

National Wastewater Sludge Management Plan



National Wastewater Sludge Management Plan

Asset Strategy



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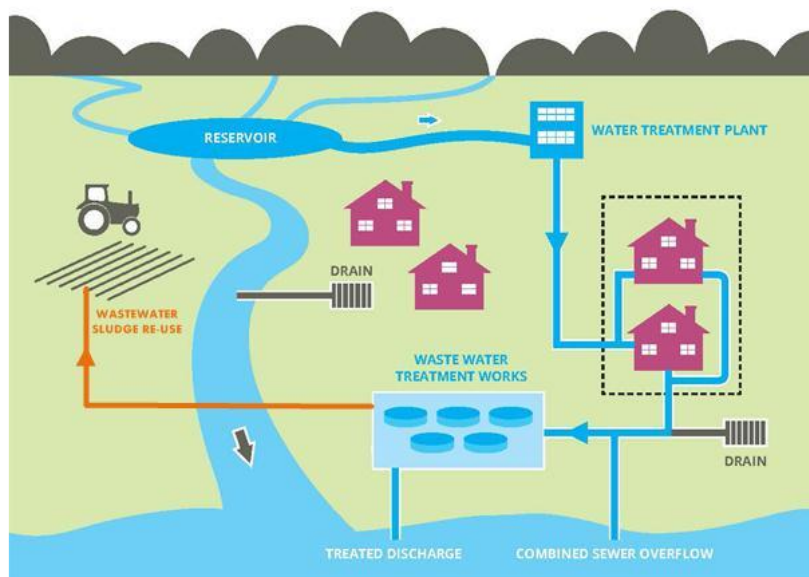
Appendix 1 - Glossary and Abbreviations

Executive Summary

General

Since its incorporation in 2014, Irish Water has taken over the responsibility to provide water and wastewater services in Ireland from 31 local authorities. This includes managing approximately 856 water treatment plants and approximately 1,000 wastewater treatment plants.

Our responsibility for wastewater commences when the wastewater effluent reaches the public wastewater network and includes the transfer of effluent to wastewater treatment plants, the treatment itself and the subsequent discharge of the treated wastewater back into the water environment.



The wastewater treatment process generates sludge, which requires further treatment prior to its reuse or disposal. Wastewater Sludge is made up mainly of organic matter that has been removed during the treatment process and may contain some contaminants. Further treatment is required to this sludge to ensure its safe and efficient re-use or disposal.

Irish Water estimates that the quantity of wastewater sludge generated is expected to increase by more than 80% by 2040 as new and upgraded plants are completed to treat our wastewater. The management of this wastewater sludge poses economic, planning and environmental challenges. In order to address these challenges and in line with the strategic objectives of the Water Services Strategic Plan, Irish Water have developed the first National Wastewater Sludge Management Plan.

The National Wastewater Sludge Management Plan (NWSMP) outlines Irish Water's strategy to ensure a nationwide standardised approach for managing wastewater sludge over the next 25 years. This national and sustainable approach to wastewater sludge management will ensure efficiency and ongoing improvements to the benefit of the public and the environment we all live in.

As part of the development of the NWSMP, Irish Water has looked at how wastewater sludge is currently managed and has set out sustainable proposals for the investment in future treatment, transport and reuse or disposal of the sludge in keeping with the following objectives: -

- To avoid endangering human health or harming the environment;
- To maximise the benefits of wastewater sludge as a soil conditioner and source of nutrients;

- To ensure that all regulatory and legislative controls are met, and due regard is given to non-statutory Codes of Practice and industry guidance;
- To establish long term, secure and sustainable reuse/disposal methods;
- To ensure cost-effective and efficient treatment and reuse/disposal techniques;
- To reduce potential for disruption from sludge transport and sludge facilities;
- To extract energy and other resources where economically feasible; and
- To drive operational efficiencies, e.g. through the use of Sludge Hub Centres.

Sludge Composition, Loads and Outlets

There have been over 1,000 agglomerations identified under the Wastewater Discharge Licencing Regulations, represented as applications for licences (or certificates for populations under 500) under the Wastewater Discharge Licencing Regulations. Over 95% of these agglomerations currently have some level of wastewater treatment and are consequently producing wastewater sludge. The total quantity of wastewater sludge generated in 2014, as reported to the EPA, was 53,543 tonnes dry solids (tds), i.e. the dry solids equivalent excluding water content. Over 98% of this was reused in agriculture. The wastewater sludge produced includes primary, biological, chemical and septic tank sludges which undergo further treatment prior to reuse in agriculture.

The quantity of wastewater sludge produced is expected to increase over the next 25 years, as new and upgraded wastewater treatment plants are commissioned. The predicted sludge quantity in 2040 is 96,442 tds/annum, this is the equivalent to a volume of approximately 900,000m³ or approximately 50,000 truck-loads. Additional wastewater sludge is produced in individual Domestic Wastewater Treatment Systems (DWWTS's), mainly septic tanks, some of which is currently accepted at Irish Water wastewater treatment plants. It is expected that the amount of DWWTS sludge accepted by Irish Water will increase over the duration of the NWSMP.

Where sludge is used in agriculture or other land-use, there are benefits from provision of nutrient content in terms of phosphorus and nitrogen and also levels of potassium, sulphur, magnesium and micronutrients which are present in the sludge. In addition, the organic content of the sludge can improve soil quality. These benefits make re-use of properly treated sludge an attractive and economically favoured option for crop production in agriculture.

The sludge also, however, contains contaminants including metals, pathogens, and organic and emerging pollutants such as pesticides and medicinal residues. Monitoring of sludge is required prior to use in agriculture for these contaminants, with monitoring undertaken of both sludge and soils. The risks associated with the constituents of wastewater sludge are considered further in this document.

Review of Standards and Plans

There are three main European Directives which significantly impact the management of wastewater sludge as follows:-

- *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 - referred to hereafter as the 'Sewage Sludge Directive';*
- *Council Directive 91/676/EEC concerning the protection of waters against pollution caused by nitrates from agricultural sources - referred to hereafter as the 'Nitrates Directive';*
- *Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives - referred to hereafter as the 'Waste Framework Directive'.*

It is expected that future legislation will provide a broader protection of soil, in addition to more stringent controls on the use of wastewater sludge. A revision of the EU regulation on fertilisers is proposed which will involve new measures to facilitate the EU wide recognition of organic and waste-based fertilisers. This will lead to the sustainable development of an EU-wide market for properly treated sludge.

The Regional Waste Management Plans, prepared on behalf of the regional waste authorities, set out the overall strategy for waste management for the country. These have been reviewed in the development of this plan. Sludge management plans were prepared by individual Local Authorities in the late 1990's and early 2000's. These plans have also been reviewed and recommendations incorporated into the NWSMP where appropriate.

Standards in relation to sludge management have been produced by the European Committee for Standardisation, CEN, which provides recommendations for sludge management particularly in relation to treatment, reuse and risk assessment. In Ireland, the Department of Housing, Planning, Community and Local Government (DHPCLG) (formerly the Department of the Environment, Community and Local Government) developed a *Code of Good Practice for Use of Biosolids in Agriculture*. Irish Water policy requires compliance with this code of good practice.

Environmental Assessment and Consultation

Strategic Environmental Assessment (SEA) and Appropriate Assessment (AA) have been carried out in parallel with the development of the NWSMP. The general public, interested individuals and organisations, and statutory bodies have been involved in the development of the plan as part of the SEA and AA process through public consultation at key stages, including:

- Consultation 1 – a six-week non-statutory public consultation seeking feedback on the SEA Scoping Report for the NWSMP to determine the scope and level of detail of information to be included in the environmental report. (May-June 2015);
- Consultation 2 – an eight-week statutory public consultation seeking feedback on the Draft NWSMP and associated SEA Environmental Report and Natura Impact Statement. (March - May 2016).

All feedback received during the public consultations was reviewed by the project team and relevant feedback has been incorporated into the Final NWSMP. The SEA Statement outlines how environmental considerations have been integrated into the NWSMP and how consultation influenced the development of the NWSMP.

Sludge Treatment Processes

Sludge treatment processes can be generally divided into the following main categories:-

- Sludge volume reduction (removal of water by separation);
- Sludge quantity reduction (destruction of solids by treatment);
- Sludge biosolids production (change in composition & removal of pathogens).

Sludge volume reduction is achieved by thickening and dewatering. Water is removed by mechanical means with the filtrate water recycled back into the wastewater treatment process. The sludge quantity can be further reduced by aerobic or anaerobic digestion leading to destruction of organic solids. There are numerous treatment options available for sludge volume reduction.

A final treatment process to produce 'biosolids', is required where agricultural reuse is proposed. The term 'biosolids' applies to a fully treated sludge product which is both biologically stable and free of harmful pathogens (bacteria, viruses). Biosolids are suitable for use as a fertiliser and soil conditioner subject to careful monitoring for possible contaminants.

There are advanced thermal treatment options available for sludge, leading to more complete destruction of the sludge, as an alternative to biosolids production. Currently, the main process

for thermal conversion of wastewater sludge internationally is incineration. This may, if necessary in the future, provide an alternative outlet for Irish Water. Other thermal treatment processes include pyrolysis, gasification, wet oxidation and melting furnace. However, these options are not currently available on a commercial scale in Ireland. The main output of thermal treatment processes, in addition to energy production (heat and electricity), is a residual ash which may either be reused or disposed of as waste.

Sludge Transport Strategy

Transportation plays a significant role in sludge management in terms of environmental impacts and cost. The total volume of sludge produced in wastewater treatment plants is estimated to be up to 900,000m³/annum. To achieve the best balance between the cost of sludge transport and the cost of treatment to reduce the volume of sludge, Irish Water has identified a number of options for reducing sludge volumes for transport and optimising transportation. We have identified a shortfall in Satellite Dewatering Sites that would allow more efficient sludge management. Options for sludge volume reductions on-site have been considered and require further investigation to establish the most appropriate solution for each site. There is the potential to reduce the volume of sludge for transport by up to 25% by optimising sludge thickening at smaller wastewater treatment plants.

An overall assessment of sludge infrastructure requirements was carried out based on sludge transport and operating requirements. General recommendations have been provided as a guide to the type of infrastructure needed relative to the size and location of the wastewater treatment plant (WWTP). Site specific reviews are required to assess each particular WWTP requirements. The option of sludge reed beds as an alternative technology to transportation of liquid sludge may provide a sustainable solution for smaller plants, particularly where there are long transport distances to the nearest satellite dewatering site.

Sludge Satellite Dewatering and Hub Infrastructure

The use of a 'Sludge Hub Centre and Satellite Dewatering Site' system for the management of wastewater sludge has been implemented in a number of counties in Ireland. The use of Sludge Hub Centres backed up with Satellite Dewatering Sites allows for economies of scale and greater flexibility in the selection of sludge treatment processes, particularly energy recovery. Quality control over the outputs from any sludge treatment process is also improved using this system

This system is commonly used internationally and it is considered that it is appropriate for use by Irish Water given the large number of small communities dispersed across the country. It should be noted that local authority areas will no longer be considered individually which allows greater flexibility and efficiency on a regional basis. Where treated wastewater sludge storage is required to manage biosolids prior to landspreading, it may be accommodated by the hub centre or separately. The scale and location of such storage will be assessed on a regional basis.

Advanced sludge treatment is currently provided on site at approximately 24 wastewater treatment plants throughout the country. Sludge from the smaller wastewater treatment plants is transferred to existing Sludge Hub Centres for treatment prior to disposal. Off-site treatment is provided by a number of contractors. These treatments include composting, anaerobic digestion and pasteurisation and lime stabilisation facilities. The final disposal of treated sludge is generally sub-contracted by the wastewater treatment plant operator.

Each local authority area has been reviewed to assess the current situation with regard to wastewater sludge management and recommendations for the future have been made. It is intended that existing Sludge Hub Centres should be used to their maximum capacity unrestricted by county boundaries. In particular, the use of existing anaerobic digestion infrastructure should be maximised to increase energy recovery.

Sludge Outlet Options and Constraints

At present over 98% of wastewater sludge is treated to produce a biosolids product which is being reused in agriculture. There are very limited alternative options currently available in Ireland. However, it is considered important to explore alternative outlets further to reduce the risks associated with depending on agriculture alone as an outlet. Irish Water, though confident in the quality of properly treated biosolids, recognises that issues have been raised by stakeholders in relation to the use of biosolids on dairy and beef pasture, as reflected in the Bord Bia Quality Schemes. Therefore the main focus for future biosolids use is targeted at other crops, such as non-agricultural and crops for animal feed. Thermal processes have been reviewed and are considered to provide an alternative option for the future. A feasibility study is proposed to further develop alternative sludge reuse or disposal options.

Options Assessment and Alternatives

The options in relation to wastewater sludge management relate mainly to treatment, transport and reuse or disposal. The main criteria in selection of options are as follows:

- Environmental impact – emissions to air, water and land, climate change impact and energy use;
- Social impact – potential nuisance (e.g. odour, noise, traffic), public perception and food safety;
- Financial impact – life cycle costs, energy cost and recovery, reliability of technology.

These impacts cannot be considered in isolation. Any option selected, for treatment, transport or reuse/disposal, must be economically, environmentally and socially acceptable. The sustainability of any option and the risks associated with it are a combination of all potential impacts. The options for sludge management and their associated risks are considered including risks associated with landspreading.

The main treatments used for producing biosolids are thermal drying and lime stabilisation. Due largely to the high cost, a number of the thermal drying installations provided over the last 10-15 years are no longer in operational use in favour of more cost effective treatments and land re-use.

Properly controlled lime stabilisation is an acceptable method of sludge treatment. However, an audit undertaken by Irish Water of sludge management activities has identified a significant variation in the adequacy of lime treatment being provided, particularly at off-site installations. The main issues identified were inadequate dosing of lime and inadequate monitoring of temperature and pH during treatment. Due to the difficulties in controlling off-site activities, it is proposed that off-site treatment of sludge by lime stabilisation is phased out in the short-term and a minimum lime dose is specified for any use to be continued. Minimum dose lime stabilisation in combination with anaerobic digestion is currently undertaken at a number of Irish Water sites and provides a consistent sludge stabilisation process.

Studies of biosolids treatment options have indicated that advanced anaerobic digestion provides the most economically feasible option and the lowest carbon footprint for wastewater sludge treatment with the sludge quantity for reuse or disposal reduced by up to 50%. There are fourteen wastewater treatment plants in Ireland with anaerobic digestion currently in operation. Over 50% of all wastewater sludge was anaerobically digested in 2014. This is expected to increase to approximately 65% when WWTP upgrades, currently underway, are completed. It is proposed that the number of sites with anaerobic digestion is increased to nineteen, as the optimum strategy for treatment, with the biogas produced used for energy recovery in all cases. Advanced anaerobic digestion followed by reuse of the residual biosolids on land has been evaluated to be the most sustainable solution for wastewater sludge treatment and disposal.

There may be a demand in the short to medium term for advanced thermal sludge treatment in order to reduce the current dependence on a single reuse outlet for sludge i.e. landspreading to agriculture. At present, the only viable option for this would be incineration.

Quality Assurance, Monitoring and Reporting

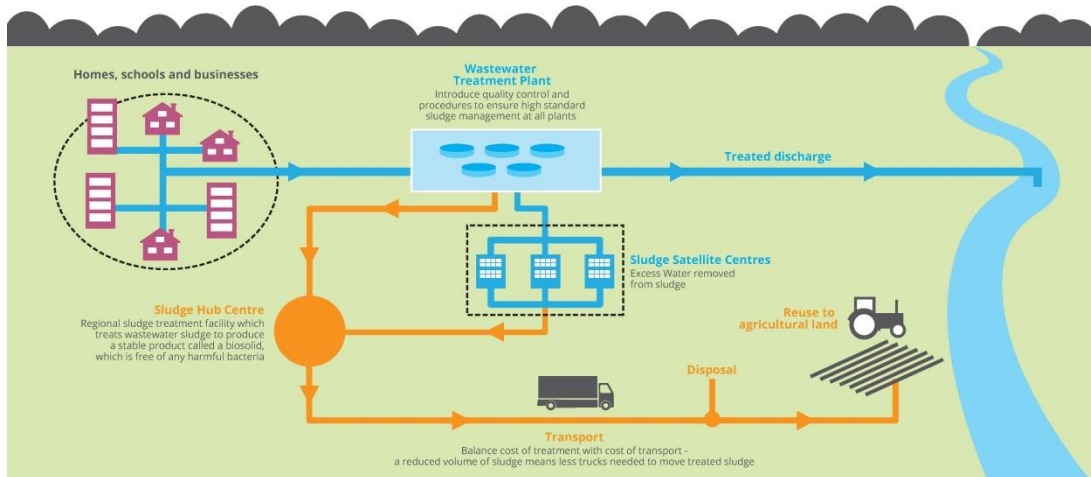
There are a number of statutory requirements in relation to monitoring and reporting of sludge management activities. However, in order to ensure that the risks and perception issues are addressed, it is recommended that an independently audited quality assurance system is put in place for sludge management activities. An annual audit of sludge management activities will be undertaken by Irish Water pending a fully developed quality control scheme. Separate Standard Operating Procedures (SOP's) and control procedures are being developed by Irish Water to ensure that the whole process from source control of pollutants, through to wastewater sludge treatment and reuse is controlled and monitored. Full monitoring and reporting is required for each step of the process to ensure a quality assured biosolids product.

Irish Water is applying source control principles to commercial and industrial customers that discharge wastewater to the public sewer network. Through source control, standardised conditions are applied to their discharge licences. These conditions are based on the nature of the business customer's discharge activity, the capacity of the receiving sewer and the capability of the wastewater treatment plant to remove pollutants. Source control is preferable to end-of-pipe treatment to minimise the risk of specific pollutants associated with trade effluent (e.g., metals, persistent organic pollutants, pharmaceutical products, etc.) in the biosolids. This is a key step in minimising the risk of contaminants in the sludge and is being achieved through more consistent application of the provisions of Section 16 of the Local Government (Water Pollution) Act 1977 (as amended), the powers of which have transferred to Irish Water under the Water Services (No. 2) Bill 2013.

Summary of Actions proposed in the NWSMP

Key actions proposed in the NWSMP are summarised as follows:

- The introduction of a quality assurance system for the whole wastewater treatment process from source control of pollutants, through to sludge treatment and reuse;
- An annual audit of sludge management activities will be undertaken on behalf of Irish Water pending a fully developed quality assurance scheme;
- Standard Operating Procedures (SOPs) for wastewater sludge management will be developed by Irish Water and requirements with respect to landspreading of treated wastewater sludge (biosolid) will be included in these SOPs;
- While thermal drying will continue to be provided where practically and economically viable, advanced anaerobic digestion is the preferred option for the majority of sites;
- Lime stabilisation at off-site centres will be phased out and any on-site lime treatment will be strictly controlled for effective treatment;
- The network of hub treatment sites and satellite dewatering plants will be further developed to optimise the balance between treatment and transport costs;
- The location of 'hubs' will be considered on a regional rather than county basis and will maximise the use of energy recovery where possible;
- The preferred option for re-use of treated wastewater sludge (biosolids) is reuse on land. Non-food tillage crops will be the primary focus for agricultural reuse of biosolids;
- A detailed feasibility study will be carried out to investigate alternative sludge outlet options to reduce the dependence on the use of agricultural land for wastewater sludge reuse.



The NWSMP will be revised and updated in 2021 for the period 2022-2027. The actions and objectives as set out in the NWSMP 2016-2021 will be reviewed and progress measured. The revised plan will invite feedback during its development prior to adoption.

This document, the SEA Statement and AA Determination are available for download online at:
www.water.ie/wastewater-sludge-management



1 Introduction

1.1 Irish Water Role and Responsibilities

Irish Water was established under the Water Services Acts 2013. Irish Water became responsible for all of the public water and wastewater activities of Ireland's then 34 Local Authorities on 1st January, 2014¹.

Our responsibilities for wastewater commence when effluent reaches the public wastewater network. We are responsible for its transfer to wastewater treatment plants, its treatment and the subsequent discharge of the treated effluent back into the water environment. We are also responsible for the treatment and disposal of the sludge that is generated from both our water and wastewater treatment plants. The NWSMP assesses the management of wastewater sludge only. A separate plan will be prepared in relation to sludge produced at drinking water plants.

The wastewater treatment process generates sludge which requires further treatment prior to reuse or disposal. Effective and safe management of wastewater sludge, utilising its potential for energy generation and/or reuse where feasible, is identified as a key objective in Irish Water's Water Services Strategic Plan (WSSP).

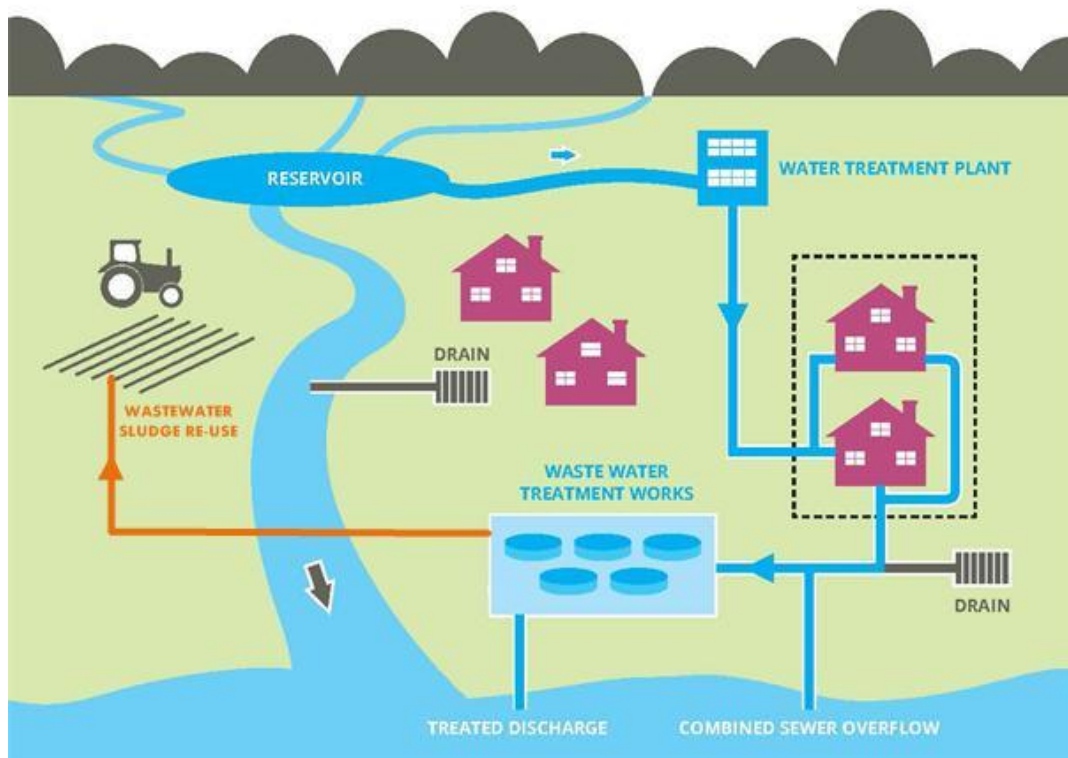


Figure 1.1 – Irish Water Responsibilities

1.2 Background to Plan

Irish Water completed its Water Services Strategic Plan (WSSP) in October 2015 which is required under Section 33 of the Water Service No. 2 Act of 2013. The WSSP forms the highest tier of asset management plans which Irish Water will prepare and it sets the overarching

¹ Since 1 June 2014 (under the Local Government Reform Act 2014), there are 31 city and county councils with integrated municipal districts.

framework for subsequent detailed (Tier 2) implementation plans and water services projects. Figure 1.2 illustrates the position of the WSSP in terms of the overall Irish Water asset management planning and environmental assessment hierarchy context.

