-Lex

The Code of Good Practice for the use of biosolids in Agriculture (1999)

The Code of Good Practice for the use of biosolids in Agriculture (CoGP) (1999) provides detailed information on best practice for the treatment, reuse, and monitoring of treated biosolids. We treat all wastewater sludge to meet the requirements of the CoGP and reuse as fertiliser and soil conditioner. This requires a stable pasteurised product, complying with the standards for safe use in agriculture. We monitor all treated wastewater sludge and biosolids in accordance with the monitoring requirements set out in the CoGP. A multi stakeholder working group including UÉ was set up in 2024 to review and update the CoGP to consider developments in monitoring requirements and technologies.

Wastewater sludge transportation legislation

UÉ Sludge Framework Contractors carry out all elements of the works related to the transportation of sludge to UÉ satisfaction and in accordance with current legislation, regulations and the requirements set out within the Code of Good Practice. The Waste Management Act 1996 (as amended) is the primary legislation governing waste management in Ireland. It provides the legal framework for the collection, transport, and disposal of waste, including sewage sludge. Further legislation includes but not limited to European Communities (Waste Directive) Regulations 2011 (S.I. No. 126/2011) and Waste Management (Collection Permit) Regulations 2007 (S.I. No. 820/2007).

Appendix B – Legislative context of the draft National Bioresources Strategy

The draft National Bioresources is subject to Strategic Environmental Assessment (SEA) and Appropriate Assessment (AA), and an SEA and AA have been carried out in parallel with the development of the draft Strategy. The relevant environmental legislation relating to the development of the draft National Bioresources Strategy are listed below and further information on associated guidance documents and departmental circulars can be found in the draft National Bioresources Strategy Natura Impact Statement (NIS).

Relevant European and National Legislation

- Council Directive 2001/42/EC on the assessment of the effects of certain plans and programmes on the environment, relating to SEA.
- Council Directive 2009/147/EC on the conservation of wild birds, codified version (also known as the 'Birds Directive').
- Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (also known as the 'Habitats Directive').
- European Communities (Birds and Natural Habitats) Regulations 2011 as amended; and
- Planning and Development Act 2000, as amended.

Strategic Environmental Assessment (SEA)

SEA is a process for evaluating, at the earliest appropriate stage, the environmental consequences of implementing plan and programme initiatives prepared by authorities at a national, regional or local level or which are prepared by an authority for adoption through legislative means.

The SEA involves the following stages, and all details on the draft National Bioresources Strategy SEA can be found in the SEA Environmental Report and the SEA Statement.

- Screening
- Scoping and Statutory Consultation
- SEA Environmental Report
- SEA Statement

The SEA Environmental Report assesses the following:

- Biodiversity, Flora, and Fauna
- Population and Human Health
- Soils
- Water
- Air Quality and Climatic Factors
- Material Assets
- Cultural Heritage
- Landscape

The purpose of the SEA process is to ensure that the environmental consequences of plans and programmes are assessed both during their preparation and prior to adoption. The SEA process also gives interested parties an opportunity to comment on the environmental impacts of the proposed plan or programme and to be kept informed during the decision-making process.