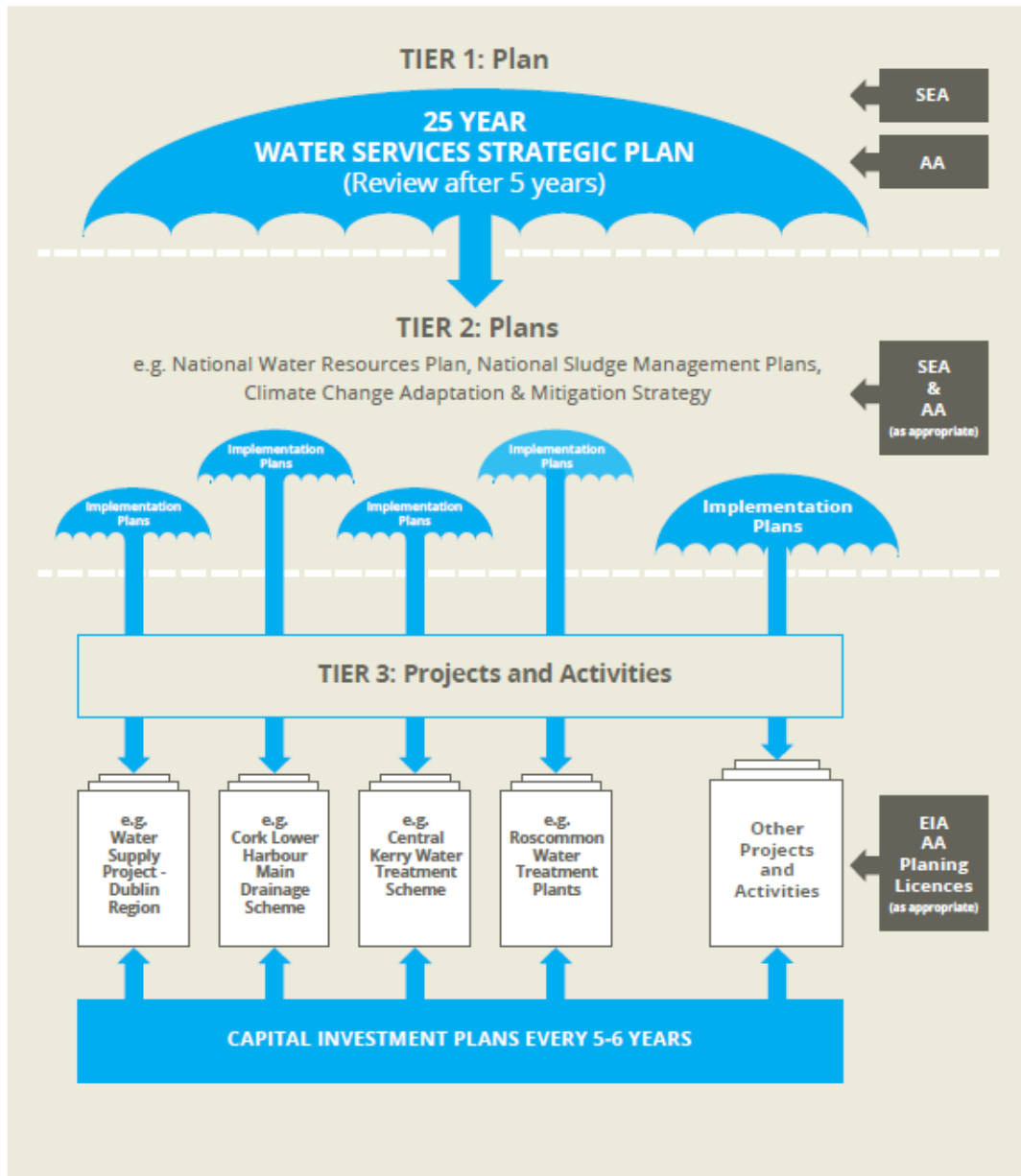


Figure 1.2 - Planning and Environmental Assessment Hierarchy for Water Services

As identified in the WSSP, the implementation of the strategies identified in the WSSP will be detailed in a number of Implementation Plans (Tier 2) which are being prepared by Irish Water following the approval of the WSSP by the Minister of the Environment Community and Local Government in October 2015. One of the Tier 2 Implementation Plans identified is the National Wastewater Sludge Management Plan (NWSMP).

As a public plan, the Draft NWSMP has been subjected to Strategic Environmental Assessment (SEA) in accordance with the European Union (EU) SEA Directive (2001/42/EC) and Appropriate Assessment (under the EU Habitats Directive) and these documents are also published for review.

1.3 Interaction with Irish Water Tier 2 Plans

A number of Tier 2 plans are currently being prepared by Irish Water, some of which will impact, directly or indirectly on the NWSMP. The following Tier 2 plans will have interactions with the NWSMP:

- National Water Resources Plan;
- Lead Compliance Strategy (National Lead in Drinking Water Mitigation Plan);
- Wastewater Compliance Strategy;
- Climate Change Adaptation and Mitigation Strategy;
- Corporate Waste Management Strategy/Plan;
- Sustainable Energy Strategy.

The planning for waterworks sludge management, i.e. sludge from drinking water treatment plants, is being considered separately. The management of liquid sludge, from drinking water treatment plants, is being assessed on a site by site basis, as part of the National Water Resources Plan, to establish whether the sludge will be discharged to sewer or dewatered on site. A separate plan is being developed in relation to recovery, reuse or disposal of waterworks sludge.

Waterworks sludge contains coagulants such as aluminium or ferric sulphate used in the treatment of drinking water. The disposal of waterworks sludge to sewer has a potential impact on the quantity of wastewater sludge produced at a wastewater treatment plant and may also increase the concentration of phosphorus in the sludge.

Irish Water has introduced limits on the quantity of waterworks sludge which may be accepted at a WWTP which will mitigate any potential impact on the treatment process. Where waterworks sludge is discharged to the inlet of a wastewater treatment plant at appropriate levels, it may have a beneficial effect where phosphorus reduction is required as the waterworks sludge typically contains aluminium or ferric sulphate which is beneficial in the removal phosphorus from wastewater.

The National Lead in Drinking Water Mitigation Plan is currently being prepared. One of the options being considered to reduce lead in drinking water is orthophosphate treatment. The extent and location of this dosing is not yet finalised. However, where there is a potential impact on receiving waters, it will be necessary to remove the phosphorus from the wastewater prior to discharge. Studies in the UK, where orthophosphate treatment has been ongoing for a number of years, have indicated that the quantity of wastewater sludge produced can increase by approximately 6%.

The Irish Water Sustainable Energy Strategy is linked to the NWSMP in terms of energy use in producing biosolids, energy generation and transportation. The Sustainable Energy Strategy will describe how Irish Water will achieve our 33% increase in energy efficiency obligation by 2020, using 2009 as our baseline year. The Sustainable Energy Strategy will also set out how Irish Water will mitigate the effects of climate change by reducing our carbon emissions and inform on how we will manage our risk in relation to future energy costs as well as ensuring security of supply.

The efficient generation and use of energy are key to achieving our objectives. Irish Water recognises the opportunity for using wastewater sludge as a renewable energy resource. The Sustainable Energy Strategy will detail how Irish Water will increase the amount of energy we use from renewable sources. The Sustainable Energy Strategy will also inform how Irish Water will work towards the efficient and low carbon transport of materials and staff.

The Irish Water Climate Change Adaptation and Mitigation Strategy is due to be published in 2016. This strategy is currently at the early stages of development but it is expected that our Sustainable Energy Strategy will be used to drive the decarbonisation of our energy mix and

mitigate the effects of climate change. The benefits of treated wastewater sludge as a possible carbon sink may also be considered in the strategy.

The Irish Water Corporate Waste Management Strategy/Plan will address the management of all wastes produced by Irish Water. The particular requirements for the management of wastewater sludge are addressed in the NWSMP in line with Irish Water's overall strategy for waste management.

What is Wastewater Sludge ?

Sludge from wastewater treatment plants is primarily the organic by-product of the biological treatment of wastewater, and comprises the solids removed during the treatment processes. Wastewater treatment plants 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.

Wastewater sludge is considered to be a valuable product with potential benefits in terms of nutrients, organic and energy content. In particular, wastewater sludge is a source of phosphorus which is a limited diminishing resource essential for all plant growth.

1.4 Purpose of National Wastewater Sludge Management Plan

The National Wastewater Sludge Management Plan (NWSMP) is required in order to set out the short, medium and long-term strategy for management of sludge produced at wastewater treatment plants under the control of Irish Water. The NWSMP, in conjunction with the associated Strategic Environmental Assessment, takes into account current legislation and guidance documents in relation to the treatment and utilisation of wastewater sludge in addition to potential environmental impacts and sustainability of proposals. The proposals of the National Wastewater Sludge Management Plan will be used to inform future capital and operational activities in relation to sludge management.

The NWSMP will assess issues in relation to long-term sludge management:-

- Current and predicted future sludge quantities;
- Statutory and guideline requirements for utilisation of sludge;
- Potential for sludge reduction and increased energy recovery;
- Availability of sludge outlets and risks to current outlets;
- Monitoring and reporting on treated sludge quality and lands receiving biosolids.

It is proposed that the NWSMP will have ongoing five yearly reviews. The NWSMP will consider wastewater sludge only, with the potential for imports of domestic wastewater treatment systems sludge (i.e. sludge from septic tanks and individual treatment systems) considered in Section 2.5. Other non-hazardous sludges, such as industrial or agricultural sludges are not considered in this plan with the exception of industrial or commercial sludge treated at wastewater treatment plants under the control of Irish Water. Sludge from water treatment plants will be considered in a separate plan.

1.5 Key Objectives

The Irish Water National Wastewater Sludge Management Plan has been prepared to set out the long-term strategy for management of sludge produced at wastewater treatment plants under the control of Irish Water together with any wastewater sludge accepted by Irish Water from other domestic and non-domestic wastewater treatment plants.

The management of sludge includes sludge production, treatment, transport, reuse or disposal, monitoring, reporting and consultation with stakeholders. Source control of discharges to wastewater treatment plants is also important in ensuring the quality of the treated sludge product. The NWSMP takes into account current legislation, guidance documents and Irish Water policies. The NWSMP reviews current practice in sludge management and assesses options for optimisation. The development of the NWSMP includes a consultation process with the public and stakeholders to allow input from interested parties. The NWSMP sets out a strategy for future capital works, operating procedures, quality control and risk management systems to ensure a sustainable strategy for wastewater sludge management.

The following objectives of Irish Water in terms of sludge management are addressed in this plan:-

- To avoid endangering human health or harming the environment;
- To maximise the benefits of wastewater sludge as a soil conditioner and source of nutrients;
- To ensure that all regulatory and legislative controls are met, and due regard is taken of non-statutory Codes of Practice and industry guidance;
- To establish long term, secure and sustainable disposal routes and outlets;
- To ensure cost-effective and efficient treatment and reuse/disposal techniques;
- To reduce potential for nuisance from sludge transport and sludge facilities;
- To extract energy and other resources where economically feasible;
- To drive operational efficiencies, e.g. through use of Sludge Hub Centres.

The European Commission considers that using wastewater sludge as fertiliser on agricultural soils remains one of the best environmental options, provided it poses no threat to the environment or to animal and human health and is desirable under the Hierarchy of Waste Management, as shown in Figure 1.3. As wastewater sludge arisings cannot be prevented, the primary aim is to minimise production with beneficial reuse of the remaining sludge produced.

Recent communication from the EU² recognises that recycled nutrients are a distinct and important category of secondary raw materials, present in organic waste material, and can be returned to soils as fertilisers. Their sustainable use in agriculture reduces the need for mineral-based fertilisers, the production of which has negative environmental impacts, and depends on imports of phosphate rock, a limited resource.

² Communication from the Commission to the European Parliament, The Council, The European Economic and Social Committee and the Committee of the Regions - Closing the loop - An EU action plan for the Circular Economy (2015)



Figure 1.3 Hierarchy of Waste Management

We aim to treat all wastewater sludge, for use in agriculture, to meet the requirements of the Code of Good Practice for Use of Biosolids in Agriculture and reuse as fertiliser and soil conditioner. This requires a stable pasteurised product, complying with chemical standards for safe use in agriculture or equivalent use. Irish Water will work with stakeholders and industry to develop alternatives for the beneficial reuse of wastewater sludge and the possible recovery of energy and/or constituents in a sustainable and economically viable manner. The NWSMP supports the Hierarchy of Waste Management by optimal minimisation of volume and organic stabilisation followed by reuse with disposal to landfill only considered where alternative reuse or recovery options are not available.

2 Sludge Composition, Loads and Outlets

2.1 Introduction

The quantity of wastewater sludge being produced in Ireland has increased in line with the increase in secondary wastewater treatment since the implementation of the Council Directive 91/271/EEC concerning urban waste water treatment. In 2014, over 93% of wastewater produced in Ireland received secondary treatment or more stringent treatment. This has increased from 25% in 1998. There has consequently been a significant increase in sludge production. Proposed new and upgraded works to provide secondary or more stringent treatment for existing agglomerations and works to reduce stormwater overflows will further increase wastewater sludge production in the coming years.

Over 98% of wastewater sludge produced at Irish Water wastewater treatment plants is currently reused in agriculture including sludge which is composted and subsequently reused in agriculture. Over 95% of this was treated, in accordance with the treatment processes recommended in the *Code of Good Practice for Use of Biosolids in Agriculture*, in 2014 with further improvements to treatment levels introduced during 2015. It is intended to undertake a detailed feasibility study of alternative options for sludge reuse or disposal to reduce the dependence on a single outlet for sludge.

2.2 Minimisation of Sludge

In accordance with the waste hierarchy, minimisation is the next most preferred waste solution after prevention. Wastewater treatment processes can be designed to reduce the quantity of sludge produced. Traditional extended aeration treatment plants with long sludge ages can produce smaller quantities of sludge. However, the additional capital and operating cost is generally insufficient to warrant increasing process tank sizes. Similarly, other wastewater treatment processes such as integrated constructed wetlands (ICWs) significantly reduce the amount of sludge produced. ICWs are being considered by Irish Water where the technology is considered appropriate. New and emerging technologies with substantially lower sludge production are being developed. Techniques for the minimisation of sludge include treatment process modification, sludge digestion, advanced digestion and wetland/reed bed application.

Further details of sludge treatment processes are included in Section 5. The utilisation of these processes needs to be examined on a case by case basis taking into account economic and environmental criteria. It is both environmentally and financially advantageous to make maximum use of existing sludge digestion facilities for minimisation of sludge. For new or upgraded wastewater treatment plants or Sludge Hub Centres, an individual assessment is required to assess whether upgrading to reduce sludge quantities is economically viable.

2.3 Reported Sludge Loads and Outlets

There is an obligation to report wastewater sludge data annually to the EPA. The sludge register data provided to the EPA from 2009 to 2014 is summarised in Table 2.1 below. This is a compilation of all sludge data compiled by the Local Authorities relating to sludge produced within their administrative areas. The requirement for sludge register data only applies to wastewater treatment plants with a population equivalent of greater than 5,000. However, reporting of sludge data to the EPA is also required under the Urban Waste Water Treatment Directive for all licenced plants over 2,000 PE. Sludge quantities are reported as 'tonnes dry solids' equivalent (i.e. net weight of solids fraction only). The total sludge weights are not meaningful without knowing the water content, hence the use of tonnes dry solids equivalent for reporting purposes. There has been some misreporting of data over the last number of years where total tonnes of wet sludge have been reported in some cases. This accounts for the drop in reported sludge production since 2009.

Table 2.1 – Summary of Sludge Register Data

Year	Quantity (tonnes dry solids)			Total
	Agriculture	Landfill	Other (e.g. land remediation, forestry etc.) ¹	
2009	66,194	63	40,521	106,778
2010	82,670	188	7,133	89,991
2011	57,699	304	27,645	85,648
2012	68,329	4	4,096	72,429
2013	66,022	2,866	959	69,847
2014	51,749	381	1,433	53,543
2015	57,643	94	650	58,387

Notes: 1. Sludge reported as “other” in 2014 is all sludge in storage

2.4 Estimated Current and Future Sludge Loads

2.4.1 General

An estimate of the expected sludge production from wastewater treatment plants has been undertaken based on the agglomeration population equivalent (PE) and the type of treatment process in place. A breakdown of the type of treatment nationally is shown in Figure 2.1 below.

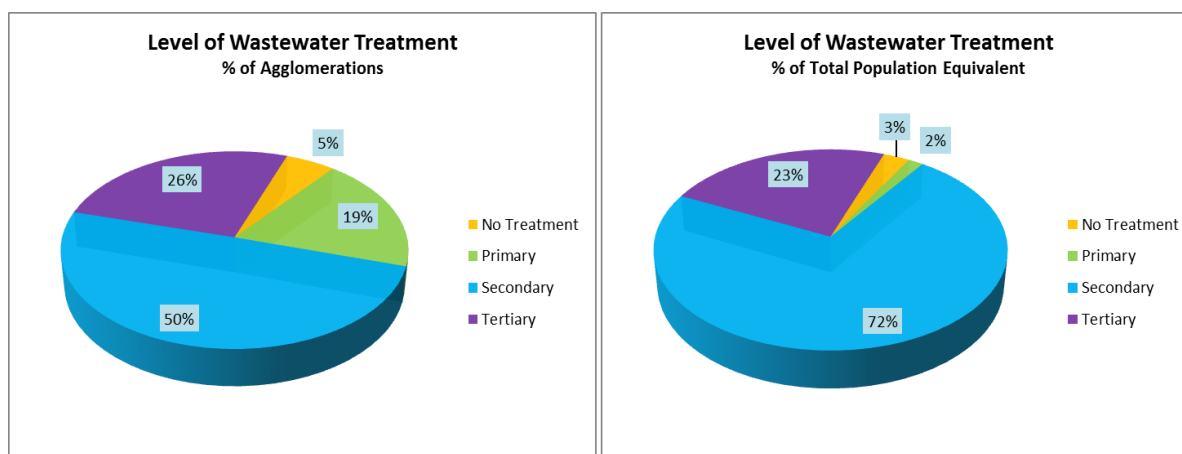


Figure 2.1 – Level of Treatment by % of Agglomerations and Population Equivalent

A substantial number of the existing wastewater treatment plants that currently have secondary treatment will require more stringent treatment for nutrient removal in the coming years. The projected change to sludge loads over the next 25 years will depend on a number of factors. The main factors are as follows:-

- Population and non-domestic effluent growth rates;
- Provision of new or upgraded WWTP's;
- Changes to wastewater treatment processes;
- Changes to sludge treatment processes;
- Increases due to orthophosphate treatment for lead mitigation³;

³ The option of ortho-phosphate treatment is currently being considered in the National Lead in Drinking Water Mitigation Plan. The locations, if any, where this will proceed will be identified in

- Scheduled desludging of small WWTP's;
- Import of domestic wastewater treatment plant (DWWTS) sludge.

2.4.2 Sludge Production per PE

Sludge loading design parameters for the main treatment processes in place in Ireland has been assessed and summarised in Table 2.2. These design parameters will be used to estimate current load and predict future loading. It should be noted that where a wastewater treatment plant is underloaded or designed as an extended aeration system the quantity of sludge produced is lower due to a higher sludge age being achieved in the biological process. In addition where treatment performance is poor, this is likely to show lower sludge production due to losses in the effluent.

Table 2.2 – Sludge Loading per PE

	Treatment Process	g/PE/day¹
1	Primary only	30
2	Primary and secondary sludge	65
3a	Primary, secondary and P removal	70
3b	Primary, secondary and NP removal	65
3b	Primary, secondary and N removal	60
4	Secondary treatment only	55
5a	Secondary and P removal	60
5b	Secondary and NP removal	55
5c	Secondary and N removal	50
6	Reduction with Anaerobic Digestion	30%
7	Reduction with Anaerobic Digestion and hydrolysis	45-55%

Notes:

1. For wastewater treatment plants where detailed information is available on actual sludge production and/or reduction in sludge by digestion these values have been used in estimating the sludge produced.

2.4.3 Population Growth Rate

Population growth rates have been reviewed by ESRI on behalf of Irish Water. Predicted growth rates have been provided on a county by county basis. It is proposed that population growth rates and consequent sludge production should be reviewed every 5-years as part of the 5-year review of the NWSMP. This will allow the most up to date Census and wastewater load data to be used in planning wastewater sludge management. A pro-rata increase in non-domestic effluent is assumed. The quantity of sludge produced at wastewater treatment plants will increase in line with increased populations.

2.4.4 Estimated Sludge Loads

An estimate of current and future sludge production for all municipal wastewater treatment plants has been undertaken as detailed above. These loads are summarised per local authority in Table 2.3 below. The estimated sludge loads for 2015 includes predicted sludge load for treatment of existing wastewater loads at all agglomerations including nutrient removal where required. The completion dates for treatment plants with no treatment will extend beyond 2015 in a number of cases. It is expected that all agglomerations will have treatment by 2021 with 99% compliance with the Urban Wastewater Treatment Directive standards by 2027. As the level of compliance increases the actual sludge load will increase to the predicted sludge loads

2016. Its use would result in a small increase in sludge production due to removal of additional phosphorus in wastewater treatment.

as detailed in Table 2.3. There are additional sludge loads due to imports from private wastewater treatment plants. However, the quantities of such sludge imported, for further treatment is low relative to the indigenous wastewater treatment plant sludge.