Table B.1: SEA Mitigation for draft Strategy

Reference	Proposed Mitigation/Recommendations
Section 8.4.1 - Sustainable Management of Wastewater Sludge and Bioresources	**Recommendation:** • Action 1.3: Apply the UÉ Route and Site Selection Guidance, V03 2024 (and subsequebt updates) for all developments arisng from the draft NbioS as approrpiate. • Action 1.3: Proper digestate management, emission controls, and transport planning are essential to maximize benefits and minimize risks of co-digestion. In this regard, UÉ's invest to outcome procedures, includes a suite of SOP's and manuals to ensure each project lifecycle is outcome focused. • Action 1.7: Understanding of alternative outlets should be underpinned by environmental safeguards to prevent unintended negative consequences.
Section 8.4.2 - Protect and Restore our Environment	**Mitigation:** • Action 2.6 – A timeline for the delivery of the revised Code of Good Practice for the Use of Biosolids in Agriculture should be stipulated to avoid further delays in addressing this key guidance. It is acknowledged that UÉ are not the lead stakeholder in this. • Action 2.7 – For transparency, UÉ should maintain a public list of the organisations they are collaborating with on research and innovation in relation to biosolids management, particularly with regard to emerging contaminants. This should include information on specific projects and related timelines. **Recommendations:** • Action 2.3: To further complement supporting text in chapter 5 of the draft NBioS an additional commitment should be included that reaffirms UÉ's commitment to consider wider environment effects beyond ecological matter through application of assessments such as SEA and/or EIA. • Actions 2.5 and 2.6: The draft Strategy should include a commitment a specific to review and update the final National Bioresource Strategy in line with the revised Code of Good Practice and revisions to any other relevant legislation including Sewage Sludge Directive and Industrial Directive, if revised before the next anticipated review of the Strategy in 5 years. • Action 2.11: Environmental risk assessments should be used to inform decision making at a local scale on the feasibility / suitability of alternative uses if the risk to land bank materialises. • Action 2.14 – The use of site selection tools should be stipulated in this action e.g. constraints analysis, heat mapping etc.
Section 8.4.3 - Support our Communities Growth and the Bioeconomy	• None proposed.
Section 8.4.3 - Efficient Operation of Wastewater Sludge and Bioresources Operating Centres	• None proposed.

Table B.2: Proposed Environmental Monitoring Programme for draft Strategy

SEA Topic	Rationale	Indicator	Target	Data Source	Frequency
Cross-cutting	Concern regarding public and ecosystem health resulting from contaminants in wastewater sludge	Contaminants in wastewater sludge	Achieve the monitoring requirements, particularly Article 21, under the rUWWTD.	• Uisce Éireann • EPA • DAFM	As per rUWWTD
Cross-cutting	To promote producer responsibility in dealing with pollutants	Levels of pollutants particularly PFAS and microplastics at inlet/ outlet points in urban WWTP	Decreasing trend in PFAS and microplastics at urban WWTP	Uisce Éireann	As per rUWWTD
Cross-cutting	Ensure contractors are transporting and landspreading in accordance with UE contractual requirements	Audit of compliance of bioresource management contractors with the UE standards.	100% compliance	Uisce Éireann	Annual
Air Quality and Climate	To ensure that transport related emissions associated with biosolid reuse are minimised both in terms of km travelled and fuel source	• Total Km travelled in securing reuse of biosolids • % of Clean and Energy-Efficient Road Transport Vehicles used	• Decreasing trend in total km travelled using National Bioresources Strategic Decision Support Tool (DST). • Increase in % of Clean and Energy-Efficient Road Transport Vehicles used.	Uisce Éireann	Annual
Water, Land and Soils, Material Assets and Biodiversity	Ensure nutrient recovery and reuse	Quality of Nutrient management plans	100% compliance in NMP reviews	Uisce Éireann	Ongoing
Climate	To ensure there is energy reduction and recovery to minimise potential for GHG emissions from management of biosolids	• Energy usage in management of biosolids • Energy recovered from management of biosolids	• Decreasing trends in energy usage in treatment assets • Increasing trend in energy recovery • Overall improved balance between energy usage and recovery across the asset base	Uisce Éireann	Ongoing. Analysis of energy metrics reported to SEAI

Appropriate Assessment (AA)

An AA is carried out to determine whether the project may affect a European Site, also known as Natura 2000 sites, such as a Special Area of Conservation (SAC) or Special Protection Area (SPA) that are classified under the Birds and Habitats Directives. Natura 2000 sites are sites across the European Union which have been designated to protect threatened habitats and species across Europe.

The requirement for AA derives from Article 6(3) of the EU Habitats Directive 92/43/EC and relates to the consideration of plans or projects with respect to European sites forming the Natura 2000 network. Article 6(3) requires that "any plan or proposed development not directly connected with or necessary to the management of the site but likely to have a significant effect thereon either individually or in combination with other plans or proposed developments, shall be subject to appropriate assessment of its implications for the site in view of the site's conservation objectives. In the light of the conclusions of the assessment of the implications for the site and subject to the provisions of paragraph 4, the competent national authorities shall agree to the plan or proposed development only after having ascertained that it will not adversely affect the integrity of the site concerned and if appropriate, after having obtained the opinion of the general public".