Table 2.3 Predicted Sludge Load per County¹

County	TDS/a (2015)	TDS/a (2020)	TDS/a (2030)	TDS/a (2040)
Carlow	1,032	1,066	1,137	1,214
Cavan	1,217	1,321	1,557	1,842
Clare	1,538	1,656	1,921	2,229
Cork ²	5,087	5,331	5,856	6,433
Cork City	3,243	3,409	3,768	4,164
Donegal	1,768	1,848	2,021	2,212
Dublin City	18,036	18,922	20,828	22,925
Dun Laoghaire-Rathdown	1,011	1,061	1,167	1,285
Fingal	3,007	3,155	3,472	3,822
Galway	1,326	1,391	1,531	1,684
Galway City	2,089	2,294	2,765	3,332
Kerry	1,789	1,897	2,134	2,403
Kildare	3,301	3,807	5,067	6,747
Kilkenny	1,332	1,407	1,569	1,751
Laois	1,083	1,154	1,309	1,487
Leitrim	342	343	344	346
Limerick	3,557	3,746	4,153	4,605
Longford	395	399	407	416
Louth ³	2,284	2,359	2,516	2,684
Mayo	1,708	1,838	2,132	2,482
Meath	2,075	2,546	3,836	5,796
Monaghan	927	966	1,049	1,139
Offaly	1,204	1,249	1,343	1,446
Roscommon	875	916	1,004	1,103
Sligo ³	845	864	905	948
Tipperary ³	2,808	2,875	3,013	3,163
Waterford	1,788	1,862	2,017	2,186
Westmeath	1,439	1,495	1,612	1,738
Wexford	2,019	2,071	2,178	2,290
Wicklow	1,768	1,905	2,212	2,570
Total	70,894	75,150	84,820	96,442

Notes:

1. Predicted sludge loads are estimated based on sludge loads with full wastewater compliance and standard sludge production values. Actual sludge loads generated will be lower than the predicted sludge load until full compliance with final effluent standards is achieved at all wastewater treatment plants. A detailed assessment of sludge loads will be undertaken on a case by case basis where new infrastructure is proposed.
2. Predicted sludge loads in Cork include sludge from wastewater treatment plants in Youghal and the Cork Lower Harbour which are currently under construction and will significantly increase sludge production.
3. The sludge quantities in Louth, Sligo and Tipperary are based on predicted sludge quantities at individual wastewater treatment plants. The reduction in sludge following transport to off-site sludge hubs with anaerobic digestion has not been taken into account

There are substantial variations in the predicted and reported sludge volumes. This is due to a number of reasons. The main reasons are considered to be as follows:-

- The predicted sludge loads have been calculated based on reported influent wastewater loads. There is uncertainty on the accuracy of this data as it is normally based on 6 to 12 samples per year with variation in the accuracy of the sampling and flow monitoring equipment;

- The reported sludge loads are based on estimates of sludge dry solids concentrations which are measured infrequently;
- The level of wastewater treatment at a large number of treatment plants is not in accordance with licenced requirements. Compliance with the ELV's set by the EPA will lead to an increase in sludge production in many cases;
- Desludging at some wastewater treatment plants is infrequent, particularly at small septic tank treatment plants;
- The actual sludge produced is normally less than the predicted quantity where there is a high sludge age. This is common where a wastewater treatment plant is substantially underloaded. The quantity of sludge produced may increase where aeration systems are optimised to increase energy efficiency.

2.4.5 Sludge Volume

In order to assess sludge volumes for transport and reuse or disposal, it is essential to know the sludge dry solids concentration in addition to the dry solids production from each WWTP. The volume of sludge produced has been estimated based on the expected performance of sludge thickening and dewatering facilities on site. Ongoing monitoring of dry solids concentration is required to ensure effective thickening performance so that volumes of sludge for transport are minimised where possible.

2.5 Domestic Wastewater Treatment Systems Sludge

Irish Water has no statutory obligations in relation to Domestic Waste Water Treatment Systems, (DWWTSs), (septic tanks and individual single house WWTP's). However, following the system of registration put into place over the last number of years, and ongoing inspections, it is expected that emptying of DWWTS's will become more frequent and the demand for acceptance of DWWTS sludge at wastewater treatment plants will increase. Up to 90% of DWWTS's are septic tanks with the remainder being package plants. The WSSP adopted an EPA recommendation that Irish Water plan for reception of this type of sludge.

An EPA Strive Report, Strive Report Series No.123, on the *Management Options for the Collection, Treatment and Disposal of Sludge Derived from Domestic Wastewater Treatment Systems* identifies that upgrades are needed at existing wastewater treatment plants to provide for acceptance of sludge from individual septic tanks. A number of sites have been recommended in the Strive Report as suitable locations for accepting sludge from DWWTS's. The number of WWTP sites required will depend on the type of desludging, i.e., where sludge is dewatered to 6-8% on a scheduled routine, the sustainable transport distance increases from approximately 25km to 80km.

In order to develop nationwide facilities for acceptance of sludge from DWWTS's, a minimum of three new acceptance facilities are recommended by the Strive Report. If mobile dewatering is not used, approximately 13 new acceptance facilities would be required. The existing sludge reception facilities are not generally adequately sized to cater for all the Domestic WWTS's sludge generated in the surrounding region and some level of upgrade would be required.

It is recommended that any new or upgraded sludge acceptance facilities to cater for sludge from DWWTS's, would be developed at those sites defined as satellite dewatering sites. This would provide efficiencies in terms of acceptance and blending infrastructure in addition to efficiencies in terms of manpower required for supervision, monitoring and reporting. However, the number and size of these facilities would be based on a commercial demand. Sludge acceptance facilities for DWWTS sludge will need to generate an adequate income stream from the acceptance of DWWTS sludge to fund initial investment and the ongoing CAPEX and OPEX costs associated with treating and disposing of DWWTS sludge. Irish Water will continue to accept DWWTS sludge at wastewater treatment plants where the acceptance of sludge is not having a negative impact on the operation of the plant and will review the capacity available for

accepting DWWTS sludge if there is a significant increase in the demand for acceptance facilities.

It is estimated that 20% to 30% of the estimated volume of DWWTS sludge produced is currently collected by private contractors and treated at Irish Water facilities. It is likely that the recommended average desludging frequency of 3 years, recommended in the Strive Report, would only be complied with if new legislation and/or enforcement is undertaken. The implementation of scheduled desludging of septic tanks, as recommended in the Strive report referred to above, would provide transportation efficiencies and potential cost benefits to customers.

Table 2.4 – Estimated Sludge Load per County from Domestic WWTS’s

Local Authority	Total DWWTS	Sludge Production (tds/a)	Sludge Volume (m3/a) @ 2% D.S.	Sludge Volume (m3/a) @ 6% D.S.
Carlow	7,190	142	7,100	2,367
Cavan	14,477	285	14,250	4,750
Clare	19,769	390	19,500	6,500
Cork City	586	12	600	200
Cork County	57,993	1143	57,150	19,050
Donegal	32,955	650	32,500	10,833
Dublin City	2,718	54	2,700	900
Dún Laoghaire-Rathdown	1,928	38	1,900	633
Fingal	5,213	103	5,150	1,717
Galway City & County	43,306	854	42,700	14,233
Kerry	28,277	557	27,850	9,283
Kildare	16,795	331	16,550	5,517
Kilkenny	15,368	303	15,150	5,050
Laois	11,309	223	11,150	3,717
Leitrim	7,005	138	6,900	2,300
Limerick City & County	24,627	485	24,250	8,083
Longford	7,556	149	7,450	2,483
Louth	11,633	229	11,450	3,817
Mayo	26,659	525	26,250	8,750
Meath	21,687	427	21,350	7,117
Monaghan	12,065	238	11,900	3,967
Offaly	11,170	220	11,000	3,667
Roscommon	14,297	282	14,100	4,700
Sligo	11,192	221	11,050	3,683
South Dublin	2,266	45	2,250	750
Tipperary	26,784	528	26,400	8,800
Waterford City & County	11,954	236	11,800	3,933
Westmeath	12,165	240	12,000	4,000
Wexford	26,267	518	25,900	8,633
Wicklow	12,070	238	11,900	3,967
Totals	497,281	9,804	490,200	163,400

The spatial distribution of existing DWWTS systems has been considered in assessing areas where future sludge acceptance facilities or upgrades of existing facilities are likely to be required. It is not expected that there will be significant increases in DWWTS sludge produced over the duration of the NWSMP as population growth in rural areas is low.

2.6 Type of Sludge

There is a range of sludge types produced at Irish Water wastewater treatment plants. This includes the following:-

- Primary sludge;
- Biological sludge – including activated sludge and humus sludge;
- Chemical sludge;
- Septic tank sludge.

Sludge is also accepted at a number of wastewater treatment plants from Domestic Wastewater Treatment Plant Systems and industrial or commercial sludge subject to available capacity and compliance with import procedures.

2.6.1 Primary Sludge

Primary sludge is typically produced in Ireland in the very large or very small wastewater treatment plants, i.e. >10,000 PE and < 1,000 PE. Primary treatment is included on approximately 170 licenced wastewater treatment plants. Over 200 of the certified wastewater treatment plants (i.e. with a P.E. < 500) are estimated to have primary treatment. In larger wastewater treatment plants, primary settlement is normally included together with anaerobic digestion. In smaller agglomerations, there may be primary treatment only or primary treatment within a package type wastewater treatment plant.

The addition of primary treatment at an existing wastewater treatment plant can provide a relatively straightforward and economic way of increasing the capacity of the plant. The overall quantity of sludge increases where primary treatment is used as it is a physical process to remove solids with no biological reduction of the sludge. The cost of treating and disposing of additional sludge in addition to the capacity of existing sludge treatment equipment should be considered in any proposal to add primary treatment.

Primary sludge is typically more odorous than biological sludge and management of this type of sludge must take into account the potential for an odour nuisance.

2.6.2 Biological Sludge

Biological sludge is produced at approximately 80% of wastewater treatment plants accounting for over 94% of the population equivalent treated. Biological treatment is most commonly by way of the activated sludge process but other processes including biological filters, rotating biological contactors and trickling filters are also utilised. The quantity of sludge produced 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. Therefore, where nitrogen removal is included, the estimated sludge production is reduced. However, it should be noted that in some cases, existing wastewater treatment plants have been designed for longer sludge ages where nitrogen removal was not required. Therefore estimated sludge production must be based on an understanding of the actual wastewater treatment processes at each site.

2.6.3 Sludge from Phosphorus Removal

The most common method for removal of phosphorus is chemical dosing with ferric sulphate or ferric chloride. The removal of phosphorus from wastewater using chemical dosing leads to an increase in sludge production of up to 25%. Biological phosphorus removal is in place in a small number of WWTP's. However, due to the additional process control and infrastructure required for biological phosphorus removal, chemical removal is generally favoured. However, the number of WWTP's with biological phosphorus removal may increase due to the high cost of chemicals and high sludge production associated with chemical dosing for phosphorus removal.

2.6.4 Changes to Sludge Treatment Processes

The quantity of sludge produced and the consequent cost of treatment and reuse or disposal needs to be assessed in terms of both the volume and the total dry solids. A significant

proportion of the costs associated with sludge relate to sludge transport. This ranges from less than 10% at larger wastewater treatment plants up to 40% of the cost for smaller wastewater treatment plants in areas remote from the final treatment and disposal locations. There is a balance to be achieved between the cost of sludge transport and the cost of treatment to reduce the volume of sludge. This is assessed in more detail in **Section 6**.

The main technology used to reduce the quantity of sludge is anaerobic digestion including advanced anaerobic digestion processes which may include hydrolysis or pasteurisation. Sludge quantities may be reduced by up to 50% with advanced anaerobic digestion techniques which increase the level of destruction of volatile organic solids.

2.6.5 Desludging Small Wastewater Treatment Plants

There are a large number of small wastewater treatment plants in Ireland including municipal septic tanks. In some cases desludging is undertaken only when a problem occurs. It is more cost effective in terms of transport costs and operation and maintenance of the wastewater treatment plants to undertake scheduled desludging. This also reduces the potential for pollution incidents and enables more efficient operation of the wastewater treatment plant.

2.6.6 Domestic Wastewater Treatment Plant Sludge

Sludge from DWWTS's (septic tanks and individual private WWTP's) is not the responsibility of Irish Water. However, it is expected that following the introduction of legislation in regard to registration of septic tanks, that more frequent desludging of septic tanks will be required. As detailed in Section 2.5, the most economical and practical way to provide suitable treatment and disposal of this sludge is within Irish Water controlled wastewater treatment plants. 90% of individual treatment systems are septic tanks with approximately 497,000 houses within Ireland reported in the 2011 census as having a septic tank or individual treatment system. The percentage of the population connected to public schemes varies widely across Ireland with over 98% reported as connected to public schemes in the main urban centres in the 2011 census. Many counties with a larger rural population reported less than 50% of houses connected to a public scheme in the 2011 census.

2.7 Constituents of Wastewater Sludge

Wastewater sludge consists of the organic residue of the wastewater treatment processes. Wastewater sludge contains organic matter and nutrients that can provide soil benefits. The sludge also, however, contains contaminants including metals, pathogens, and organic and emerging pollutants, such as pharmaceutical residues. Monitoring of sludge is required prior to use in agriculture with monitoring undertaken of both sludge and soils. Organic and emerging pollutants include persistent organic pollutants, pharmaceuticals and personal care products. The risks associated with the constituents of wastewater sludge are considered further in Section 9.12. Detailed information on the levels of organic and emerging pollutants in wastewater sludge is not readily available due to the large number of potential compounds and the variable factors contributing to them.

The legislation and other standards controlling the use of wastewater sludge in agriculture are detailed in Section 3. The amount of phosphorus in wastewater sludge is normally the limiting parameter in agricultural use based on the nutrient level needed for crops. Nutrient management plans are developed in order to manage the application of phosphorus and nitrogen to plant needs.

2.8 Value of Wastewater Sludge

Wastewater sludge can be considered to be a valuable resource due to its energy content in addition to its value for use on land. Anaerobic digestion of wastewater sludge produces methane gas which by conversion to electricity can significantly reduce energy costs for operating wastewater treatment plants, with energy recovery further increased where thermal

hydrolysis is provided in addition to conventional anaerobic digestion with the sludge quantity for reuse or disposal reduced by up to 50% during the digestion process.

Where sludge is used in agriculture or other land-use, there are benefits from provision of nutrient content in terms of phosphorus and nitrogen and also levels of potassium, sulphur, magnesium and micronutrients which are present in the sludge. In addition, the organic content of the sludge can improve soil quality.

3 Review of Standards and Plans

3.1 Introduction

The majority of sludge treatment standards and legislation relate to agricultural use of wastewater sludge. Waste management legislation is also relevant to the management of wastewater sludge.

In addition to legislation there are a number of guidance documents and plans both nationally and internationally in relation to sludge management. The regional waste management plans for Ireland, published in May 2015, consider the quantities of wastewater sludge being produced and the requirements for management. The European Committee for Standardisation (CEN) has issued a number of documents in relation to wastewater sludge. Sludge management plans were prepared by Local Authorities as a subset of their obligations for waste management planning.

3.2 Current Legislation

There are three main European Directives which significantly impact the management of wastewater sludge as follows:-

- *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 - referred to hereafter as the Sewage Sludge Directive;*
- *Council Directive 91/676/EEC concerning the protection of waters against pollution caused by nitrates from agricultural sources - referred to hereafter as the Nitrates Directive;*
- *Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives - referred to hereafter as the Waste Framework Directive.*

3.2.1 Sewage Sludge Directive

The main European legislation in relation to use of wastewater sludge is the Council Directive 86/278/EEC of 12 June 1986 on the protection of the environment, and in particular of the soil, when wastewater sludge is used in agriculture (*Sewage Sludge Directive*). The Directive 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 summarised in Table 3.1.

Table 3.1 – Maximum Annual Rates of Application of Parameters in Wastewater Sludge

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

Table 3.2 – Maximum Levels of Parameters in Soil

Parameter	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%, provided that there is no resulting hazard to human health, the environment or, in particular, ground water

3.2.2 Waste Framework Directive

The management of the sludge is governed by waste legislation based on European Directives. The Waste Framework Directive establishes the framework requirements for management of waste and the main provisions relating to wastewater sludge management in Ireland have been transposed through the following legislation:-

- Waste Management Act of 1996;
- European Communities (Waste Directive) Regulations 2011 (S.I. 126 of 2011);
- S.I. 821 of 2007 Waste Management (Facility Permit and Registration) as amended by S.I. 86 of 2008, S.I. 320 of 2014 and S.I. 546 of 2014;
- S.I. 820 of 2007 Waste Management (Collection Permit) Regulations 2007, as amended by S.I. 87 of 2008 and S.I. 197 of 2015;
- S.I. 32 of 2010 - Waste Management (Registration of Sewage Sludge Facility) Regulations.

Wastewater sludge is classified as a waste under the EU “List of Waste “Codes in Irish Legislation⁴. A waste licence is not required for wastewater sludge for use in agriculture. The use of wastewater sludge on non-agricultural land, e.g. silviculture and biomass crops, is regulated by S.I. 821 of 2007 as amended. S.I. No. 32 of 2010, Waste Management (Registration of Sewage Sludge Facility) Regulations 2010, introduced a requirement for registration of wastewater sludge facilities. This excludes wastewater treatment plants and as

⁴ EWC 19 08 05 sludges from treatment of urban waste water

such does not apply to Irish Water sludge facilities which are located within wastewater treatment plants. Facilities which are licenced under a Waste Licence are also excluded from these regulations. The collection and transport of sludge is regulated by S.I. 821 of 2007, as amended.

3.2.3 Nitrates Directive

The other main legislation relevant to sludge reuse in agriculture is the Nitrates Directive (Council Directive 91/676/EEC concerning the protection of waters against pollution caused by nitrates from agricultural sources). This Directive was transposed into Irish legislation by S.I. No. 610 of 2010: which has subsequently been replaced by S.I. 31 of 2014 European Union (Good Agricultural Practices for Protection of Waters) Regulations 2014 as amended by S.I. 134 of 2014.

3.3 Proposed Legislation

As detailed in Section 3.2, the main European legislation in relation to use of wastewater sludge is the *Sewage Sludge Directive*. The European Commission is currently considering whether the current Directive should be revised. A detailed study of current sludge disposal practices was undertaken by Milieu Ltd, WRc and RPA for the European Commission, DG Environment under Study Contract DG ENV.G.4/ETU/2008/0076. Reports were issued in 2010⁵. This study was undertaken as part of the assessment being undertaken by the European Commission on whether the current Directive should be reviewed. The study considered the agricultural reuse of wastewater sludge in accordance with Directive 86/278/EEC and the options for changes to this directive as follows:-

- Option 1: do-nothing: keeping the Directive as it is;
- Option 2: introduce certain more stringent standards, especially for heavy metals, standards for some organics and pathogens, and more stringent requirements on the application, sampling and monitoring of sludge;
- Option 3: introduce more stringent standards across all substances and bans on application of sludge to some crops;
- Option 4: total ban on the use of sludge on land; and
- Option 5: repeal of the Directive.

This study evaluates the cost impact of the options identified but does not make any specific recommendations apart from excluding repeal of the Directive as an option, i.e. Option 5. It has been noted that Option 4, total ban on the use of sludge on land would have a significant cost implication in addition to conflicting with the waste hierarchy in the Waste Directive which gives priority to the recovery and recycling of waste. The report notes that there is no evidence of problems due to the land application of wastewater sludge. However, its acceptance in terms of public perception is recognised. This is examined further in the SEA and in Sections 2.5 and 9 of this document, including assessment of alternatives.

The Commission has undertaken a review of EU waste policy and legislation under REFIT which was due to be concluded in 2014.⁶ It is expected that future legislation will provide a broader protection of soil, in addition to more stringent controls on the use wastewater sludge. A revision of the EU regulation on fertilisers is proposed, which will involve new measures to facilitate the EU wide recognition of organic and waste-based fertilisers, thus stimulating the sustainable development of an EU-wide market. Irish Water will undertake assessments of EU reports and proposed legislation on an ongoing basis to ensure that any new or upcoming requirements in relation to the management of wastewater sludge are complied with.

⁵ Working document on sludge and bio-waste: <http://ec.europa.eu/environment/waste/sludge/>

⁶ Communication from the Commission to the European Parliament, the Council, the European Social and Economic Committee and the Committee of the Regions; Regulatory Fitness and Performance (REFIT): Results and Next Steps

3.4 Legislation within other EU Member States

The Sewage Sludge Directive has been implemented in EU member states by national legislation. In some countries, more stringent requirements have been included in the legislation. In general, untreated sludge is no longer applied to land within the EU and in several member states it is prohibited. National, and in some cases regional, requirements vary across the EU. In the Netherlands, the use of wastewater sludge in agriculture is banned and in regions of other countries including the Flemish region in Belgium and Bavaria in Germany, stringent standards have resulted in an effective ban on use of sludge for agriculture. Denmark, Finland and Sweden also have legislation in place which is substantially more stringent than that required by the *Sewage Sludge Directive*. In the UK and Sweden, voluntary agreements set more stringent requirements than those in the Directive or in national regulations. As further detailed in Section 8, reuse in agriculture is the main outlet for treated sludge in the EU with sludge produced by wastewater treatment plant being used in accordance with national legislation in 23 EU countries.

3.5 Sludge Treatment Standards and Guidance Documents

3.5.1 EU Standards

The European Committee for Standardisation, CEN, develops and publishes European Standards and technical specifications to meet the needs of European organisations to improve safety, quality and reliability of products, services, processes. CEN have produced a number of Technical Reports in relation to wastewater sludge. The main standards and reports taken into account in developing the wastewater sludge strategy for Irish Water are as follows:-

- CEN/TR 13097:2010 : Characterization of sludges - Good practice for sludge utilisation in agriculture 2010-06-02;
- CEN/TS 13714:2013: Characterization of sludges - Sludge management in relation to use or disposal 2013-07-24;
- CR 13846:2000 : Recommendations to preserve and extend sludge utilization and disposal routes 2000-03-22;
- CEN/TR 15584:2007 : Characterisation of sludges - Guide to risk assessment especially in relation to use and disposal of sludges 2007-07-25;
- CEN/TR 15809:2008 : Characterization of sludges - Hygienic aspects - Treatments 2008-11-26.

3.5.2 Sludge Treatment Guidance Documents

The main guidance document referred to in current contracts for Irish Water in relation to sludge treatment is the *Code of Good Practice for the Use of Biosolids in Agriculture (DoELG, 1999) (COGP)*. This document provides detailed information on good practice for both treatment and disposal. The requirement for treatment in the COGP is a more onerous requirement than current legislation requires. It is Irish Water policy to comply with the *COGP*. The sampling and analysis of sludge and soil is carried out in accordance with this document. Irish Water intends to liaise with the Department of Housing, Planning, Community and Local Government (formerly the Department of the Environment, Community and Local Government) in relation to a review of the *Code of Good Practice for the Use of Biosolids in Agriculture* to take into account current legislation. Irish Water proposes to develop Standard Operating Procedures for sludge management which will include the requirements in relation to landspreading. These Standard Operating Procedures will incorporate the requirements of the *COGP* and current legislation and will be updated as necessary to taken into account any update of the *COGP* or legislation.

The requirement for additional sampling to ensure that there are no long-term impacts on soil quality where sludge is used in agriculture will be reviewed on an ongoing basis taking into account current legislation, guidance documents, EU standards and codes of practice and the latest available research.

The Food Safety Authority of Ireland (FSAI) produced a guidance document for landspreading in relation to food safety⁷: This document states that the use of untreated wastewater sludge in agriculture is a matter of concern for food safety and recommends that all sludge undergoes treatment.

3.5.3 International Guidance on Sludge Treatment and Disposal

The main other source of guidance documents and regulations in relation to treatment and disposal of wastewater sludge is the United States Environmental Protection Agency (US EPA). The terminology of 'Class A' and 'Class B' commonly used in Ireland originates from *The Standards for the Use or Disposal of Sewage Sludge*, CFR Part 503, issued by the US EPA. The treatment processes recommended in the Code of Good Practice for the Use of Biosolids in Agriculture provide a product equivalent to a Class A product.

3.6 Waste Management Plans

Three Waste Management Planning Regions have been set up and draft plans prepared for each of the regions. The regions for the Waste Management Plans are the planning regions, as set out in S.I. No. 573/2014 - Local Government Act 1991 (Regional Assemblies) (Establishment) Order 2014 and are the same as the regions used by Irish Water, i.e. East-Midlands, North-West (Connacht-Ulster) and Southern. The Regional Waste Management Plans were launched on 18th November 2014 for public consultation. The final plans were published in May 2015.

The regional waste management plans refer to sludge management by Irish Water and propose that ongoing liaison is undertaken. Policy H1 of each of the Regional Waste Management Plans proposes that the regional waste authorities '*Work with the relevant stakeholders and take measures to ensure systems and facilities are in place for the safe and sustainable management of sludges (sewage, waterworks, agricultural, industrial, and septic tank) generated in the region having due regard to environmental legislation and prevailing national guidance documents*'. Ongoing liaison between Irish Water and the Regional Waste Authorities, Local Authorities and other stakeholders is necessary to ensure that all aspects of sludge management are properly controlled. This will include liaison in relation to the availability of alternative thermal treatment sludge outlets nationally.

3.7 Review of Sludge Management Plans

3.7.1 General

Previous guidance documents on sludge strategy and management included the Strategy Study On Options For The Treatment And Disposal Of Sewage Sludge In Ireland (DoELG 1993) and *Sludge Management Plans: A Guide To Their Preparation and Implementation (DoELG 1998)*.

Sludge management plans were prepared by individual Local Authorities based on *Sludge Management Plans: A Guide To Their Preparation And Implementation (DoELG 1998)*. The sludge management plans examined all non-hazardous sludge produced in each local authority area. The sludge management plans were intended to be a subset of the relevant waste management plan and in some cases were adopted as such. However, in most cases, the sludge management plan was referred to in the waste management plan but did not form part of the document.

The DoELG document, 'Sludge Management Plans: A Guide to Their Preparation and Implementation' recommended the adoption of a 'Sludge Hub Centre and Satellite Site' system for the treatment of wastewater sludge. Such a system provides for wastewater sludge from outlying rural works to be directed via intermediate WWTP's (Satellite dewatering sites) where

⁷ Food Safety Implications of Land-spreading – Agricultural, Municipal and Industrial Organic Materials on Agricultural Land used for Food Production in Ireland, FSAI 2008

sludge is dewatered prior to transfer to a centralised treatment facility (the Sludge Hub Centre). The dewatering of sludge at the Satellite Dewatering Sites reduces onward transport costs and traffic movements. The Hub Centres facilitate the effective treatment of sludge and its storage prior to final reuse. Off-site storage of treated sludge is used to cater for constraints on land spreading due to seasonal factors.

3.7.2 Recommendations of Sludge Management Plans

Each of the sludge management plans set out recommendations for sludge transport, use of satellite / hub centres and types of sludge treatment at each location. The sludge management plans also included information in relation to sludge loads, existing infrastructure and proposed upgrades. However, as the majority of these plans are over 10 years old, the information is not up-to-date.

A review of the main recommendations of the county sludge management plans and subsequent reviews has been undertaken. A summary of the recommended Sludge Hub Centres and satellites has been included in Table 3.3. A summary of the current status of Sludge Hub Centres is included in Table 3.4.

Table 3.3 Summary of the Recommended Hub Centres and Satellites in County Sludge Management Plans

Local Authority	SMP Year	Proposed Sludge Hub (s)	Proposed Sludge Satellites (s)
Carlow	2001 smp	Carlow	Tullow, Bagnalstown (short-term only)
Cavan	2009 review	Cavan	None
Clare ¹	2003	Ennis	Lisdoonvarna, Kilkee, Mountshannon, Sixmilebridge, Scarriff
Cork City ¹	2002	Carrigrennan (no imports)	None
Cork ¹	2002	Skibereen; Castletownbere; Ringaskiddy; Ballincollig; Midleton; Mallow and Mitchelstown	Bantry; Clonakilty; Blarney; Bandon; Fermoy; Buttevant and Kanturk
Donegal	2006	Donegal Town, Letterkenny	Buncrana, Gweedore, Carndonagh, Ballybofey/Stranorlar, Dunfanaghy/Portnablagh, Milford, Ballyshannon, Killybegs
Dublin City	-	Ringsend	None
Dun Laoghaire Rathdown	2002	Shanganagh (no imports)	None
Fingal	2013 review	GDD WWTP	Swords, Malahide, Barnageeragh, Portrane/Donabate and Oldtown. Cake only to be transferred to SHC.
Galway City ¹	2011	Mutton Island (no imports)	None
Galway ¹	2011	East Galway WWTP	Tuam, Loughrea, Oughterard, Clifden and Ballinasloe
Kerry	2003	Tralee, Killarney, Caherciveen and Waterville, Listowel	Castleisland, Kenmare, Killorglin and Dingle
Kildare	2001	Osberstown	Osberstown, Leixlip, Athy and Castledermot
Kilkenny	2003	Kilkenny City	None
Laois	2001	Portlaoise	Mountmellick and Portarlinton
Leitrim	2009 review	Carrick-on-Shannon	Manorhamilton and Ballinamore
Limerick City and County ¹	2003	Limerick City and Ennis	Rathkeale, Newcastlewest, Foynes / Shanagolden and Cappamore
Longford	2006 review	Longford	None
Louth	1999	Dundalk and Drogheda	None

Mayo	2002 review	Ballina and Derrinnumera Landfill	Westport, Ballinrobe, Claremorris, Swinford, Ballina, Achill Island, Achill Sound and Newport
Meath	2001	Navan	Kells, Castletown Tara, Duleek and Enfield
Monaghan	2002	Monaghan and Carrickmacross	Smithborough
North Tipperary ²	2003	Nenagh	Thurles
Offaly	2001	Tullamore	Birr, Ferbane and Edenderry
Roscommon	2007 review	Roscommon	Castlerea
Sligo	2002	Sligo	Ballymote, Enniscrone, Tubbercurry, Collooney and Grange
South Dublin	-	n/a	n/a
South Tipperary ²	1999/ 2000	Clonmel	Fethard, Cashel, Cahir and Carrick-on-Suir
Waterford City	2003	Waterford	None
Waterford	2001	Dungarvan	Cappoquin and Portlaw
Westmeath	2002	Mullingar and Athlone	Castlepollard, Moate and Rochfordbridge
Wexford	2001	Wexford	Courtown, Enniscorthy, New Ross
Wicklow	2010 addendum	Wicklow	Blessington, Baltinglass, Carnew, Arklow and Rathdrum

Notes:

1. Single plans prepared for Limerick City and County and County Clare, Cork City and County, Galway City and County
2. North and South Tipperary became a single local authority in 2014

Table 3.4 Summary of the Current Status

Local Authority	Sludge Satellites(s) / Hub (s)
Carlow	Sludge import facilities at Carlow (Mortarstown WWTP), Tullow and Muinebheag. Temporary sludge treatment (lime stabilisation) at Carlow (Mortarstown WWTP)
Cavan	Sludge import facilities with screening at Cavan; off site treatment and disposal
Clare	Off site treatment and disposal. Sludge import facilities at Scariff
Cork City Council	Sludge treatment at Carrigrennan with no import facilities.
Cork County Council	Separate sludge contracts for four regions with off site treatment. Liquid sludge import facilities at Blarney and Buttevant.
Donegal County Council	Sludge hubs with thermal drying complete at Letterkenny and Donegal Town. Hubs include liquid and cake import facilities.
Dublin City Council	Sludge hub at Ringsend complete. Liquid sludge import facilities at Ringsend.
Dun Laoghaire Rathdown CC	Sludge treatment at Bray-Shanganagh with no import facilities.
Fingal County Council	Sludge hub planned as part of GDD WWTP.
Galway City Council	Sludge treatment with no sludge import facilities.
Galway County Council	Temporary sludge treatment (lime stabilisation) facilities at Tuam.
Kerry County Council	Off site treatment and disposal
Kildare County Council	Sludge Hub Centre at Osberstown not currently operational. Upgrade of sludge hub including liquid and cake sludge import facilities ongoing.
Kilkenny County Council	Kilkenny City operating as sludge hub with temporary lime stabilisation.
Laois County Council	Portlaoise sludge hub complete. Liquid and cake sludge import facilities at hub.
Leitrim County Council	Liquid sludge import facilities at Carrick-on-Shannon. Off site treatment and disposal
Limerick City Council	Limerick SHC complete. Liquid and cake sludge import facilities at hub.
Limerick County Council	Limerick SHC complete. Liquid and cake sludge import facilities at hub.
Longford County Council	Temporary sludge treatment (lime stabilisation) provided at Longford.
Louth County Council	Sludge Hub Centres complete in Dundalk and Drogheda. Liquid and cake sludge import facilities at Dundalk hub.
Mayo County Council	Off site treatment and disposal
Meath County Council	Temporary sludge treatment (lime stabilisation) provided at Navan.
Monaghan County Council	Off site treatment and disposal
Offaly County Council	Sludge Hub Centre complete at Tullamore. Liquid and cake sludge import facilities at hub.
Roscommon County Council	Off site treatment and disposal
Sligo County Council	Sludge Hub Centre complete. No satellites proposed.
Tipperary CC	Thermal dryer at Clonmel for sludge from South Tipperary. Liquid and cake sludge import facilities at hub, liquid sludge acceptance facilities at Cahir, Carrick-on-Suir, Cashel, Fethard and Tipperary Town. North Tipperary sludge treated off-site

Waterford City Council	Sludge Hub Centre complete at Waterford City WWTO; no import facilities
Waterford County Council	Sludge Hub Centre complete at Dungarvan with import facilities
Westmeath County Council	Sludge Hub Centre complete at Mullingar. Liquid and cake sludge import facilities at hub.
Wexford County Council	Sludge Hub Centre complete at Wexford. Liquid and cake sludge import facilities at hub.
Wicklow County Council	Sludge hub complete at Wicklow with import facilities for sludge cake only. Liquid sludge imports discharged to WWTP.

4 Consultation Process

4.1 Introduction

In order to successfully implement a long term sustainable sludge management strategy it is important not only to comply with legislation but also to ensure confidence of stakeholders including government departments, agricultural and food bodies, local communities, environmental bodies, users of the final product and any other stakeholders impacted by the strategy.

4.2 Stakeholders / Consultees

A list of statutory and other interested parties to be consulted was prepared at an early stage prior to publication of the Strategic Environmental Assessment Scoping Report. In addition to the identified consultees, Irish Water placed a newspaper advertisement in the Irish Independent on 12th May 2015 and published information on the Irish Water website in order to inform the public and any other interested parties of the development of the NWSMP, SEA and AA.

Irish Water placed a newspaper advertisement for the statutory consultation on the Draft NWSMP and associated environmental reports in the Irish Independent on 24th March 2016 and updated the Irish Water Website with information on the plan and the Draft NWSMP and associated environmental reports available as downloads. A copy of the Draft NWSMP and associated environmental reports was also sent to each Local Authority with a request to make the documents available at planning counters.

4.3 Public Information Strategy

There are three phases to the public information strategy for the NWSMP as follows:-

- Non-statutory public consultation at SEA Scoping stage;
- Statutory consultation on the Draft NWSMP and associated environmental reports and;
- Publication of the finalised NWSMP and SEA Statement.

A project roadmap has been prepared to provide a synopsis of the project activity, what it will involve and how and when the public can participate. A copy of this is included in **Figure 4.1**. Submissions from the first stage of consultation at the SEA Scoping stage were reviewed and taken into account in the development of the Draft NWSMP and associated environmental reports.

Submissions on the Draft NWSMP and associated environmental reports have been taken into account, in the preparation of final documents.

NWSMP Project Roadmap



Figure 4.1 – Roadmap for NWSMP Project

4.4 Public Consultation Feedback Report

An eight-week consultation period for the NWSMP and SEA commenced on 23rd March 2016 and finished on 18th May 2016. Submissions on the content of the Draft NWSMP, the Environmental Report and the Natura Impact Statement were received from twenty three stakeholders and interested parties.

All feedback received as part of this second consultation – Consultation 2 - has been reviewed by the project team and the issues raised has been published in the NWSMP Consultation 2 Report and is published on the website www.water.ie/wastewater-sludge-management.

Submissions from individuals are reported anonymously in the Consultation Reports, while feedback from organisations is attributed to them. Feedback from the two stages of public consultation has informed the National Wastewater Sludge Management Plan.

The reports on the two stages of consultation, namely Consultation 1 Report and Consultation 2 Report are published on the website www.water.ie/wastewater-sludge-management. The consultation reports provide further details of the consultation process and feedback.

The feedback from the two stages of consultation has been considered both in the development of the plan and in the final documents. The SEA Statement, published on the website www.water.ie/wastewater-sludge-management, provides details on how the Strategic Environmental Assessment and consultation process has informed the development of the final NWSMP.

The main topics in the submissions received in the public consultation are as follows:-

- Agricultural reuse and associated risks;
- Benefits of reuse of wastewater sludge in land application;
- Energy recovery;
- Acceptance of Domestic Wastewater Treatment Systems sludge.

Additional consideration has been given to these topics within the plan and “Agri-Food” has been added as an additional topic area in the Strategic Environmental Assessment to specifically assess the implications of the plan on the agri-food sector. Prior to the next iteration of the NWSMP, a detailed feasibility study on alternative outlet options will be completed to further address the concerns of agricultural industry stakeholders and to assess alternative options proposed by stakeholders during the public consultation phase including energy recovery options, use on energy crops, thermal treatment and use in cement industry. This will identify options that can be developed that will reduce the dependency on reuse in agriculture.

5 Sludge Treatment Processes

5.1 Introduction

Sludge processes can be generally divided into the following main categories:-

- Sludge volume reduction;
- Sludge quantity reduction;
- Sludge biosolids production.

These categories are not mutually exclusive, e.g. thermal drying substantially reduces sludge volume by evaporation of water and also produces a microbiologically safe and stable biosolid by heat treatment of the organic solids. Anaerobic digestion, when carried out in conjunction with pasteurisation or hydrolysis, reduces the quantity of sludge, in terms of TDS, and produces a biosolid product.

A schematic showing the recommended processes for sludge treatment is included in Figure 5.1. Note that alternative processes that can demonstrate the same level of pathogen reduction will also be considered. Further details of options and alternatives are included in **Section 9**. The extent of sludge volume reduction at a WWTP is dependent on the size and location of the WWTP. The main purpose of volume reduction is to reduce transportation costs. This is assessed in further detail in Section 6.

5.2 Sludge Volume Reduction

Sludge volume reduction is provided at wastewater treatment plants to reduce the cost of transport of waste sludge from the treatment process. The reduction of sludge volumes is provided mainly by sludge thickening and dewatering processes. The main processes currently in use in Ireland are as follows:

Sludge thickening technologies:

- Picket fence thickeners;
- Consolidation tanks;
- Drum thickeners;
- Gravity belt.

Sludge dewatering technologies:

- Belt presses;
- Centrifuges;
- Sludge drying beds;
- Sludge reed beds.

There is a balance which needs to be achieved between the capital and operating costs of sludge thickening and dewatering and the cost of sludge transport. Recommendations for the level of thickening and dewatering are included in Section 6. In some cases, technologies such as containerised dewatering units or mobile dewatering are suitable for reducing sludge volumes where a permanent dewatering installation is not economically justified.

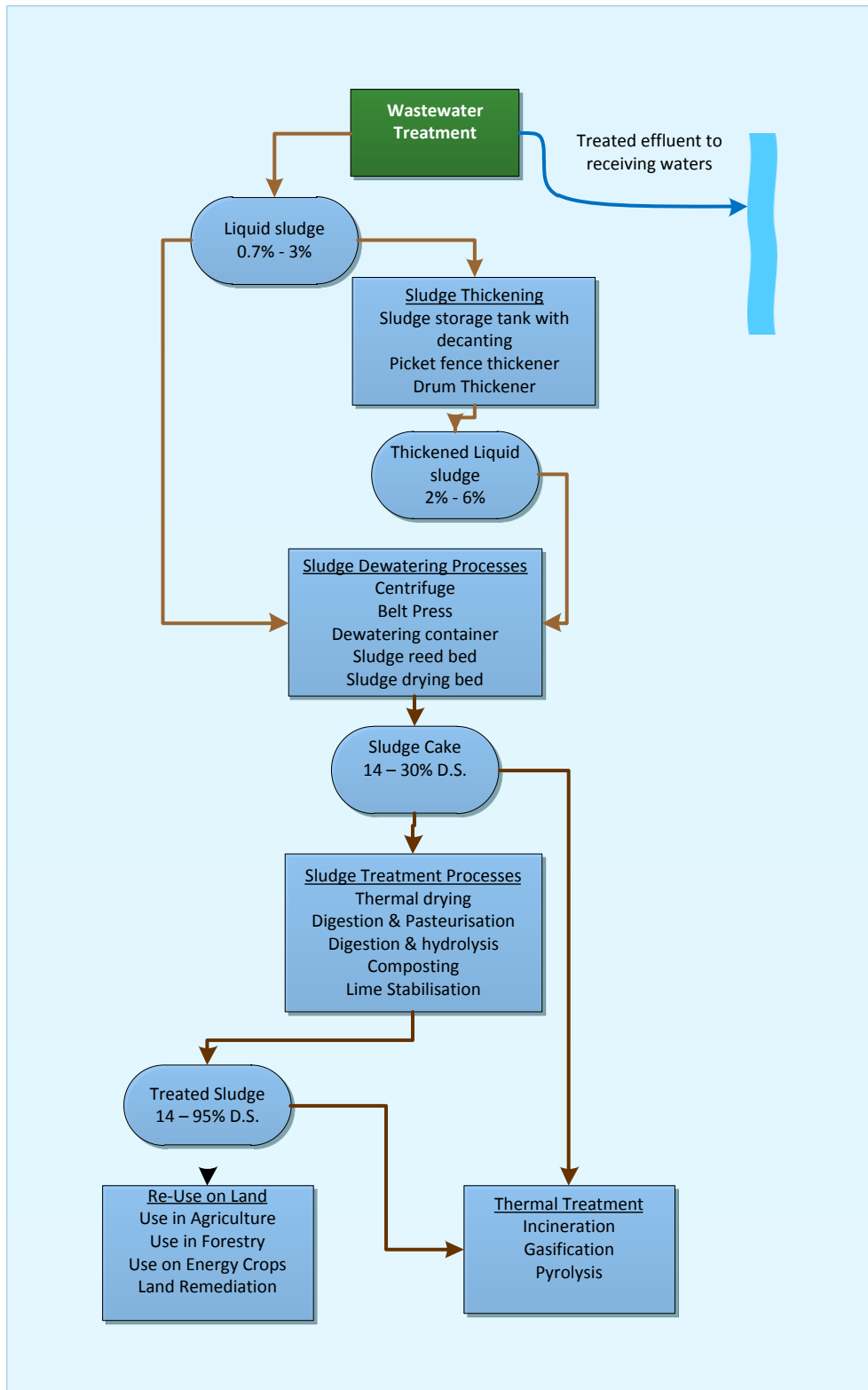


Figure 5.1 – Schematic of Sludge Treatment Options

5.3 Treatment Processes to Produce Biosolids

A number of treatment processes have been accepted as providing pathogen reduction to ensure sludge is suitable for use in agriculture. These processes, which have been incorporated

into the *Code of Good Practice for Use of Biosolids in Agriculture*, are listed in Table 5.1. The options for treatment are all considered to be acceptable in relation to suitability for use in agriculture.

The preferred option for production of biosolids identified in the majority of sludge management plans prepared for Local Authorities was thermal drying. The main reason identified for this was the potential for use as an alternative fuel if agricultural reuse was not possible. Thermally dried sludge has a calorific value similar to peat and can potentially be used as a fuel in industry to replace fossil fuels. However, the economics of this option have led in some cases to thermal drying facilities not being utilised in favour of more costs effective treatment and land reuse.

Further details on each of the options for production of biosolids, identified in Table 5.1, is included in Section 5.3.1 to 5.3.6.

Table 5.1 - Recommended Sludge Treatment Processes (from the Code of Good Practice, Appendix 3 Table 1)

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 ≥70°C or for 2 hours at a temperature ≥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 ≥55°C or of at least 4 hours at a temperature ≥50°C.
Thermophilic Aerobic Digestion	Mean retention period of at least 7 days. All sludge to be subject to a temperature of ≥55°C for at least 4 hours. Must achieve a reduction of volatile solids of ≥38%.
Composting	Windrows: To be held at 55°C for at least 15 days, during which time a temperature of ≥55°C must be maintained over 5 turnings of the windrow. Static Pile or In-vessel: A temperature of ≥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 ≥52°C for at least 12 hours. At the end of the 72 hour period, air dry to a dry solid content of ≥50%.
Thermal Drying	Drying by direct or indirect contact with hot gases. Moisture content of the dried Biosolids to be ≤10%. Either the temperature of the Biosolids >80°C or the wet bulb temperature of the gas in contact with the Biosolids as the Biosolids leaves the drier >80°C

In addition to the sludge treatment processes described above, there are emerging technologies, such as ultrasonic treatment which may provide an alternative means of achieving the required level of pathogen destruction. Use of any such techniques will require process proving in trials before adoption.

5.3.1 Mesophilic Anaerobic Digestion with pre- or post-pasteurisation

Anaerobic digestion of sludge can be either mesophilic or thermophilic. Mesophilic and thermophilic refer to the temperature at which the digestion occurs. Mesophilic anaerobic digestion is insufficient on its own to provide full pasteurisation of sludge. A pre or post pasteurisation stage, where sludge is retained at a temperature $\geq 70^{\circ}\text{C}$ for 1 hour or 55°C for 2 hours is required. A number of wastewater treatment plants currently have pasteurisation and mesophilic anaerobic digestion in operation. Thermal hydrolysis with mesophilic anaerobic digestion followed by agricultural reuse of the residual biosolids has been evaluated to be the most sustainable solution for wastewater sludge treatment and disposal. However, the minimum size for a thermal hydrolysis plant is approximately 2,500 tds/a (equivalent to sludge from approximately 100,000 PE). Typically thermal hydrolysis is not considered economic below about 200,000 PE. However, smaller, more efficient thermal hydrolysis plants are currently being developed making smaller plants more economically viable. There are a number of options for advanced anaerobic and aerobic digestion processes which are normally proprietary processes.