Thus, Article 6(3) provides a two-stage process:

- The first stage involves a screening for appropriate assessment.
- The second stage arises where, having screened the plan or project, it is determined that there is potential for likely significant effects, and an AA is required to inform decision making by the relevant Competent Authority.

A Natura Impact Statement (NIS) is an output of an AA.

In the event that the assessment completed with respect to Article 6(3) is unable to conclude no adverse effect on the integrity of an European site, Article 6(4) makes provision for the consenting of such projects subject to the absence of alternative solutions, a requirement for the plan or project to be carried out for imperative reasons of overriding public interest and the provision of all compensatory measures necessary to ensure that the overall coherence of the Natura 2000 network is protected.

The provisions of the Habitats Directive have been transposed into Irish legislation via the European Communities (Birds and Natural Habitats) Regulations 2011, as amended (SI. No. 293/2021), and the parallel provisions relating to AA in planning legislation (Part XAB of the Planning and Development Act, 2000, as amended, and associated Regulations).

The Natura Impact Statement (NIS) assessment prepared for the draft National Bioresources Strategy has been prepared with reference to the relevant primary and domestic legislation described above. The NIS sets out the assessment with respect to Article 6(3) as it relates to the assessment of adverse effects on the integrity of European sites with reference to their published Conservation Objectives.

Assessment and analyses in the NIS have been used to guide the development of the alternatives to be considered as part of the SEA. The NIS also feeds directly into the assessment of biodiversity, flora, and fauna in this SEA.

Appendix C – Estimated future bioresource quantities

An estimate of the future quantities in each county is shown in Table C.1 below. These projections are based on the published draft revised National Planning Framework (NPF) and 2022 Census population figures. As new WWTPs and upgrades occur, the level of compliance will increase, and the actual sludge load will increase to the predicted quantities as shown below.

Table C.1: Estimated future quantities tDS/yr

County	2030 tDS/yr	2040 tDS/yr	2050 tDS/yr
Carlow	1,305	1,400	1,462
Cavan	1,765	1,865	1,946
Clare	2,728	3,018	3,146
Cork City & County	13,551	19,342	20,472
Donegal	3,656	3,820	3,987
Dublin (incl DLR, Fingal, South Dublin and Dublin City)	31,628	36,986	38,442
Galway City and County	6,611	6,748	7,026
Kerry	3,395	3,734	3,890
Kildare	5,300	6,297	6,545
Kilkenny	2,281	2,344	2,448
Laois	1,943	2,171	2,263
Leitrim	737	844	879
Limerick	5,065	4,941	5,230

County	2030 tDS/yr	2040 tDS/yr	2050 tDS/yr
Longford	938	1,071	1,118
Louth	3,013	3,245	3,384
Mayo	2,997	3,003	3,141
Meath	4,605	5,457	5,767
Monaghan	1,413	1,465	1,531
Offaly	1,793	1,869	1,952
Roscommon	1,484	1,683	1,754
Sligo	1,504	1,654	1,724
Tipperary	3,666	3,911	4,079
Waterford	2,855	2,919	3,046
Westmeath	2,042	2,166	2,263
Wexford	3,437	3,815	3,979
Wicklow	3,266	3,739	3,895

Appendix D – Description of treatment technology details for stabilisation as per Code of Good Practice

Anaerobic digestion (AD) and advanced anaerobic digestion (AAD)

Anaerobic digestion (AD) of wastewater sludge can be either mesophilic or thermophilic. Mesophilic and thermophilic refer to the temperature at which the digestion occurs. Mesophilic digestion is insufficient on its own to provide full stabilisation of wastewater sludge. Therefore, a pre or post treatment stage is required to ensure full stabilisation and a Class A biosolid.

Advanced anaerobic digestion (AAD) can incorporate a pre or post pasteurisation stage, where sludge is retained at a temperature greater than or equal to 70°C for 1 hour or 55°C for 2 hours is required. Several WWTPs currently have pasteurisation and mesophilic digestion in operation.