5.3.2 Thermophilic Anaerobic Digestion

There are no thermophilic anaerobic digestion facilities in operation by Irish Water. 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 anaerobic digestion is unlikely to be a practical option for any future developments by Irish Water.

5.3.3 Thermophilic Aerobic Digestion

There is one thermophilic aerobic digestion facility in operation by Irish Water at the Killarney WWTP. The process is operated in a batch fashion making it 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 by Irish Water.

5.3.4 Composting

Composting is undertaken 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. In order 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 this process are relatively low operating costs and an easily handled product. The main disadvantages are the higher capital cost compared to alkaline stabilisation, potential for inadequate treatment if not properly controlled and potential for odours.

There are no composting facilities owned by Irish Water. However, a number of private composting facilities have been developed in Ireland to treat wastewater sludge produced by Irish Water. These facilities may be used for treatment of wastewater sludge only or combined with green waste for composting.

5.3.5 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 >12 with a minimum temperature of 70°C for 30 minutes or, maintain a pH > 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 a large number of 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.

5.3.6 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 and operating costs, with high energy costs in particular. There is also a relatively high risk of fire associated with thermal drying.

5.4 Advanced Thermal Sludge Treatment Processes

5.4.1 General

The main process for thermal conversion of wastewater sludge is currently incineration which is widely used internationally. Wastewater sludge is not currently incinerated in Ireland. However, restrictions on agricultural landspreading due to quality assurance schemes implemented by the agricultural sector and lack of viable alternative uses may lead to incineration being the only viable option for some or all of the wastewater sludge produced in Ireland..

There are a number of thermal conversion technologies for the treatment of sludge. Advanced thermal treatment processes for sludge, leading to destruction of the sludge, normally with energy recovery and an ash product have been under development for a number of years. These processes include the following:-

- Wet oxidation
- Pyrolysis
- Gasification
- Melting furnace
- Incineration

To date, incineration is the only thermal treatment process which has been generally commercially available for wastewater sludge. However, recent developments are likely to make more advanced technologies such as pyrolysis and gasification available on a commercial basis. Due to the relatively small scale of wastewater installations in Ireland, it is likely to take longer before these technologies are commercially available to Irish Water. However, if restrictions on land application increase, it may be necessary to provide for this type of technology in Ireland. However, any use of such technologies is likely to involve a complex and protracted planning period before it could become available.

Other similar technologies which produce a fuel as an end-product have been developed. These technologies are not generally commercially available. Commercially viable pyrolysis and gasification treatment processes are being developed and are likely to offer viable alternatives to incineration in the short-term. The cost for any advanced thermal treatment is typically 30 to 50% more than the current practice of reuse in agriculture. However, they are likely to provide a sustainable outlet in the future, if insufficient agricultural land is available for use of sludge. In

the longer term, as energy costs continue to rise, it is likely that pyrolysis and gasification will provide viable options.

5.4.2 Incineration

Incineration of wastewater sludge requires sludge to be dewatered to a minimum of 25 to 30% dry solids for the process to be self-sustaining, i.e. 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. The ash is typically disposed of to landfill. 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 anaerobic digestion upstream of incineration rather than incineration of raw sludge. The possibility of co-incineration with other waste forms can also be considered.

5.4.3 Pyrolysis and Gasification

The gasification process converts carbonaceous materials by partial oxidation of the wastewater sludge in a reducing atmosphere in the presence of steam at high temperatures to convert the feedstock to synthesis gas (syngas). Pyrolysis is a similar process to gasification but the decomposition of organic material takes place in anaerobic conditions to produce a fuel which may be in gaseous or liquid (tar like) form and a solid biochar product.

As there is potential for sludge gasification or pyrolysis to provide net energy recovery, there is a potential for a lower carbon footprint than other sludge management techniques. However, at present, there is insufficient information on commercial scale systems to assess the potential viability of sludge gasification or pyrolysis in Ireland in the short term. However, it is expected that these technologies will become economically viable option in the coming years.

5.5 Emerging Sludge Treatment Processes

Emerging processes for sludge treatment being developed are largely related to sludge minimisation and increasing energy recovery. Anaerobic digestion is very effective on primary sludge at reducing solids. However, the level of solids reduction on waste activated sludge is low without pre-treatment. A number of technologies have been developed or improved in recent years in order to provide disintegration and cell lysis upstream of anaerobic digestion.

Technologies for advanced digestions include:

- Thermal hydrolysis
- Enhanced enzyme hydrolysis
- Thermophilic digestion
- Ultrasound
- Microsludge
- OpenCEL
- Cell Rupture

Thermal hydrolysis of sludge is a well known technology and a large number of plants have been developed in recent years. Other technologies to improve disintegration of sludge upstream of digestion have been developed to commercial use in recent years and may be a viable option for Sludge Hub Centres in Ireland.

New and emerging technologies in wastewater treatment impact the quantity of sludge produced. Treatment processes such as the granular activated sludge process recently installed in the Clonakilty WWTP produces a lower quantity of sludge than conventional activated sludge.

Similarly, other proprietary wastewater treatment processes developed in recent years, which allow a higher level of treatment or higher sludge age without increasing the activated sludge volume, lead to a lower level of sludge production.



Figure 5.2 – Clonakilty Wastewater Treatment Plant

5.6 Sludge Treatment Process to Produce Biosolids

The sludge treatment processes in use in Ireland include all of the processes detailed in Table 5.1 and Figure 5.3. The breakdown in Table 5.1 details all sludge treatment for stabilisation. Figure 5.3 details the final treatment to produce biosolids. The proportion of sludge being treated by each of the treatment processes has been estimated below based on the 2014 sludge returns.

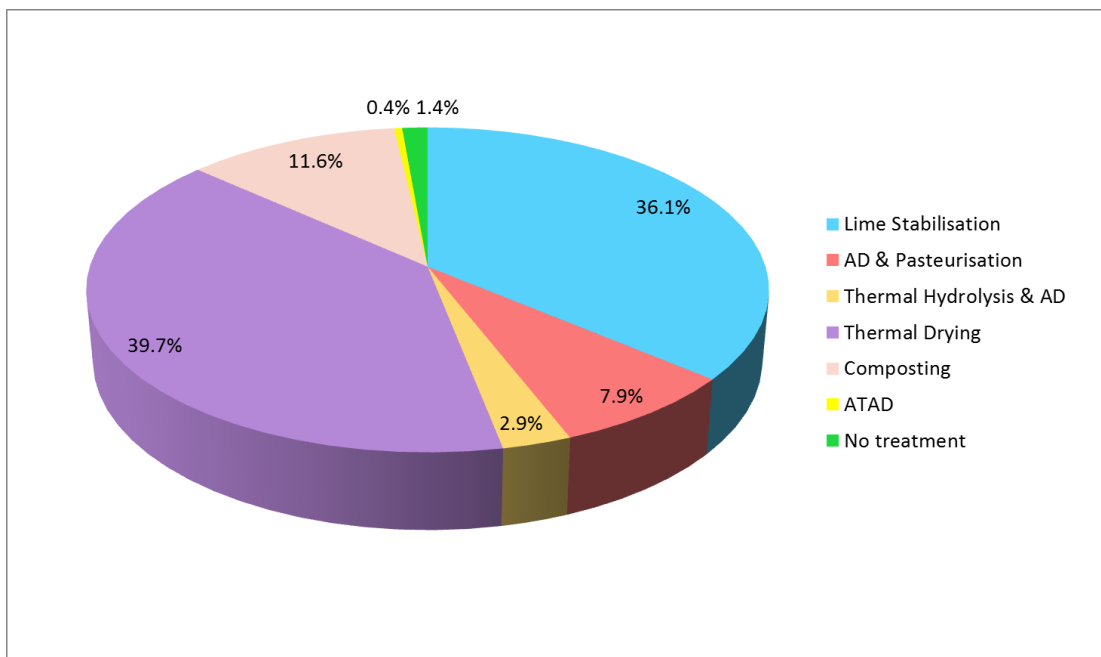


Figure 5.3 – 2014 Type of Sludge Treatment to Produce Biosolids

Table 5.2 – Type of Sludge Treatment, 2014

Treatment Type	TDS/Annum	% of Total TDS
Autothermal Thermophilic Aerobic Digestion (ATAD)	226	0.4%
Anaerobic Digestion & Thermal Drying	2,124	4.0%
Anaerobic Digestion & Lime Stabilisation	4,529	8.5%
Anaerobic Digestion & Pasteurisation	4,239	7.9%
Composting	6,206	11.6%
Lime Stabilisation	14,815	27.7%
Thermal Drying	4,904	9.2%
Thermal Hydrolysis, Anaerobic Digestion, Thermal Drying	14,220	26.6%
Thermal Hydrolysis, Anaerobic Digestion	1,543	2.9%
No treatment	737	1.4%
Total	53,543	100.0%

The type of treatment varies from year to year. There are thermal drying facilities available at thirteen wastewater treatment plants which have a combined sludge drying capacity of approximately 60,000 tds/annum. However, less than a third of this capacity is currently used, due mainly to the high cost and operational difficulties with thermal drying.

6 Sludge Transport Strategy

6.1 General

Transportation is a significant part of sludge management in terms of environmental impacts and cost. The transportation strategy must be sustainable taking into account carbon footprint and potential impacts in terms of traffic, odour and noise. The cost of sludge transport has been assessed by the EU⁸ as approximately 30% of the total cost. In smaller wastewater treatment plants in Ireland, transport accounts for a substantially larger proportion of the costs associated with sludge treatment.

The need for sustainable transportation of sludge produced in plants is identified in the WSSP which states that '*Transport and reuse/disposal of all wastewater sludge will be managed by Irish Water to ensure compliance with our standards for treatment and disposal by registered contractors with full traceability.*'

Procedures for removing liquid sludge from the wastewater treatment process are an important factor in ensuring compliance of final effluent from WWTP's. Standard operating procedures being developed by Irish Water will include procedures for on-site sludge management. In order to optimise desludging, the sludge infrastructure at the WWTP needs to be adequate and a transportation strategy in place to remove sludge from the site. Infrastructure upgrades will be undertaken in accordance with Irish Water Standard Specifications currently being developed.

6.2 Existing Sludge Transport

The total volume of sludge from wastewater treatment plants is estimated as up to 900,000m³/annum. Over 80% of this is from WWTP's being operated by Local Authorities with the remainder from plants being operated by DBO contractors. Approximately 75% of the sludge, in terms of tonnes dry solids, is produced at WWTP's operated by DBO contractors as these include the majority of larger WWTP's. The volume of sludge from DBO plants varies largely depending on the use of thermal drying facilities. The majority of wastewater treatment plants being operated by DBO contractors include sludge dewatering as a minimum with thermal drying at the larger wastewater treatment plants and the majority of existing sludge hubs.

The cost for transport of sludge varies widely from approximately €8 to €25 per wet tonne, with 1 tonne approximately equal to 1m³ of sludge for liquid sludge. The annual transport cost is estimated as approximately €8-10 million. There is substantial variation in transport costs depending on the location of the particular wastewater treatment plant.

6.3 Sludge Transport Strategy

There are a number of options to reduce the volume of sludge currently being transported. This has benefits in terms of environmental, social and financial impacts. Reducing sludge transport has the benefit of reducing greenhouse gas emissions due to reduced fuel use. This must be balanced against the lifecycle cost, environmental and social impacts of additional sludge infrastructure at a higher number of sites, with additional staff transportation required to operate and maintain equipment. Similarly the transport of sludge to the final disposal location is dependent on the availability of suitable land for landspreading and agreements between individual landowners and sludge management contractors. Contracts should ensure that, where practicable, sludge is transported and spread on the nearest suitable spread lands to the source of the treated sludge. This phase needs to be supported by suitable strategic sludge storage to facilitate land-spreading of the biosolids by providing storage during periods when sludge cannot be used on land. This can be accommodated at hub sites or at dedicated storage centres.

⁸ Disposal and recycling routes for sewage sludge, European Communities, 2002

The lifecycle cost for transport versus further on-site thickening, dewatering and/or treatment prior to final disposal has been reviewed to establish economically viable transport distances. This initial assessment of the recommended maximum transport distances depends on size of plant, distance to satellite centre and type of treatment process. Where transport of liquid sludge is not viable, the options in terms of fixed plant and mobile thickening or dewatering plant have been assessed.

An assessment of the cost of provision of a satellite centre versus transport directly to a Sludge Hub Centre has also been undertaken to provide an initial assessment of where additional Satellite Dewatering Sites for dewatering are justified. The estimated cost for upgrade of a wastewater treatment plant to act as a satellite dewatering site is in the order of €500,000. This cost may increase substantially in some cases, e.g. if additional buildings are required to accommodate dewatering plant upgrades or if an access road upgrade would be required to facilitate the satellite dewatering site.

The transport cost saving of using a satellite dewatering plant to reduce the volume of sludge can be up to €100,000 per annum versus transport directly to the proposed Sludge Hub Centre. In some cases, it is considered more economic to continue to accept sludge at the inlet works to a treatment plant rather than provide a full sludge acceptance facility.

The selection of the location and number of Satellite Dewatering Sites requires a detailed assessment on a site by site basis to establish suitability. This assessment must take into account the environmental, social and financial impacts of any proposal. A review of other constraints such as an existing operational contract must also be taken into account.

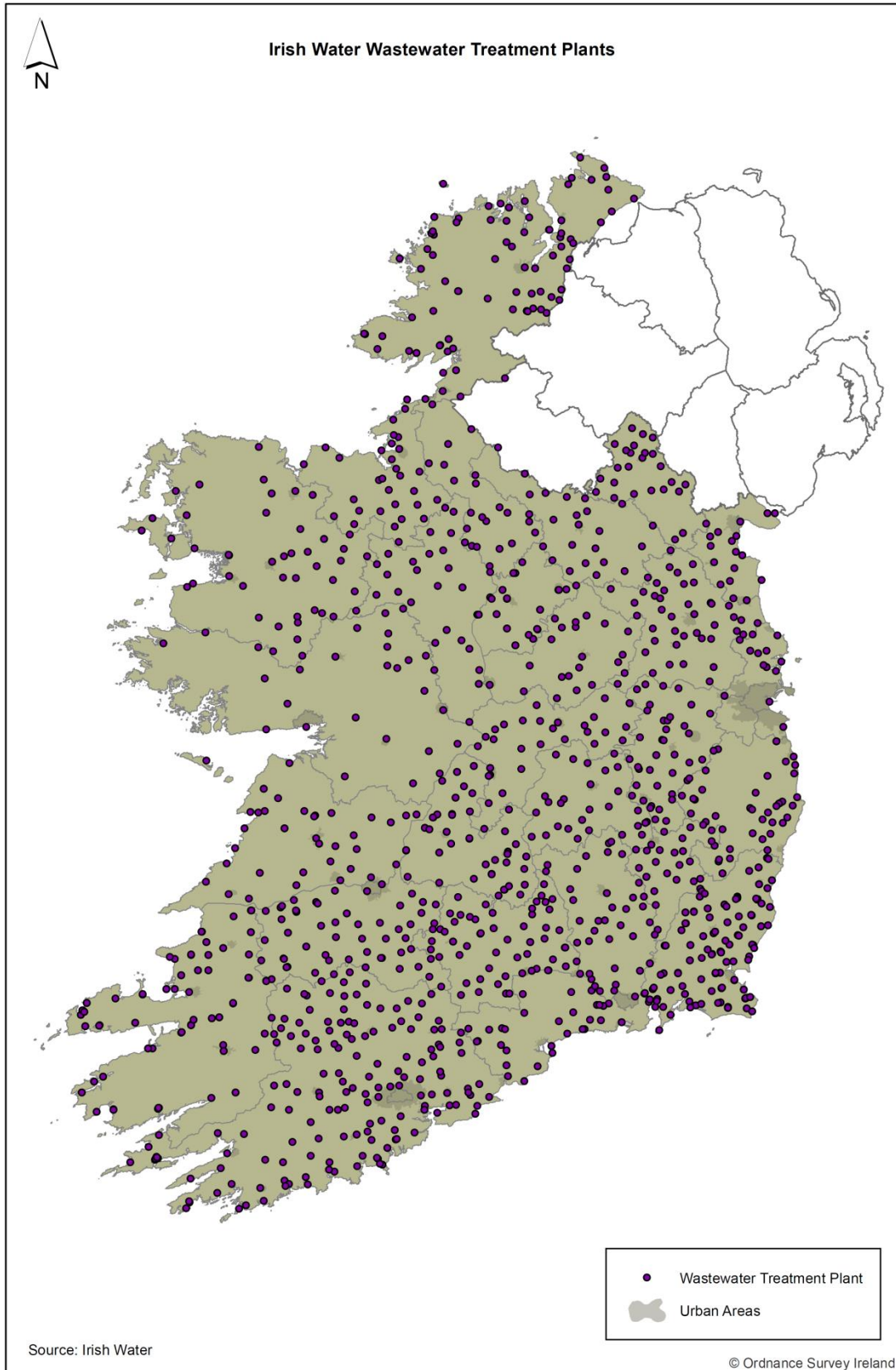


Figure 6.1 – Location of Wastewater Treatment Plants in Ireland

6.4 Sludge Infrastructure to Optimise Transport Volumes

6.4.1 General

An overall assessment of sludge infrastructure requirements has been carried out based on the sludge transport assessment and operating requirements. The recommendations below provide a general guide to the type of infrastructure required, relative to the size and location of the WWTP. This may vary depending on particular WWTP requirements.

The design and operation of the sludge infrastructure can have a significant impact on the operation of the wastewater treatment plant main treatment process. Inadequate sludge management, in terms of either plant design or operation, including frequency of desludging and/or impact of supernatant return, can potentially lead to breaches of emission limit values, odours and high operating cost. A desludging schedule is proposed for all WWTP sites taking into account the treatment process, sludge production and site location. Upgrades and/or changes to operational procedures will be required where the requirements set out below to optimise transportation are not currently being met. This may include upgrades to access to individual sites.

6.4.2 Sludge Storage

In order to optimise sludge transport costs, sludge storage is required at wastewater treatment plants. For smaller wastewater treatment plants (< 500 p.e), it is adequate if sludge storage is provided within the treatment process providing adequate storage is available. The frequency of sludge removal will depend on the treatment process in addition to the storage volume. It is reported that digestion of sludge in a storage tank can commence after 3 weeks in some cases but may take as long as six weeks for sludge from trickling filters. The volume of storage may need to be increased in order to optimise the desludging schedule. Removal of sludge every 2 weeks is recommended for wastewater treatment plants with secondary treatment. This frequency may be decreased for septic tanks and will need to be assessed on an individual basis. However, it is recommended that all septic tanks operated by Irish Water are desludged annually as a minimum.

Following a review of sludge transport costs the minimum recommended provisions for sludge storage are summarised in Table 6.1:-

Table 6.1 – Recommended Minimum Storage

Population Equivalent	Minimum Storage (days)
0 – 500	28 days
500 – 1,000	14 -28 days
1,000 – 3,000	14 days
3,000 – 10,000	7 days – no dewatering 4 days – with dewatering
> 10,000 ⁽¹⁾	3 days

Notes: (1) The particular requirements for wastewater treatment plants greater than 10,000p.e.

6.4.3 Sludge Thickening

Sludge from secondary treatment is normally removed from the process stream at less than 1% dry solids (d.s.), i.e. 99% water content, with primary sludge removed at approximately 2-3% d.s. In general, sludge should be thickened to a minimum of 2% dry solids prior to removal from site. This can be achieved by decanting from a sludge holding tank with no mechanical equipment required.

UKWIR⁹ report that the use of picket fence thickeners (settlement in circular tanks aided by gentle stirring mechanism) is only considered cost effective for WWTP's greater than 2,000 PE. For WWTP's less than 1,000 PE, the distance to the closest satellite dewatering sites should be reviewed prior to carrying out any capital upgrades as the sludge volumes will be low. For wastewater treatment plants from 1,000 to 2,000 PE, thickening should be provided by gravity consolidation tanks with decanting. This provides a guide only as dry solids concentration of sludge from a wastewater treatment process varies substantially. Other considerations such as available space on the site, environmental impacts and options for on-site treatment options, such as sludge reed beds or other low cost low maintenance techniques should be considered prior to any upgrade to provide sludge thickening.

WWTP's with a population equivalent greater than 2,000p.e. should include sludge thickening to a minimum of 3% dry solids. Where transport distances exceed 25km, consideration should be given to chemical dosing to increase sludge dry solids concentration to a minimum of 4% dry solids. Picket fence thickeners should be designed to achieve a target dry solids of 4%. However, in practice, this can be difficult to achieve consistently with activated sludge.

There is the potential to reduce the volume of sludge for transport by 20 to 25% by optimising sludge thickening at smaller wastewater treatment plants. There are a large number of sites with existing sludge storage tanks where sludge thickening could be optimised by automating the decant process. A review of existing technologies is recommended in order to identify the most suitable technologies to achieve this. Where automatic decanting is not economically justified, manually decanting sludge tanks prior to removal of sludge from a WWTP should be undertaken. The option of provision of a sludge reed bed or similar system should be considered in each case for remote sites. The additional data being gathered in the asset register, as further detailed in Section 10.5, will be used to inform the site specific upgrade requirements.

For wastewater treatment plants with a population equivalent of less than 2,000p.e., sludge thickening or alternative sludge disposal should be considered where:-

- Transport distance to satellite is > 20km for a p.e. < 1,000 – 2,000
- Transport distance to satellite is > 30km for a p.e. 500 – 1,000
- Transport distance to satellite is > 50km for p.e. < 500

6.4.4 Sludge Reed Beds

On-site sludge reed beds provide a viable economic alternative to sludge transport. A number of sludge reed beds have been provided in Ireland in recent years and are operating successfully. Sludge reed beds are particularly beneficial in smaller remote wastewater treatment plants where the cost of transport of sludge to a satellite dewatering site is unsustainable. There is a higher risk of odours where a treatment plant includes primary sludge which should be taken into account in assessing the suitability of a site for reed beds. Also, in order to ensure that the final sludge product is suitable for use in agriculture, it is recommended that sludge reed beds are used only where inlet screens are in place at a WWTP. A further study of the feasibility of sludge reed beds at potentially suitable sites is recommended. This will take into account the siting criteria detailed in Section 9.5.

6.4.5 Sludge Dewatering

All wastewater treatment plants with a population equivalent greater than 10,000 p.e. should include sludge dewatering to a minimum of 18% dry solids. For population equivalents greater than 5,000 p.e. and transport distances of >20km to a satellite, sludge dewatering should also be provided. Sludge dewatering is currently in place at all wastewater treatment plants greater than

⁹ UKWIR Sustainable Sludge Thickening and Treatment at Small WwTWs, 2013

5,000 p.e. and at a number of smaller wastewater treatment plants. In general, sludge dewatering is not economically viable for plants less than 5,000 p.e. However, a cost comparison sludge transport costs should be undertaken for plants between 2,000 p.e. and 5,000 p.e. to compare the cost of dewatering to the cost of transport of liquid sludge.

There are substantial operating costs associated with sludge dewatering which can out-weigh the benefits in reduced sludge volumes for transport in smaller WWTP's. Other considerations such as available space on the site, environmental impacts and options for on-site treatment options, such as sludge reed beds, should be considered prior to installation of sludge dewatering.

A programme of review of sludge dewatering performance is proposed for all dewatering sites to assess whether dry solids concentrations can be improved. In some cases, older single belt presses have been installed which provide inadequate dewatering and replacement or decommissioning of these should be considered. The option of containerised dewatering units or mobile dewatering will be considered in cases where fixed dewatering is not economically justified taking into account the environmental impacts, in addition to an economic evaluation of options.

In general, sludge cake storage should have a minimum capacity of 7 days up to a maximum skip size of 20m³. The replacement of existing sludge skips should be considered where inadequate storage is provided as this can be justified based on the transportation cost savings, particularly at larger sites. In addition, storage of sludge biosolids (cake or granules), may be required, either on site or off site, between production and application to land. Off-site storage is commonly provided by Contractors at present. Any such arrangements are reviewed by Irish Water, as part of it's auditing process, to ensure that such facilities are in compliance with all required environmental and planning controls and permits with an assessment of the viability of development of new storage facilities also being conducted by Irish Water.

7 Sludge Satellite and Hub Infrastructure

7.1 General

The use of a 'Sludge Hub Centre and Satellite Dewatering Site' system for the management of wastewater sludge has been implemented in a number of counties in Ireland. As detailed in Section 3.7, this use of a Sludge Hub Centre and Satellite dewatering site system allows for economies of scale and greater flexibility in the selection of treatment processes, particularly energy recovery and also assists in the maintenance of quality control over the outputs from any selected treatment processes.

This system of satellite and hubs is commonly used internationally and is considered to be appropriate for use by Irish Water. Irish Water intend to maximise energy recovery from anaerobic digestion by maximising use of Sludge Hub Centres with energy recovery and upgrading existing Sludge Hub Centres to provide energy recovery where economically feasible. However, local authority areas will no longer be considered individually allowing greater flexibility and efficiency from regional consideration. Locations for sludge satellite and hub centres were identified in the county sludge management plans undertaken in the late 1990's and early 2000's. An outline of the recommended satellite and hub centres, from the county sludge management plans, is included in Section 3.7.

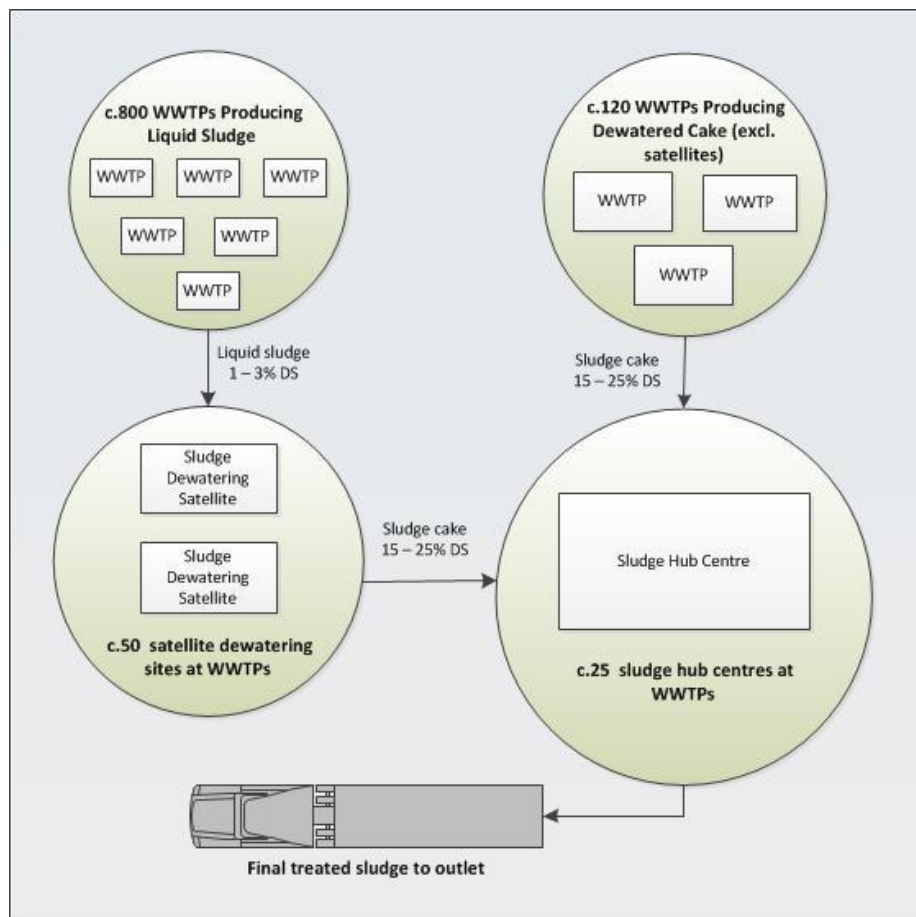


Figure 7.1 – Schematic of Hub and Satellite System

7.2 Sludge Satellite Dewatering Infrastructure

7.2.1 Liquid Sludge Imports

Liquid sludge imports to wastewater treatment plants consist of liquid sludge from smaller wastewater treatment plants and septic tank sludge from private contractors. In some cases,

wastewater treatment plants have installed sludge acceptance facilities with screening and storage facilities. In order to accept sludge from smaller wastewater treatment plants without fine screens and septic tank sludge, a sludge acceptance screen at the Satellite Dewatering Site is needed. There are currently thirty wastewater treatment plant sites which have been identified as having sludge screening equipment.

The requirement for new imported liquid sludge facilities is assessed further in Section 7.4. All liquid sludge acceptance sites should, where feasible, include acceptance of DWWTS sludge. Due to the high level of screenings in the DWWTS sludge, this sludge is frequently unsuitable for discharge to a sludge acceptance screen. The option of discharge to the inlet works, via a balancing tank, should be considered.

It is proposed to increase the number of satellite dewatering sites and to provide for balancing of sludge, with discharge to the inlet works, at sites where the proposed level of imports is insufficient to justify a full liquid sludge acceptance facility. This will have the benefit of reducing sludge transport costs and reduce the traffic impacts if all sludge were to be transported directly to Sludge Hub Centres.

7.2.2 Sludge Imports from External Sources

There are a number of external sources of sludge imports to wastewater treatment plants from sources outside the responsibility of Irish Water. The main external source of imported sludge is Domestic Wastewater Treatment Systems (DWWTS), i.e. single house septic tanks or treatment systems. It is likely that, in the coming years, there will be a significant increase in demand for acceptance of this type of sludge. There is an opportunity for Irish Water to accept this sludge on a commercial basis. The EPA published, in April 2014, a document on *Management Options for the Collection, Treatment and Disposal of Sludge Derived from Domestic Wastewater Treatment Systems*, Strive Report Series 123 which reviews best practice regarding management of predicted DWWTS sludge volumes associated with the implementation of S.I. No. 223/2012 - Water Services Acts 2007 and 2012 (Domestic Waste Water Treatment Systems) Regulations 2012.

Further to the implementation of the Water Services (Amendment) Act 2012 (No. 2 of 2012) regarding the registration and inspections of DWWTS's, it is anticipated that the volume of sludge from DWWTS's requiring disposal will increase substantially over the next number of years. The report prepared on behalf of the EPA estimates that there is capacity for approximately 50% of the existing septic tank sludge to be accommodated within existing wastewater treatment plants. This would increase where the sludge is increased up to 6-8% dry solids, prior to transport using mobile dewatering units.

7.2.3 Requirements for Satellite Dewatering Sites

Designated sludge Satellite Dewatering Sites 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

For Sludge Hub Centres and larger Satellite Dewatering Sites, additional facilities may be required including additional tanker unloading bays, sludge blending tank, weighbridge etc. All sites with sludge imports will require operating procedures to control the quantity and type of

sludge imported. Inadequate control of sludge imports may impact the final effluent and sludge quality. These procedures will be developed as part of Irish Water's Standard Operating Procedures.

There are imported liquid sludge facilities at approximately 30 existing wastewater treatment plants which are currently acting as Satellite Dewatering Sites with 20 of these sites also acting as sludge hubs. Over 100 WWTP's reported liquid sludge imports in 2014. However, in the majority of cases, the sludge was discharged directly to the inlet works. These sites have not been classified as existing 'Satellite Dewatering Sites' as the appropriate infrastructure is not in place. In order to optimise sludge transport and dewatering, it is expected that a further 20-30 Satellite Dewatering Sites are required. An individual assessment is required of each proposed Satellite Dewatering Site and any existing Satellite Dewatering Sites where it is proposed to upgrade the capacity. The following should be assessed as a minimum:-

- Accessibility and traffic impacts
- Impact on wastewater treatment plant and final effluent quality
- Potential odour and noise impacts
- Availability of space within or adjacent to the existing site
- Capacity and condition of existing sludge treatment facilities
- Site suitability and consideration of alternatives

There are potential requirements for planning permission and/or review of the wastewater discharge licence for the particular site. These requirements will be identified as part of the site assessment.

7.3 Sludge Hubs and Treatment Centres

7.3.1 Existing Sludge Hub Centres

There are 24 existing wastewater treatment plants where full sludge treatment to produce biosolids is provided. 20 of these plants currently act as Sludge Hub Centres, i.e. have full sludge treatment and the site accepts imports. This includes five sites where temporary lime stabilisation equipment has been installed to produce biosolids. It is considered necessary to upgrade the Sludge Hub Centres that have temporary lime stabilisation to provide an alternative long-term sustainable solution.

It is considered that an additional two to three Sludge Hub Centres are required, in addition to upgrade of existing Sludge Hub Centres. This will provide the required capacity for sludge treatment for long-term sustainable treatment. The capacity of the existing sludge hub at Limerick is insufficient, at present, to accept sludge from County Clare, as proposed. Existing sludge treatment centres at Waterford and Cork may provide a cost effective way to provide sludge hub capacity for the Waterford and Cork regions. Upgrade of existing Sludge Hub Centres to provide anaerobic digestion or advanced anaerobic digestion should be considered at all sites. In general all Sludge Hub Centres should also act as Satellite Dewatering Sites with upgrades required to allow this where the required facilities are not in place at present.

A detailed individual assessment is required for sludge treatment centres or Sludge Hub Centres where it is proposed to upgrade the capacity or provide for importation of sludge. The assessment required will be similar to the assessment required for a Satellite Dewatering Site as detailed in Section 7.2.3.

Table 7.1 – Existing Sludge Hub and Treatment Centres

Local Authority	Agglomeration¹	Sludge Treatment Process	Current Sludge Treatment Capacity (PE)²
Carlow	Carlow	Lime stabilisation	70,000
Cork	Cork City ³	AD and Thermal Drying	413,000
Donegal	Letterkenny	Thermal Drying	120,000
Donegal	Donegal Town	Thermal Drying	83,000
Dublin	Ringsend	AAD and Thermal Drying	1,900,000 ⁴
Dun Laoghaire R	Shanganagh ³	AD and Thermal Drying	186,000
Galway	Tuam	Lime stabilisation	170,000
Galway City	Galway City ³	AD and pasteurisation	170,000
Kerry	Killarney	ATAD	54,000
Kildare	Upper Liffey Valley	Thermal Drying	400,000
Kilkenny	Kilkenny City	Lime stabilisation	50,000
Laois	Portlaoise	Thermal Drying	80,000
Limerick	Limerick	Thermal Drying	160,000
Longford	Longford	Lime stabilisation	80,000
Louth	Dundalk	AD and Thermal Drying	179,000
Meath	Navan	Lime stabilisation	90,000
Offaly	Tullamore	AD and Thermal Drying	80,000
Sligo	Sligo	AD and pasteurisation	83,000
Tipperary	Clonmel	Thermal Drying	90,000
Waterford	Dungarvan	Thermal Drying	80,000
Waterford	Waterford city ³	AD and pasteurisation	190,000
Westmeath	Mullingar	Thermal Drying	70,000
Wexford	Wexford town	Thermal Drying	80,000
Wicklow	Wicklow	Thermal Drying	50,000

Notes:

1. Sites for sludge treatment are at licenced wastewater treatment plants. Private sludge treatment facilities and sludge treatment locations where additional treatment is provided off-site are not included
2. The current sludge treatment capacity has been estimated based on available information. Population equivalent has been estimated based on sludge production of 55g/PE/day
3. The existing sludge treatment centres at Cork City, Galway City, Shanganagh and Waterford City have no sludge imports. All other sites act as sludge hubs.
4. The capacity of the sludge treatment stream in Ringsend was upgraded following completion of the WWTP to cater for the additional loads being received.

7.3.2 Sludge Cake Imports

Importation of sludge cake has been provided for at a number of larger wastewater treatment plants which are currently operating as Sludge Hub Centres. Additional sludge cake import facilities are needed where temporary Sludge Hub Centres or sludge treatment centres are to be developed to accept sludge cake.

7.3.3 Current On-Site Sludge Treatment

The main treatment process for pathogen reduction in sludge installed in Ireland from the late 1990's to date has been thermal drying. Thermal dryers were installed following

recommendations in the county sludge management plans. The provision of sludge dryers was regarded as beneficial, based on providing a sustainable product with additional reuse options, such use as a fuel, in addition to agricultural use. However, at present all thermally dried sludge is reused in agriculture. Thermal dryers have high energy consumption and high operation and maintenance costs. Due to the significant cost and operational difficulties of operating the sludge dryers, they are not all currently in operational use.

The other sludge treatment processes currently in use include the following:-

- Anaerobic digestion with lime stabilisation
- Anaerobic digestion and pre-pasteurisation / hydrolysis
- Anaerobic digestion and post-pasteurisation
- Autothermal thermophilic aerobic digestion
- Lime stabilisation
- Composting.

Further details of sludge treatment processes to produce biosolids are included in Section 5.3.

7.3.4 Current Off-Site Sludge Treatment and Storage

There are a number of standalone privately owned sludge treatment facilities. The majority of these use lime stabilisation. There are also composting and advanced anaerobic digestion facilities being used for wastewater sludge, with sludge being imported from municipal wastewater treatment plants under service contracts.

There are 16 No. such composting/anaerobic digestion facilities licenced by the EPA under waste licencing. There are also 22 facilities registered with the EPA for wastewater sludge treatment and storage under the Waste Facility Permit and Certification of Registration system. Off-site sludge storage, not licenced under a waste licence or Waste Facility Permit and Certification of Registration must be registered under the Certification of Registration system for wastewater sludge storage with the Local Authority. This requirement does not apply to temporary storage at the place of use.

7.3.5 Sludge Storage Facilities

There is a requirement for storage of sludge being used for landspreading during the periods when application of fertilisers to land is prohibited in accordance with S.I. 31/2014 European Union (Good Agricultural Practice for Protection of Waters) Regulations 2014, as amended by S.I. 134/2014 and S.I. 463/2014. In order to ensure storage requirements for sludge are met nationally, additional sludge storage facilities are required to facilitate the predicted increase in wastewater sludge as new and upgraded treatment plants are completed. These can be located on the Sludge Hub Centre or Sludge Treatment Centre site or at a separate facility.

In line with the approach taken to other facilities in this Plan, the development of Sludge Storage Facilities will no longer be considered solely on a per-plant or per-county basis. Where appropriate, Sludge Storage Facilities will be developed to serve a number of local plants and/or a wider regional need. In particular, the upgrade to the Ringsend sludge hub and the proposed new North Dublin WWTP will result in a significant increase from current sludge volumes with a consequent increase in storage requirements. Therefore, a dedicated sludge storage facility should be developed in conjunction with the expansion of Ringsend to meet its requirements and take account of other future needs in the region.

The location and size of any new facilities will require detailed site assessment including appropriate assessment. The site selection process and assessment of potential environmental impacts in particular will be undertaken in accordance with Section 9.5. All wastewater sludge storage facilities must be registered in accordance with S.I. No. 32/2010 - Waste Management

(Registration of Sewage Sludge Facility) Regulations, 2010. Sludge storage at a wastewater treatment plant or a waste licenced facility is excluded from this requirement for registration.

7.3.6 Current Sludge Contracts

Responsibility for operation of existing wastewater treatment plants and associated sludge treatment and/or disposal has been reviewed. The majority of wastewater treatment plants, over 77% in terms of the number of plants, are operated and maintained directly by Local Authorities (LA's) through a Service Level Agreement with Irish Water. However, the majority of sludge produced from wastewater treatment plants over 500p.e. (approximately 70%) is dealt with by DBO contractors (i.e. with outsourced operation and maintenance) representing the larger plants nationally. The disposal of sludge from the DBO and LA operated plants is normally subcontracted to specialist sludge management contractors.

There are approximately 500 wastewater treatment plants serving agglomerations less than 500p.e. Over 90% of these are operated by Local Authorities with the remainder being operated under DBO contracts. These plants account for less than 3% of the total population equivalent served by municipal wastewater treatment with the proportion of sludge being even lower as a significant number of these small treatment plants are primary or septic tank type treatment plants.

7.3.7 Sludge Transport Contracts

Sludge transport from WWTP's operated by the Local Authorities is undertaken either by a transport contractor or directly by the local authority. This accounts for over 80% of the volume of sludge transport. DBO Contracts may include responsibility for transport of sludge to a Sludge Hub Centre. DBO Contracts for wastewater treatment plants with full sludge treatment include responsibility for sludge transport from the sludge treatment to the final reuse location.

7.3.8 DBO Contracts

The majority of permanent Sludge Hub Centres and sludge treatment centres are currently operated under DBO Contracts. These contracts include full responsibility for sludge treatment and reuse or disposal. Over 150 wastewater treatment plants are currently being operated by DBO contractors. These include the majority of the larger plants in the country. Sludge from DBO operated plants accounts for over 70% of wastewater sludge produced in Ireland.

7.4 Sludge Hub and Satellite Centre Assessment by Local Authority Area

7.4.1 General

Each local authority area (excluding South Dublin which has no wastewater treatment plants in the county) has been reviewed to assess the current situation and recommendations for the future. It is intended that existing Sludge Hub Centres should be used to their maximum capacity unrestricted by county boundaries. In particular, the use of existing anaerobic digestion infrastructure should be maximised to increase energy recovery. In the case of thermal drying facilities, the maximum use of the Sludge Hub Centre may not be the most economically advantageous solution.

The overall strategy is to allow flexibility in the use of sludge hub infrastructure to enable diversion of sludge loads to alternative sites during periods of maintenance or peak loading. A number of existing sludge treatment sites being operated by Design Build Operate contractors are recommended for upgrade to facilitate the acceptance of sludge from outside the local authority area.

There are over 100 wastewater treatment plants currently reporting imports of wastewater sludge. In most cases the facilities on the wastewater treatment plant sites are inadequate to properly manage and control these imports, particularly where they are discharged directly to the

inlet works. Particular sites which are considered geographically suitable as satellite dewatering sites or sludge hubs have been identified. These sites will be subject to detailed assessments on a site by site basis to establish suitability. This assessment must take into account the environmental, social and financial impacts of any proposal. The site selection process and assessment of potential environmental impacts in particular will be undertaken in accordance with Section 9.5 to 9.7. A review of other constraints such as an existing operational contract must also be taken into account. Particular site issues such as restricted access, risk to Natura 2000 sites, impacts on receptors, availability of space and economic feasibility need to be considered in the final site selection.

7.4.2 Carlow County Council

Sludge within County Carlow is currently lime stabilised at the Mortarstown Wastewater Treatment Plant under a contract with Irish Water. The Mortarstown WWTP also acts as both a sludge hub and a Satellite Dewatering Site. The Sludge Hub Centre at Osberstown was designed to accept sludge from County Kildare over a 20 year growth period. It is proposed to upgrade the Osberstown hub to advanced anaerobic digestion, with the works due to commence in 2016. It is recommended, that the energy recovery at Osberstown is maximised by importing sludge from Carlow until the capacity of the Sludge Hub Centre is reached.

The wastewater treatment plants at Carlow, Tullow and Muinebheag currently accept imports of liquid sludge. However, the Tullow and Muinebheag sites do not currently have adequate facilities for efficient sludge acceptance. In order to continue to accept sludge at these sites, improved sludge acceptance facilities are recommended.

7.4.3 Cavan County Council

There are no WWTP sites in Cavan reported as being used as sludge hubs. Sludge within County Cavan was lime stabilised at the Cavan WWTP, for a number of years, under a temporary contract. Due to the recent WWTP upgrade works contract, this lime stabilisation now takes place off-site. The quantity of sludge produced in Cavan is not sufficient to economically justify advanced anaerobic digestion. A Sludge Hub Centre to cater for sludge from Cavan and surrounding counties is recommended. Longford Town has been assessed to be suitably located for a sludge hub for sludge from Cavan.

The Cavan WWTP is considered to be in a suitable location to act as a Satellite Dewatering Site and the upgrade of the WWTP included sludge acceptance facilities. It is intended that the Cavan WWTP should accept liquid sludge from the smaller wastewater treatment plants in the county for dewatering. The upgrade of the wastewater treatment plant includes facilities for the acceptance of liquid sludge including a balancing tank and sludge acceptance screen. No further works are considered to be necessary.

7.4.4 Clare County Council

There are no WWTP sites in Clare being used as sludge hubs. The sludge management plan for Clare and Limerick proposed that sludge from Clare would be treated in Limerick. At present, a framework contract for sludge treatment and disposal from sites in Clare is in operation. However, the Limerick City WWTP should be considered in the future as a sludge hub for County Clare.

The wastewater treatment plants at Clareabbey, Scarriff, Shannon Town, Corofin, Lahinch and Sixmilebridge were reported as accepting imports in 2014. It is considered more economic to reduce the number of sites accepting imports and to provide appropriate facilities at these sites. The wastewater treatment plants at Ennis and Lahinch have been considered for acceptance of imports of liquid sludge. In order to cater for septic tank sludge an additional sludge satellite should be considered at Kilrush. These sites do not currently have sludge acceptance facilities and these are recommended.

7.4.5 Cork City Council

The Cork City wastewater treatment plant is located at Carrigrennan, Co Cork. The plant currently has anaerobic digestion and thermal drying of sludge. There is a potential for upgrade of this facility to include advanced anaerobic digestion to increase energy recovery. The import of sludge to the existing Carrigrennan WWTP was excluded from the planning granted. However, as there is substantial spare organic capacity at the wastewater treatment plant and within the sludge stream which could be utilised for sludge imports from the Cork county area, a review of the planning and infrastructure requirements including an assessment of potential traffic impacts is proposed to assess feasibility of importing sludge to this site.