Alternatively, advanced digestion can include a thermal hydrolysis process (THP) with mesophilic digestion either before digestion or as an intermediate treatment stage. Advanced digestion using THP has been evaluated to be a sustainable solution for wastewater sludge treatment and stabilisation. It also results in a high volatile solids reduction (VSR), higher biogas and energy yields, and a reduction in sludge quantity.

The minimum size available for a thermal hydrolysis plant is approximately 2,000 tds/year (equivalent to approximately 100,000 P.E.).

Thermophilic anaerobic digestion

There are no thermophilic anaerobic digestion facilities in operation at our sites. Thermophilic digestion is usually more expensive to operate as it requires additional energy to maintain the higher operating temperatures and has a greater sensitivity to operational and environmental conditions. As such thermophilic AD is unlikely to be a practical option for any future developments or investment.

Thermophilic aerobic digestion

There is one thermophilic aerobic digestion facility in operation at Killarney WWTP. The process is operated in a batch mode making is suitable for the significant variation between winter and summer loads in Killarney. Due to the energy requirement of aerobic digestion processes, they are not commonly used and are unlikely to be a preferred option for any future developments or investment.

Composting

Composting occurs by mixing dewatered sludge with a bulking agent to provide carbon and increase porosity. The resulting mixture is placed in windrows, static piles or a vessel where microbial activity causes the temperature of the mixture to rise. To achieve the required level of pasteurisation, a minimum temperature of 55°C must be maintained. In the case of windrow composting the temperature must be maintained for at least 15 days over 5 turnings of the windrow. For static pile or in-vessel composting, the temperature must be maintained uniformly for a minimum of 3 days.

The main advantages of composting are the relatively low operating costs and an easily handled product. The main disadvantages are the higher capital cost compared to alkaline stabilisation, and the risk of inadequate treatment if the process and temperature are not properly controlled. We do not own or operate any composting facilities directly; however, a number of private composting facilities have been developed in Ireland to treat our wastewater sludge.

Alkaline stabilisation

Alkaline stabilisation is undertaken by mixing an alkaline additive with dewatered sludge. Normally hydrated lime or quicklime are used as alkaline stabilisers. In order to achieve the required level of pasteurisation, the pH must be more than 12 with a minimum temperature of 70°C for 30 minutes or, maintain a pH more than 12 for 72 hours and a minimum temperature of 52°C for at least 12 hours. A higher dose of lime or external heating is required to reach the higher temperatures.

The main advantage of this process is relatively low capital and operating costs. In addition, a large proportion of land in Ireland is lime deficient and the use of lime stabilised sludge can provide an additional benefit in agriculture. The main disadvantages are the higher volume of sludge for reuse, potential for inadequate treatment if not properly controlled and monitored, low nitrogen content and odours due to ammonia release. There are many lime stabilisation facilities currently being used for treatment of wastewater sludge. Four of these are located at wastewater treatment plants with the remainder being operated at off-site private facilities taking wastewater sludge on a contract basis.

Thermal drying

Thermal drying is undertaken by direct or indirect application of an external heat source to dewatered sludge to evaporate water from the sludge. Thermal drying produces a fully pasteurised granular product with a dry solids content greater than 90%. The main advantages of this process are the significant volume reduction of sludge and the potential for alternative outlets to land-spreading. The main disadvantages are the high capital, operating and maintenance costs, with high energy costs in particular. There is also a relatively high risk of fire associated with thermal drying.

Appendix E – Bioresource centres where full wastewater sludge treatment and stabilisation take place

E.1 Bioresource Centres where full wastewater sludge treatment and stabilisation take place