7.4.6 Cork County Council

There are no WWTP sites in Cork county being used as sludge hubs. At present, framework contracts for sludge treatment and disposal from sites in Cork are in operation. As detailed in Section 7.4.5, the Cork City wastewater treatment plant at Carrigrennan is considered to be in a suitable location to be used as a sludge hub. A detailed assessment of this option is recommended in order to establish the suitability of the site and feasibility of developing a Sludge Hub Centre with advanced digestion. As stated above this is subject to planning and infrastructure requirements including an assessment of potential traffic impacts is proposed to assess feasibility of importing sludge to this site.

The wastewater treatment plants at Fermoy, Mallow, Macroom, Dunmanway, Skibbereen, Rosscarbery-Owenincha, Castletownbere, Glengarriff, Ballineen-Enniskeane, Durrus, Buttevant, Ballincollig, Carrigtwohill and Bandon are reported as accepting imports of liquid sludge. There are existing sludge acceptance facilities at Buttevant and Blarney. Mallow and Fermoy have sludge import screens which are currently not in use. It is considered more economic to reduce the number of sites accepting imports and to provide appropriate facilities at these sites. Additional sludge acceptance facilities are recommended at:

- Ballincollig
- Bantry
- Carrigtoohil
- Clonakilty
- Fermoy
- Mallow
- Middleton
- Skibbereen

7.4.7 Donegal County Council

There are currently two sludge hubs in operation in County Donegal, at Donegal Town and Letterkenny. Both of these sludge hubs have import facilities and treatment by thermal drying. Letterkenny also has a facility for anaerobic digestion which is currently not in use. The Sludge Hub Centres in Donegal were both constructed in the last 10 years and are considered to have sufficient capacity for the foreseeable future.

The wastewater treatment plant at Buncrana currently accepts imports of liquid sludge. However, this site does not currently have adequate facilities to allow efficient sludge acceptance. In order to continue to accept sludge here, improved sludge facilities are recommended. No additional sludge satellites are considered to be required in Donegal.

7.4.8 Dublin City Council

The Ringsend WWTP currently acts as a sludge hub for the Greater Dublin area. Sludge treatment is provided by thermal hydrolysis and anaerobic digestion followed by thermal drying. The Sludge Hub Centre in Ringsend will be retained and upgraded, as necessary, during the upgrade of the wastewater treatment plant.

There is a requirement for Sludge Storage Facilities for any sludge destined for use in landspreading as detailed in Section 7.3.5. Due to space limitations on the site in Ringsend, any such storage facilities are required to be located at a separate site to the existing wastewater treatment plant site. The proposed plant upgrade will result in a significant increase in sludge quantities, which will require additional off-site storage capacity. As discussed in Section 7.3.4 a new storage facility is currently being considered as part of the Ringsend plant upgrade, with a view to identifying a suitable site and seeking the necessary approvals for its development.

The site selection process and assessment of potential environmental impacts in particular is being and will be undertaken in accordance with Section 9.5. The development of such a sludge storage facility will require appropriate planning permission. As part of the planning application process, the requisite environmental assessments will be carried out to ensure the development is in compliance with all relevant environmental and planning legislation.

There is the potential for use of the waste-to-energy plant currently under construction adjacent to the Ringsend Wastewater Treatment Plant as an option for co-incineration with municipal solid waste in the future, subject to commercial terms and the applicable planning permission and other permits for both facilities. Other alternatives, such as use of dried sludge in industry may also be considered. In accordance with the waste hierarchy, it is preferable to recycle rather than incinerate wastewater sludge. However, due to current pressures on the agricultural outlet for wastewater sludge, it is considered important to consider alternative outlets. This is considered further in Section 8.

7.4.9 Fingal County Council

Sludge produced in Fingal is currently exported and treated off-site under a framework contract. A sludge management plan prepared on behalf of Fingal County Council recommended that the proposed new North Dublin WWTP (Greater Dublin Drainage Scheme www.greaterdublindrainage.ie) should include a Sludge Hub Centre for treatment of wastewater sludge produced in the Fingal area. This proposal has been reviewed by Irish Water and is considered to provide the most appropriate option for a sludge hub in Fingal. There is a requirement for sludge storage for any sludge destined for use in landspreading as detailed in Section 7.3 to store sludge during the winter period when landspreading is not permitted. An assessment of the appropriate location for storage facilities for the Fingal Sludge Hub Centre will be considered as part of the detailed design for this facility. Sludge storage may be located either at the sludge hub centre site itself or in a separate off-site Sludge Storage Facility. If an off-site storage facility is preferred a site selection process as detailed in Section 9.5 will be undertaken and all planning requirements complied with including an assessment of potential traffic impacts.

The Fingal sludge management plan recommended anaerobic digestion and thermal drying. It is recommended that advanced digestion is provided to maximise energy recovery and that the design of the site allows for the provision of thermal drying. The whole life cost for thermal drying is high and may not be justified, at the present time, but should be allowed for in the design of the plant. The availability of land-use outlets may decrease prior to construction of the wastewater treatment plant and it is important that provision is made for thermal drying. The timing of the thermal drying element of the plant should be reviewed as the scheme progresses.

There are no existing imported liquid sludge facilities in Fingal. The proposed Sludge Hub Centre for Fingal should include a full liquid sludge acceptance facility with screening to allow for

acceptance of liquid sludge from small wastewater treatment plants in the Fingal area and septic tank sludge. No additional imported liquid sludge facilities are considered to be necessary in the Fingal area.

7.4.10 *Dún Laoghaire-Rathdown County Council*

There is currently only one wastewater treatment plant in Dun Laoghaire-Rathdown, located at Shanganagh which also serves Bray, Co. Wicklow. The treatment plant currently has anaerobic digestion and thermal drying of sludge. The Bray-Shanganagh WWTP is close to the typical minimum economic size for thermal hydrolysis, so provision of advanced anaerobic digestion may not be economically feasible at this stage but may be considered in the future.

7.4.11 *Galway City Council*

The wastewater treatment plant for Galway City is located at Mutton Island. The treatment plant currently has anaerobic digestion and pasteurisation of sludge. However, the pasteurisation unit is not currently in use and the sludge produced undergoes additional treatment off-site prior to reuse. An ultrasonic sludge treatment unit was recently installed to increase the sludge reduction in anaerobic digestion. There is a potential for upgrade of this facility to include advanced anaerobic digestion to increase energy recovery. Thermal hydrolysis may be marginal at this site and should be considered from an economic perspective.

7.4.12 *Galway County Council*

There is currently a temporary sludge hub in operation in County Galway at Tuam with lime stabilisation facilities for sludge treatment. This treatment was provided on an interim basis until a long-term sludge hub was developed. Sludge import facilities are due to be provided in 2016 to improve operations at the Tuam site.

There is a requirement for a new Sludge Hub Centre in the Galway county area as the wastewater treatment plant at Mutton Island is not considered to be suitable as a Sludge Hub Centre. There are proposals for a new wastewater treatment plant to serve the eastern environs of Galway City in the future. This wastewater treatment plant may also be used as a sludge hub. However, there is no definite date for commencement of this scheme at present. Detailed consideration of this site as a Sludge Hub Centre or a Satellite Dewatering Site will be undertaken when the project progresses.

A Sludge Hub Centre is required for the Galway/Mayo region. Tuam is considered to be a suitable location for a Sludge Hub Centre. However, a detailed site assessment is required in order to confirm suitability. It is proposed that the new Sludge Hub Centre would serve parts of County Mayo with sludge from plants in north Mayo transferred to the existing hub in Sligo. A Sludge Hub Centre to include advanced anaerobic digestion is recommended. A detailed assessment is required in order to confirm the most economically feasible treatment option and to confirm the most appropriate site.

The wastewater treatment plants at Tuam, Gort, Ballinasloe and Dunmore are reported as taking imports of liquid sludge. However, these sites do not currently have adequate facilities to allow efficient sludge acceptance. In order to continue to accept sludge at these sites, improved sludge acceptance facilities are recommended. It is recommended that Satellite Dewatering Sites are developed at Ballinasloe and Moycullen. Imported liquid sludge facilities should be provided at these sites and at Tuam. There are sludge reed beds in place at a number of WWTP sites in Galway reducing sludge transport costs from these sites. Additional sites in Galway may also be suitable for this technology.

7.4.13 *Kerry County Council*

The wastewater treatment plant in Killarney has an autothermal thermophilic aerobic digestion process which fully treats sludge from that plant and imported sludge from the local area. Sludge

produced in the remainder of Kerry is currently exported and treated off-site under a framework contract.

Sludge imports of liquid sludge are currently reported as accepted at a number of wastewater treatment plants in the county including:-

- Killarney WWTP
- Tralee WWTP
- Dingle WWTP
- Castleisland WWTP
- Listowel WWTP
- Cahersiveen WWTP
- Killorglin WWTP

However, the facilities for accepting sludge at these sites are not adequate to efficiently accept sludge from the surrounding plants. There is a substantial cost associated with the management of sludge across County Kerry and satellite dewatering sites with liquid sludge acceptance facilities are recommended at Killarney and Tralee. The sites at Dingle, Listowel, Castleisland and Kenmare should be provided with sludge acceptance facilities to allow sludge to be balanced and discharged to the inlet works.

Due to the geographical nature of County Kerry, there are potentially long transport distances for DWWT sludge in south-west Kerry and the Ring of Kerry. The wastewater treatment plants at Cahersiveen and Killorglin will continue to accept sludge, where there is no negative impact on the wastewater treatment plant, until such time as a scheduled approach to the collection of DWWT sludge is implemented as recommended in Strive Report No 123. On-site treatment using sludge reed beds may be appropriate at a number of sites and its feasibility should be assessed.

There is a requirement for a new Sludge Hub Centre in Kerry. It is proposed that the Sludge Hub Centre could be located at Tralee. The potential for transferring sludge from Kerry to Cork should also be considered. A full detailed site assessment is required in order to confirm suitability. A Sludge Hub Centre to provide advanced anaerobic digestion is recommended. A detailed assessment is required in order to confirm the most economically feasible treatment option and to confirm the most appropriate site.

7.4.14 Kildare County Council

There is currently one Sludge Hub Centre in operation in County Kildare, at Osberstown (Upper Liffey Valley) operated under a DBO contract. The sludge hub has import facilities for liquid and cake sludge and treatment by thermal drying. The thermal drying plant has been out of use for a number of years and sludge is currently lime stabilised prior to reuse. A proposal to upgrade the hub to advanced anaerobic digestion has been approved.

The Athy, Derrinturn, Leixlip and Osberstown WWTP's currently accept imports of liquid sludge and sludge cake. There are existing liquid sludge acceptance facilities in Leixlip and Osberstown. In order to reduce liquid sludge transport costs and to allow for acceptance of septic tank sludge a liquid sludge acceptance facilities are recommended at Athy.

7.4.15 Kilkenny County Council

There is currently a sludge hub in operation at the Kilkenny City (Purcellsinch) treatment plant with lime stabilisation facilities for sludge treatment. This treatment was provided on an interim basis until a long-term sludge hub was developed. However, there are currently no suitable sludge import facilities.

It is proposed to provide liquid sludge acceptance facilities at the Kilkenny City WWTP as part of the wastewater treatment plant upgrade. This site should be considered as a potential long-term Sludge Hub Centre with advanced anaerobic digestion along with liquid and cake sludge acceptance facilities. The upgrade of the Waterford City plant is considered to be a suitable alternative site to cater for sludge from County Kilkenny and the Waterford City area. A detailed assessment is recommended to identify the optimal solution. It is proposed that sludge from County Carlow will also be treated at this Sludge Hub Centre once the capacity of the existing Kildare Sludge Hub Centre is reached. It is not considered necessary to provide any additional sludge Satellite Dewatering Sites within County Kilkenny.

7.4.16 Laois County Council

There is currently one Sludge Hub Centre in operation in County Laois, at Portlaoise. The sludge hub has import facilities for liquid and cake sludge and treatment by thermal drying. The Sludge Hub Centre in Portlaoise was constructed in the last 10 years and is considered to have sufficient capacity for the foreseeable future. No additional sludge satellites are considered to be required in Laois.

7.4.17 Leitrim County Council

Sludge produced in Leitrim is currently exported and treated off-site under a framework contract. The Carrick-on-Shannon wastewater treatment plant acts as a satellite dewatering site and accepts liquid sludge from WWTP's in the county.

It is not considered that there is sufficient sludge produced in Leitrim to economically justify a Sludge Hub Centre. It is recommended that sludge in Leitrim is transferred to the Sligo Sludge Hub Centre or the proposed Sludge Hub Centre in Longford depending on location within the county. Liquid sludge in the north-west of the county should be transferred directly to Sligo with the remainder accepted at Carrick-on-Shannon or transferred directly to Longford.

7.4.18 Limerick City and County Council

There is currently one Sludge Hub Centre in operation in County Limerick, at Limerick City (Bunlicky). The sludge hub has import facilities for liquid and cake sludge and treatment by thermal drying. The plant is currently being upgraded to provide anaerobic digestion and has sufficient capacity for sludge produced in Limerick. It is recommended that the Sludge Hub Centre in Limerick will also cater for sludge from County Clare and is upgraded to advanced anaerobic digestion.

The Sludge Hub Centre in Limerick currently accepts imports of liquid sludge including septic tank sludge. In order to reduce liquid sludge transport costs a satellite dewatering site with liquid sludge import facilities is recommended at Newcastle West.

7.4.19 Longford County Council

There is currently a sludge hub in operation in County Longford at Longford Town with lime stabilisation facilities for sludge treatment. This treatment was provided on an interim basis until a long-term sludge hub was developed.

It is recommended that the existing site in Longford be assessed as the location for a long-term Sludge Hub Centre with advanced anaerobic digestion and liquid and cake sludge acceptance facilities. It is proposed that sludge from suitably located sites in Cavan, Leitrim and Roscommon is also treated at this Sludge Hub Centre in order to make advanced anaerobic digestion economically viable. It is not considered necessary to provide any additional sludge Satellite Dewatering Sites within County Longford.

7.4.20 Louth County Council

There are currently two sludge hubs in operation in County Louth, at Dundalk and Drogheda. Both these sludge hubs have liquid sludge import facilities and anaerobic digestion and currently accept sludge imports. There is additional sludge treatment by thermal drying at Dundalk with lime stabilisation facilities at both Drogheda and Dundalk.

The Sludge Hub Centres in Louth were both constructed in the last 15 years and are considered to have sufficient capacity for the foreseeable future. There is spare capacity at the Sludge Hub Centre in Dundalk which has the potential to be used for sludge imports from Monaghan. However, it should be noted that new industrial discharges may limit the available spare capacity. The capacity of the Sludge Hub Centre should be reviewed as part of any proposal for industrial discharges and consideration given to upgrading the hub to advanced anaerobic digestion if the existing capacity is exceeded. No additional sludge satellites are considered to be required in Louth.

7.4.21 Mayo County Council

Sludge produced in Mayo is currently exported and treated off-site under a framework contract. Sludge imports of liquid sludge are currently reported as accepted at a number of wastewater treatment plants in the county including:-

- Westport WWTP
- Castlebar WWTP
- Ballina WWTP
- Ballyhaunis WW
- Bangor Erris WWTP
- Crossmolina WWTP
- Knock WWTP
- Swinford WWTP
- Achill Island WWTP

However, the existing sludge acceptance facilities are not adequate to efficiently accept sludge from the surrounding plants. There is a substantial cost associated with the management of sludge from County Mayo and a number of satellite dewatering sites with liquid sludge acceptance facilities are recommended. It is considered more economic to reduce the number of sites accepting imports and providing appropriate facilities at these sites. It is recommended that sludge acceptance facilities are provided at the Westport, Ballina and Castlebar. The WWTP site at Achill should be provided with sludge acceptance facilities to allow sludge to be balanced and discharged to the inlet works. In addition to this, on-site treatment of sludge using sludge reed beds may be appropriate at a number of sites.

It is considered more economically feasible to develop a Sludge Hub Centre in Galway to cater for sludge from the southern part of County Mayo with sludge from North Mayo transferred to the Sligo Sludge Hub Centre.

7.4.22 Meath County Council

There is currently a sludge hub in operation in County Meath at Navan with lime stabilisation facilities for sludge treatment. This treatment was provided on an interim basis until a long-term sludge hub was developed. The sludge treatment facility is being operated under a framework contract.

It is recommended that the existing site in Navan be developed as a long-term Sludge Hub Centre with advanced anaerobic digestion and liquid and cake sludge acceptance facilities. There is existing sludge infrastructure in place, including anaerobic digestion, which may reduce

the overall cost of this facility. It is proposed that sludge from suitably located sites in Cavan is also treated at the Navan Sludge Hub Centre in order to make advanced anaerobic digestion economically viable.

Sludge imports of liquid sludge are currently reported as accepted at a number of wastewater treatment plants in the county including:-

- Athboy WWTP
- Castletown Tara WWTP
- Duleek WWTP
- Navan WWTP
- Summerhill WWTP

The Athboy, Castletown Tara, Duleek and Navan sites have facilities for accepting sludge which are not adequate at present. These existing facilities should be reviewed to assess the scope of upgrades required. Additional Satellite Dewatering Sites are proposed for the Kells and Trim WWTP's to accept liquid sludge.

7.4.23 Monaghan County Council

Sludge produced in Monaghan is currently exported and treated off-site under a framework contract. Sludge imports of liquid sludge are currently reported as accepted at a number of wastewater treatment plants in the county including Monaghan, Castleblayney, Carrickmacross and Glaslough. However, the facilities for accepting sludge at these sites are not currently adequate. Satellite dewatering sites with liquid sludge acceptance facilities are recommended at Monaghan and Carrickmacross.

It is considered more economically feasible to transfer sludge to the existing Sludge Hub Centre in Dundalk than to develop a Sludge Hub Centre for sludge produced in Monaghan.

7.4.24 Offaly County Council

There is currently one Sludge Hub Centre in operation in County Offaly, at Tullamore. The sludge hub has import facilities for liquid and cake sludge and treatment by thermal drying. The Sludge Hub Centre in Tullamore was constructed in the last 10 years and is considered to have sufficient capacity for the foreseeable future.

The wastewater treatment plants at Birr, Ferbane and Clara currently accept imports of liquid sludge. However, these sites do not currently have adequate facilities to allow efficient sludge acceptance. In order to continue to accept sludge at these sites, a full imported sludge facility is recommended. It is recommended that the sites at Birr and Ferbane are provided with imported sludge facilities and that sludge currently being delivered to Clara should be diverted to the Sludge Hub Centre in Tullamore.

7.4.25 Roscommon County Council

Sludge produced in Roscommon is currently exported and treated off-site under a framework contract. Sludge imports of liquid sludge are currently reported as accepted at a number of wastewater treatment plants in the county including Ballaghaderreen, Castlerea and Monksland. However, these facilities for accepting sludge are not adequate. An upgrade of the existing sludge acceptance facilities at Castlerea and Monksland is recommended with new sludge acceptance facilities provided at Ballaghaderreen.

It is considered more economically feasible to transfer sludge to the proposed Sludge Hub Centre in Longford than to develop a Sludge Hub Centre for sludge produced in Roscommon. In the short-term it is recommended that sludge from Roscommon is diverted to the existing Sludge

Hub Centre in Sligo until it reaches full capacity with the remaining sludge going to the temporary Sludge Hub Centre in Longford.

7.4.26 Sligo County Council

There is currently one Sludge Hub Centre in operation in County Sligo, at Sligo. The sludge hub has import facilities for liquid and cake sludge and treatment by anaerobic digestion and pasteurisation.

The Sludge Hub Centre in Sligo was constructed in the last 15 years and is considered to have sufficient capacity for the foreseeable future. The Enniscrone WWTP has liquid sludge import facilities and is operated as part of a DBO scheme. The WWTP at Ballysadare is reported as accepting imported sludge. No additional sludge satellites are considered to be required in Sligo. However, the provision of a sludge acceptance tank with discharge to the inlet works should be considered at Ballysadare to reduce the volume of liquid sludge to be transferred to Sligo. There is spare capacity available in the Sligo Sludge Hub Centre. It is recommended that this spare capacity is used to treat sludge from surrounding counties including suitably located sites in Mayo, Leitrim and Roscommon.

The existing anaerobic digestion in Sligo does not have energy recovery. The economic feasibility of this should be reviewed taking into account the proposal to maximise the use of the existing Sludge Hub Centre.

7.4.27 Tipperary County Council

There is currently one Sludge Hub Centre in County Tipperary at Clonmel. The county sludge management plans and sludge hub centre at Clonmel were developed prior to the amalgamation of North and South Tipperary local authorities and sludge management was therefore progressed separately within the county prior to 2014. Clonmel acts as a sludge hub for South Tipperary with imported sludge facilities for liquid and cake sludge imports and treatment by thermal drying. The sludge hub/treatment centre in Clonmel was both constructed in the last 10 years and is considered to have sufficient capacity for the foreseeable future.

Sludge from North Tipperary is currently managed under a framework contract and is treated by anaerobic digestion and pasteurisation at a privately owned off-site facility. The wastewater treatment plant at Roscrea accepts sludge from smaller plants in North Tipperary and sludge is anaerobically digested prior to further treatment off-site.

The following wastewater treatment plants are reported as currently accepting imports of liquid sludge:-

- Nenagh
- Thurles
- Roscrea
- Cashel WWTP
- Cahir WWTP
- Fethard WWTP
- Carrick-on-Suir WWTP
- Tipperary WWTP

However, these sites do not all currently have adequate facilities to allow efficient sludge acceptance. In order to continue to accept sludge at these sites, a review of the existing infrastructure should be undertaken and upgrading to ensure that there is a complete imported sludge facility is recommended. It is recommended that the sites at Nenagh, Thurles, Roscrea, Cashel and Tipperary Town are upgraded to have full imported sludge facilities and that

consideration should be given to diverting the sludge currently being delivered to Cahir, Fethard and Carrick-on-Suir to the other sludge import facilities.

7.4.28 Waterford City and County Council

There is currently one sludge hub and one stand-alone sludge treatment centre in operation in County Waterford. The Waterford City WWTP acts as a sludge treatment centre for sludge produced at the Waterford City WWTP. Dungarvan acts as a sludge hub for the remainder of the county with imported sludge facilities for liquid and cake sludge imports.

The sludge hub/treatment centres in Waterford were both constructed in the last 10 years and are considered to have sufficient capacity for the foreseeable future.

The Dungarvan Sludge Hub Centre currently accepts imports of liquid sludge and sludge cake. There are no other import facilities in Waterford. It is recommended that the Tramore WWTP is also used as a satellite dewatering site and that a full imported sludge facility is provided. No additional sludge satellites are considered to be required in Waterford.