County	Agglomeration	Treatment Process on-site	Design Treatment Capacity (PE)	Reported Sludge Load 2024 (tDS/yr)
Carlow	Carlow	Lime stabilisation	70,000	674
Cork	Cork City	AD	563,567	3,035
Cork	Cork Lower Harbour	AD[38]	68,000	570
Donegal	Letterkenny	AD and Thermal Drying	40,000	824
Donegal	Donegal Town	Thermal Drying	83,000	381
Dublin	Ringsend	AAD and Thermal Drying	2,400,000	18,464
Dun Laoghaire	Shanganagh	AD and Thermal Drying	186,000	1,088
Fingal	Swords	AD	90,000	815
Galway City	Galway City	AD	170,000	2,360
Kerry	Killarney	ATAD	54,000	388
Kildare	Upper Liffey Valley (Osberstown)	AAD	400,000	7,831[39]
Kilkenny	Kilkenny City	Lime stabilisation	50,000	1,244
Laois	Portlaoise	Thermal Drying	80,000	1,064
Limerick	Limerick (Bunlicky)	AD	130,000	3,310
Longford	Longford	Lime stabilisation	80,000	1,545
Louth	Dundalk	AD[40]	179,000	894
Louth	Drogheda	AD[38]	101,000	1,914
Offaly	Tullamore	AD and Thermal Drying	45,000	1,195
Sligo	Sligo	AAD	100,000	767
Waterford	Waterford city	AAD	190,000	718

[38] AD assets currently not in operation

[39] 2024 data included Lower Liffey Valley (Leixlip)

[40] AD assets undergoing upgrade

Appendix F Acronyms and Abbreviations

Abbreviation term	Definition
AA	Appropriate Assessment
ATC	Advanced Thermal Conversion
BC	Bioresource Centre
BOP	Biogas Optimisation Programme
CIP	Capital Investment Programme
CO^2	Carbon Dioxide
CoGP	Code of Good Practice for the use of Biosolids in Agriculture
CRU	Commission for Regulations of Utilities
CSRD	Corporate Sustainability Reporting Directive
DAFM	Department of Agriculture Food and the Marine
DCEE	Department of Climate, Energy and the Environment
DHLGH	Department of Housing, Local Government and Heritage
DS	Dry Solids
DWWTS	Domestic Wastewater Treatment System
EC / EU	European Commission / European Union
EPA	Environmental Protection Agency
EPR	Extended Producer Responsibility
GHG	Greenhouse Gases
ha	Hectare
IED	Industrial Emissions Directive

Abbreviation term	Definition
MAD	Mesophilic Anaerobic Digestion
NBS	Nature Based Solutions
NBioS	National Bioresources Strategy
NIS	Natura Impact Statement
NMP	Nutrient Management Plan
NWSMP	Existing National Wastewater Sludge Management Plan
P.E.	Population Equivalent
PFAS	Per and Polyfluoroalkyl Substances
SRB	Sludge Reed Beds
SEA	Strategic Environmental Assessment
SEAI	Sustainable Energy Authority of Ireland
S.I.	Statutory Instrument
SDC	Satellite Dewatering centres
SSD	Sewage Sludge Directive
SOP	Standard Operating Procedure
tDS	Tonnes Dry Solids
TAD	Thermophilic Anaerobic Digestion
THP	Thermal Hydrolysis Process
UÉ	Uisce Éireann
rUWWTD	Recast Urban Wastewater Treatment Directive
WAPCE	Waste Action Plan for a Circular Economy
WSSP	Water Services Strategic Plan
WWTP	Wastewater treatment plant

Appendix G Glossary

Abbreviation term	Definition
Agricultural reuse	Treated stabilised biosolid bioresources are spread on non-food tillage agricultural land.
Alkaline Stabilisation	Also known as lime stabilisation. The treatment of sludge by the addition of an alkaline product, usually lime, to raise the pH of the sludge to ensure predetermined quality targets are met.
Anaerobic digestion	Biological sludge treatment process during in which microorganisms break down biodegradable material in the absence of oxygen producing a stable sludge product and biogas, which is combusted to generate heat and electricity.
Ash	The inert residues from sludge processing
Biochar	Biochar is a high-carbon by-product of ATC technology processes produced via thermal decomposition of organic material in the absence of oxygen. It is lightweight, black, and porous, resembling charcoal. Biochar can be used in soils to enhance crop growth and soil health, and it sequesters carbon in the soil.
Biosolids	Wastewater sludge which has been treated to an approved standard using treatment processes such as composting, advanced digestion, thermal drying or lime stabilisation and is suitable for reuse in agriculture.
Bioresources	The term bioresources refers to stabilised wastewater sludge (biosolids) and associated by-products such as biogas/ biomethane.
Bioresource Centre (BC)	A BC is a centralised regional wastewater sludge treatment facility which provides for treatment of wastewater sludge to produce stabilised biosolids. Bioresources Centres accept imported sludge from the surrounding region for treatment. Bioresources Centres are typically located at large wastewater treatment plants and may include Sludge Storage Facilities.
Circular Economy	In a circular economy, the value of products and materials is maintained for as long as possible. Waste and resource use are minimised, and when a product reaches the end of its life, it is used again to create further value.
Composting	The mixing of Nitrogen rich (sludge) and Carbon rich (wood chippings, or straw) to ensure that predetermined quality targets are met.
CRSD	The CSRD (EU 2022/2464) requires companies to provide information on how sustainability matters affect the company and the impact of the company's activities on the environment and people.
Dewatering	Means the conversion of liquid sludge (1-3% DS) to sludge cake (18-25% DS).
DBO	Design Build Operate. This is a type of contract where a private contractor is appointed to design and construct a WWTP and then operate the plant for a fixed period of time.
DS	The weight of dry solids per unit weight of sludge expressed as a %.

Abbreviation term	Definition
EurEau	EurEau is the European Federation of National Associations of Water Services representing national drinking and wastewater service providers from 33 Countries, from both the public and private sectors.
Final effluent	Treated liquid discharge from a WWTP to a receiving water, for example river or the sea, following treatment at a WWTP.
Gasification	Gasification is the breakdown of hydrocarbons into a syngas by carefully controlling the amount of oxygen present.
Heavy metal	A term used to describe metals with a high atomic mass, some of which can be harmful to ecological and human health.
Lime stabilisation	Also known as alkaline stabilisation.
Mesophillic Anaerobic Digestion (MAD)	MAD is digestion undertaken at the temperature range 35ºC ±3ºC. This is the most commonly used type of digestion in Ireland for wastewater sludge.
P.E.	1 P.E. is the organic load from a wastewater having a biochemical oxygen demand of 0.06kg/day, equivalent to that of an average person.
Pyrolysis	The thermal treatment of wastewater sludge in the absence of air. Wastewater sludge is heated to a high temperature in an oxygen-free atmosphere to produce energy and a biochar product.
Sludge Cake	Sludge which has been dewatered to the extent that it can be managed as a solid; DS content typically ranges from 15% to 25% DS.
Sludge Reed Beds	SRBs are a nature-based solution which use reeds to treat and dry the wastewater sludge over time. They result in a reduction in sludge production and energy usage and carbon sequestration. SRBs are beneficial in smaller remote WWTPs where the transport of sludge to a satellite dewatering site is unsustainable.
Satellite Dewatering Centres	SDCs act as ‘intermediate centres’ where liquid sludge is dewatered, that is where water is eliminated from sludge using mechanical dewatering to reduce sludge volume to reduce the number of traffic movements and cost of sludge transportation. SDCs are typically located at medium to large wastewater treatment plants.
Storage Facility	A treated wastewater sludge storage facility is used for storage of treated sludge being used for land spreading during the periods when application of fertilisers to land is prohibited or unfeasible. These can be located on a Sludge Hub Centre or Sludge Treatment Centre site or at a separate facility.
tDS	Tonnes Dry Solid. This is the preferred unit of measurement for sludge and excludes the weight of water in the sludge.
Thermophilic anaerobic Digestion (TAD)	TAD is digestion undertaken at the temperature range 50 - 55ºC.

Abbreviation term	Definition
Wastewater	Domestic and industrial effluents collected by the sewerage system and conveyed to the WWTP for treatment.
Wastewater sludge	Organic by-product of the biological treatment of wastewater comprising a mixture of organic solids and water. The term wastewater sludge refers to both liquid and cake sludge prior to stabilisation.
Wastewater sludge management	Wastewater sludge management refers to all activities from production of wastewater sludge at a treatment plant and sludge treatment and stabilisation through to storage.