The Waterford City WWTP currently has substantial spare organic capacity at the wastewater treatment plant and within the sludge stream which could be utilised for sludge imports from the region subject to a review of the planning and infrastructure requirements including an assessment of potential traffic impacts. The sludge treatment process in place is anaerobic digestion and pasteurisation of sludge. There is no energy recovery from the gas produced in digestion. There is a potential for upgrade of this facility to add energy recovery. In the short to medium term sludge from Kilkenny could be imported to the Waterford City plant to optimise use of the existing infrastructure. Sludge acceptance facilities would be required in order to proceed with this. Future industrial and commercial developments in the Waterford City area may reduce the level of spare capacity at this site.

7.4.29 Westmeath County Council

There is currently one Sludge Hub Centre in operation in County Westmeath, at Mullingar. The sludge hub has import facilities for liquid and cake sludge and treatment by thermal drying.

The Sludge Hub Centre in Mullingar was constructed in the last 10 years and is considered to have sufficient capacity for the foreseeable future. No additional sludge satellites are considered to be required in Westmeath. The existing wastewater treatment plant in Athlone accepts small quantities of septic tank sludge. The quantity is insufficient to warrant provision of a sludge import facility. However, a sludge acceptance tank discharging to the inlet works should be provided. Liquid sludge import facilities at Monksland will provide sufficient capacity for imports in the area surrounding Athlone with the remainder of the liquid sludge arisings from County Westmeath going directly to the Sludge Hub Centre.

7.4.30 Wexford County Council

There is currently one Sludge Hub Centre in operation in County Wexford, at Wexford Town. The sludge hub has import facilities for liquid and cake sludge and treatment by thermal drying. This sludge hub was completed in 2003 and is considered to have sufficient capacity for the foreseeable future.

The Sludge Hub Centre in Wexford currently accepts imports of liquid sludge. In order to reduce liquid sludge transport costs and to allow for acceptance of septic tank sludge, satellite dewatering sites with liquid sludge import facilities are recommended at Enniscorthy, New Ross and Gorey.

7.4.31 Wicklow County Council

There is currently one Sludge Hub Centre in operation in County Wicklow, at Wicklow Town. The sludge hub has import facilities for cake sludge and treatment by thermal drying. This sludge hub was completed in the last 10 years and is considered to have sufficient capacity for the foreseeable future.

Sludge imports are currently reported at Baltinglass, Carnew, Blessington, Enniskerry and Wicklow. There are no liquid sludge acceptance facilities at these sites and sludge is accepted directly to the inlet works. It is recommended that liquid sludge acceptance facilities are provided at Wicklow Town. In order to reduce liquid sludge transport costs and the volume of liquid sludge imported to Wicklow town, liquid sludge acceptance facilities are recommended at Blessington. It is further recommended that liquid sludge in the south and west of County Wicklow be diverted to liquid sludge acceptance facilities in Athy, Carlow, Tullow and Osberstown.

7.5 Future upgrades

There is a total of 24 sludge hub and treatment centres in Ireland as detailed in Section 7.3. The majority of these are being operated by DBO contractors. Kilkenny County Council and Galway County Council undertake lime stabilisation at the wastewater treatment plants in Kilkenny and Tuam respectively. Other sites have lime stabilisation facilities owned and operated by contractors operating under an Irish Water Framework Contract. The location of existing and potential future Sludge Hub Centres is shown on Figure 7.2 overleaf with an outline of potential infrastructure upgrades in each local authority area detailed in Section 7.4.

Any project and any associated works, individually or in combination with other plans or projects, shall be subject to Appropriate Assessment Screening to ensure there are no likely significant effects on the integrity (defined by the structure and function) of any Natura 2000 site(s) and that the requirements of Article 6(3) and 6(4) of the EU Habitats Directive are fully satisfied in accordance with the recommendations of the Strategic Environmental Assessment of the NWSMP.

There are a number of off-site facilities owned and operated by private contractors which provide lime stabilisation, anaerobic digestion & pasteurisation and composting. An audit of these facilities has indicated that the anaerobic digestion & pasteurisation and composting facilities are generally well controlled and operated. These operations offer good value for money and it is anticipated that use of these facilities will be continued. However, the audit identified a number of concerns over the operation of lime stabilisation facilities. Due to the number of these facilities and the difficulty in monitoring the quality of the operations, it is recommended that any future lime stabilisation is restricted to Irish Water owned sites.

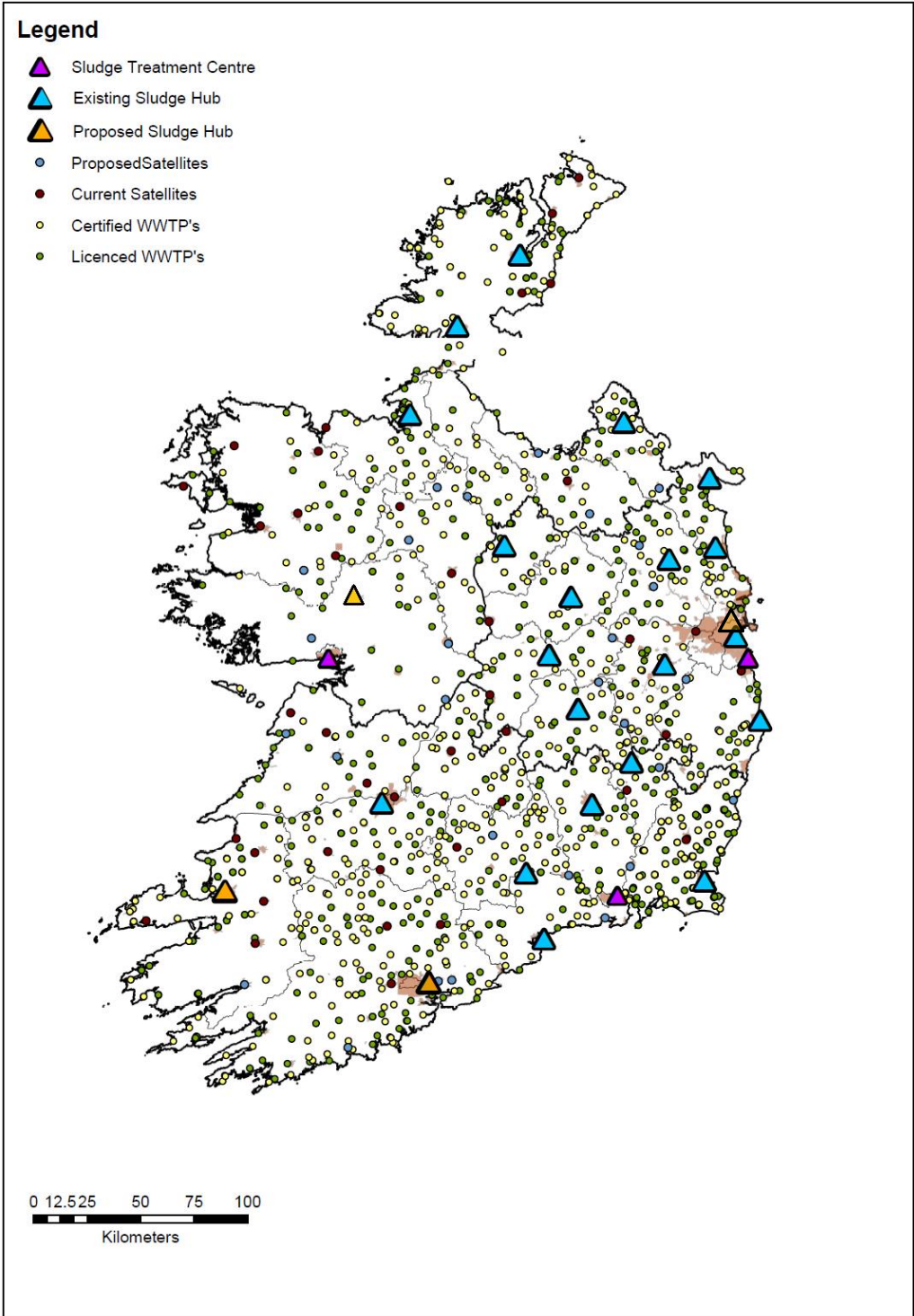


Figure 7.2 – Location of Current and Potential Future Sludge Hubs and Satellites

Table 7.2 Summary of the Current Status and Proposed Upgrades

Local Authority	Sludge Satellites(s) / Hub (s)	Proposed Upgrades
Carlow County Council	Sludge import facilities at Carlow (Mortarstown WWTP), Tullow and Muinebheag. Temporary sludge treatment (lime stabilisation) at Carlow (Mortarstown WWTP)	Sludge import facilities at Tullow and Muinebheag to be upgraded
Cavan County Council	Sludge import facilities with screening at Cavan; off site treatment and disposal	None
Clare County Council	Off site treatment and disposal. Sludge import facilities at Scariff	Upgrade of existing Sludge Hub Centre at Limerick identified as an option for sludge from Clare. Sludge import facilities to be provided at Ennis and Lahinch
Cork City Council	Sludge treatment at Carrigrennan with no import facilities.	Sludge Hub Centre proposed for Cork. Carrigrennan site identified as potential Sludge Hub Centre location.
Cork County Council	Separate sludge contracts for four regions with off site treatment. Liquid sludge import facilities at Blarney and Buttevant.	Sludge import facilities to be provided at Ballincollig, Bantry, Carrigtoohil, Clonakilty, Fermoy, Mallow, Midleton, Skibbereen.
Donegal County Council	Sludge hubs with thermal drying complete at Letterkenny and Donegal Town. Hubs include liquid and cake import facilities.	Sludge import facilities to be provided at Buncrana.
Dublin City Council	Sludge hub at Ringsend complete. Liquid sludge import facilities at Ringsend.	Sludge facilities to be upgraded as part of the WWTP upgrade. Separate treated sludge regional storage facility to be provided for storage and distribution of product en-route to end use.
Dun Laoghaire Rathdown CC	Sludge treatment at Bray-Shanganagh with no import facilities.	None
Fingal County Council	No existing sludge hubs or satellites in Fingal.	Sludge hub planned as part of GDD WWTP. Sludge storage may be located either at the sludge hub centre site itself or in a separate off-site sludge storage facility.
Galway City Council	Sludge treatment with no sludge import facilities.	None
Galway County Council	Temporary sludge treatment (lime stabilisation) facilities at Tuam.	Sludge Hub Centre proposed for Galway/Mayo. Tuam identified as potential Sludge Hub Centre location. Sludge import facilities proposed for Tuam, Ballinasloe and Moycullen.
Kerry County Council	Off site treatment and disposal	Sludge Hub Centre proposed for Kerry. Tralee identified as potential Sludge Hub Centre location. Sludge import facilities to be provided at Tralee, Killarney, Dingle, Listowel, Castleisland and Kenmare.
Kildare County Council	Sludge Hub Centre at Osberstown not currently operational. Upgrade of sludge hub including liquid and cake sludge import	Sludge Hub Centre at Osberstown to be upgraded in 2016. Sludge import facilities to be provided at Athy.

	facilities ongoing.	
Kilkenny County Council	Kilkenny City operating as sludge hub with temporary lime stabilisation.	Sludge Hub Centre proposed for south-east. Waterford City or Kilkenny City identified as potential Sludge Hub Centre locations. Sludge import facilities to be provided at Kilkenny City.
Laois County Council	Portlaoise sludge hub complete. Liquid and cake sludge import facilities at hub.	None
Leitrim County Council	Liquid sludge import facilities at Carrick-on-Shannon. Off site treatment and disposal	None
Limerick City Council	Limerick SHC complete. Liquid and cake sludge import facilities at hub.	Upgrade of existing Sludge Hub Centre required identified as an option for sludge from Clare.
Limerick County Council	Limerick SHC complete. Liquid and cake sludge import facilities at hub.	Sludge import facilities to be provided at Newcastle-West and Castletroy
Longford County Council	Temporary sludge treatment (lime stabilisation) provided at Longford.	Sludge Hub Centre proposed for Longford
Louth County Council	Sludge Hub Centres complete in Dundalk and Drogheda. Liquid and cake sludge import facilities at Dundalk hub.	None
Mayo County Council	Off site treatment and disposal	Sludge Hub Centre proposed for Galway/Mayo. Tuam identified as potential Sludge Hub Centre location. Sludge import facilities to be provided at Ballina, Castlebar, Westport and Achill.
Meath County Council	Temporary sludge treatment (lime stabilisation) provided at Navan.	Sludge Hub Centre proposed for Meath. Navan identified as potential Sludge Hub Centre location. Sludge import facilities to be upgraded at Athboy, Castletown Tara, Duleek and Navan.
Monaghan County Council	Off site treatment and disposal	Sludge import facilities to be provided at Monaghan and Carrickmacross.
Offaly County Council	Sludge Hub Centre complete at Tullamore. Liquid and cake sludge import facilities at hub.	Sludge import facilities to be provided at Birr, Ferbane and Clara.
Roscommon County Council	Off site treatment and disposal	Sludge import facilities to be upgraded at Castlerea and Monksland.
Sligo County Council	Sludge Hub Centre complete. No satellites proposed.	None
Tipperary CC ¹	Thermal dryer at Clonmel for sludge from South Tipperary. Liquid and cake sludge import facilities at hub, liquid sludge acceptance facilities at Cahir, Carrick-on-Suir, Cashel, Fethard and Tipperary Town.	Sludge import facilities to be provided at Nenagh, Thurles, Roscrea, Cashel and Tipperary Town.

	North Tipperary sludge treated off-site	
Waterford City Council	Sludge Hub Centre complete at Waterford City WWTO; no import facilities	Sludge Hub Centre proposed for south-east. Waterford City or Kilkenny City identified as potential Sludge Hub Centre locations.
Waterford County Council	Sludge Hub Centre complete at Dungarvan with import facilities	None
Westmeath County Council	Sludge Hub Centre complete at Mullingar. Liquid and cake sludge import facilities at hub.	None
Wexford County Council	Sludge Hub Centre complete at Wexford. Liquid and cake sludge import facilities at hub.	Sludge import facilities to be provided at Enniscorthy, New Ross and Gorey
Wicklow County Council	Sludge hub complete at Wicklow with import facilities for sludge cake only. Liquid sludge imports discharged to WWTP.	Sludge import facilities to be provided at Blessington

Notes:

1. The county sludge management plans and sludge hub centre at Clonmel were developed prior to the amalgamation of North and South Tipperary local authorities and are therefore considered separately in Table 7.2.

8 Sludge Outlet Options

8.1 Introduction

The main outlet for wastewater sludge in Ireland is agriculture. A review of sludge outlets currently in use in Europe shows that the most common outlet for wastewater sludge is agriculture (51% in 2012) with an additional 10% composted and also mainly used in agriculture. The main alternative to agricultural landspreading is incineration with 25% of wastewater sludge in Europe incinerated in 2012. Historically, disposal to landfill was the main outlet. However, this is not considered to be economically or environmentally sustainable and is not considered further.

Other options are available, including thermal treatment, use in energy crops, silviculture and land remediation. However, development of these outlets, apart from thermal treatment, has been limited both in Ireland and internationally. Further details of these options are included in Sections 8.7 to 8.10. It is proposed to undertake a feasibility study for identification of viable alternative options for sludge outlets within the first 5 year cycle of the plan. The current high reliance on agricultural use is considered to be a risk to Irish Water due to potential difficulties in sourcing land for sludge reuse as further detailed in Sections 8.2 to 8.4.

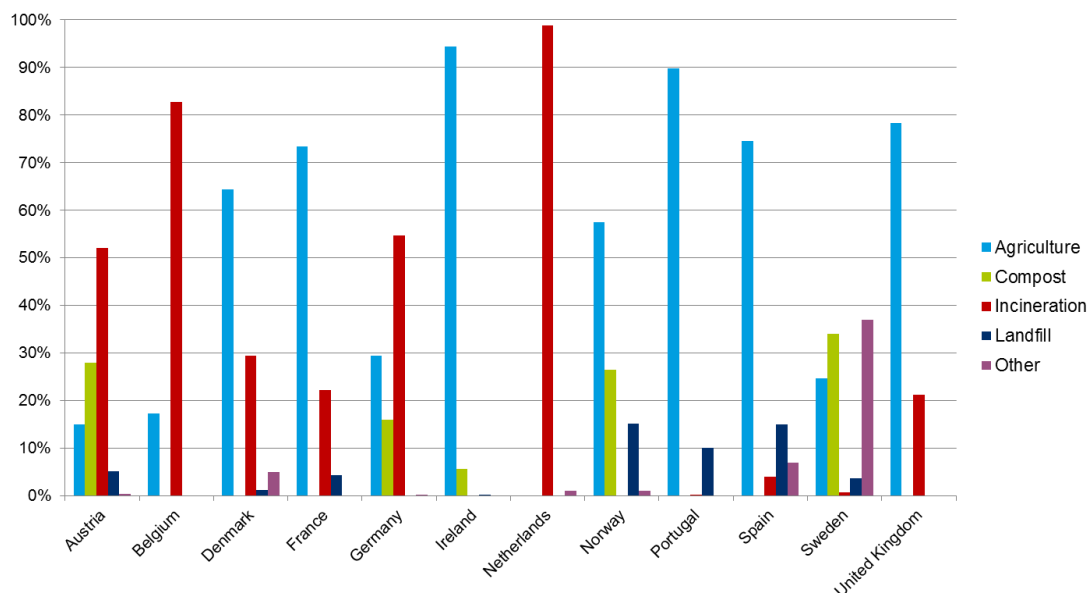


Figure 8.1 – Wastewater Sludge Outlets in Europe (2012)

Note: Data for 2012 used in Figure 8.1 as 2013 returns reported on EuroStat are incomplete.

8.2 Reuse in Agriculture

As detailed in Section 2, over 98% of wastewater sludge is currently reused in agriculture including sludge which is composted prior to agricultural reuse. The agricultural outlet for wastewater sludge is under increasing scrutiny mainly due to perceptions of contamination risk. There has been a significant reduction in availability of agricultural outlets due to a tendency to exclude wastewater sludge from lands used for agricultural production under quality assurance schemes. This includes the schemes operated by An Bord Bia and the Irish Grain Assurance Scheme.

The proposed national reporting systems for sludge reuse locations, as detailed in Section 10.6, will facilitate the operators of these schemes. Irish Water proposes to liaise with the Department of Agriculture, Food and Marine on an ongoing basis with the objective of ensuring that outlets for reuse of sludge are appropriate and support the aims of the Bord Bia and the Irish Grain

Assurance Schemes. It is expected that this will lead to a reduction in the land available for land-spreading and emphasises the importance of reduction of sludge quantities through anaerobic digestion and the need for alternative outlets to agricultural reuse.

The use of wastewater sludge as a fertiliser is considered a favourable environmental option. The use of properly treated wastewater sludge, in accordance with a nutrient management plan can avoid any adverse environmental impact on receiving waters as the quantity of phosphorus is monitored and controlled to match the quantity required by the crop being grown. The use of digested sludge in particular has been shown to improve nitrogen uptake in plants. The organic content and slow release nature of wastewater sludge compared to artificial fertiliser has added benefits in improving the condition of soil and reducing the potential for run-off of nutrients. This underlies the benefits of using such sludge under controlled conditions.

The cost of ruling out the agricultural outlet in Ireland for sludge was estimated in 2010 as €200 million over a 10 year period in a review of current sludge disposal commissioned by the EU¹⁰. Scottish water have estimated the cost of omitting the current agricultural outlet in Scotland would be £50 million from 2015 to 2021. The risk of complete loss of the agricultural outlet can be mitigated by ensuring confidence in the sludge product by adopting appropriate control (e.g. HACCP) and monitoring measures. Treatment of all sludge to ensure pathogen removal and more stringent monitoring of sludge treatment and disposal practices is necessary to support the sustainable retention of the agricultural outlet and is a core objective of this Plan.

There will be an additional cost, estimated as €2.5¹¹ million per annum for the proposed higher level of treatment and additional monitoring. However, the additional cost if the agricultural outlet is no longer available is estimated as €200 million over a 10 year period as detailed above. Some of the additional cost for treatment and monitoring may be off-set by maximising energy recovery and reducing sludge volumes. More critically, the viable alternatives are not currently available and their mobilisation is likely to take up to 10 years given statutory planning processes, funding and other logistical challenges.

8.3 Agricultural Areas in Ireland

Agricultural land-use in Ireland, from 2010-2013, from CSO data, is detailed in Table 8.1 below. The type of land typically engaged for agricultural use of wastewater sludge is land used for fodder for animals with grassland also used. Pasture and horticultural crops are subject to legislative restrictions and as such are less suitable for use. Land used for dairy cattle in particular is not considered to be a viable option due to the concerns of the dairy industry, though the issues relate to perception rather than scientific issues. An average of 300,000 hectares of agricultural land is used for producing cereals. Approximately two-thirds of cereals are used for animal feed and are thus potentially suitable for fertilising using wastewater sludge. There are additional areas of potential use in hay and silage production and grazing for drystock. None of these outlets can reasonably be said to pose any risk to food quality.

¹⁰ Environmental, economic and social impacts of the use of sewage sludge on land - Final Report; Milieu Ltd, WRc and RPA for the European Commission

¹¹ Estimated 10,000 tonnes dry solids requiring additional treatment and/or monitoring at an average additional cost of €250 per tonne dry solids.

Table 8.1 – Summary of Agricultural Land-Use in Ireland

Agricultural Land-Use	2010	2011	2012	2013
Area farmed (AAU)¹	4568.9	4555.5	4532.7	4477.8
Pasture	2507.6	2459.3	2391	2337.7
Hay	193.8	213.2	203.5	218.4
Grass silage	1076.4	1070.2	1075	1071
Beans and peas	4.6	2.9	4.1	4.5
Oilseed rape	8	12.4	17.5	13.7
Arable silage	4.1	2.9	2.4	3.9
Maize silage	22.8	19	13.7	14.5
Fodder rape and kale	1.8	1.3	1.7	1.4
Potatoes	12.2	10.4	9	10.7
Turnips	1.2	1	1.1	0.9
Beet	9.6	8.2	7.8	10.1
Vegetables for sale	4.9	3.8	3.6	3.5
Fruit	1.2	0.8	0.9	0.9
Nurseries, horticulture etc.	0.3	0.4	0.4	0.5
Other crops	9.4	4.9	4.5	4.7
Total cereals	273.9	297.4	315.4	307.8
Rough grazing in use	437.3	447.3	481.2	473.5

Notes: 1. Area in '000 hectares

8.4 Suitability of Land for Reuse in Agriculture

In considering lands suitable for reuse of properly treated wastewater sludge, a regional rather than county based approach is needed. Much of the central part of Ireland is limited by existing naturally occurring heavy metal content, mainly cadmium and nickel. In accordance with the Sewage Sludge Directive, as implemented by S.I. 148 of 1998 and amended by S.I. 267 of 2001, the levels of cadmium and nickel in soil must be less than 1mg/kg and 30 mg/kg respectively for use of sludge to be permitted. Based on these restrictions, the areas where use of wastewater sludge is not permitted are shown in red on Figure 8.2 for cadmium or red and orange in the case of nickel.

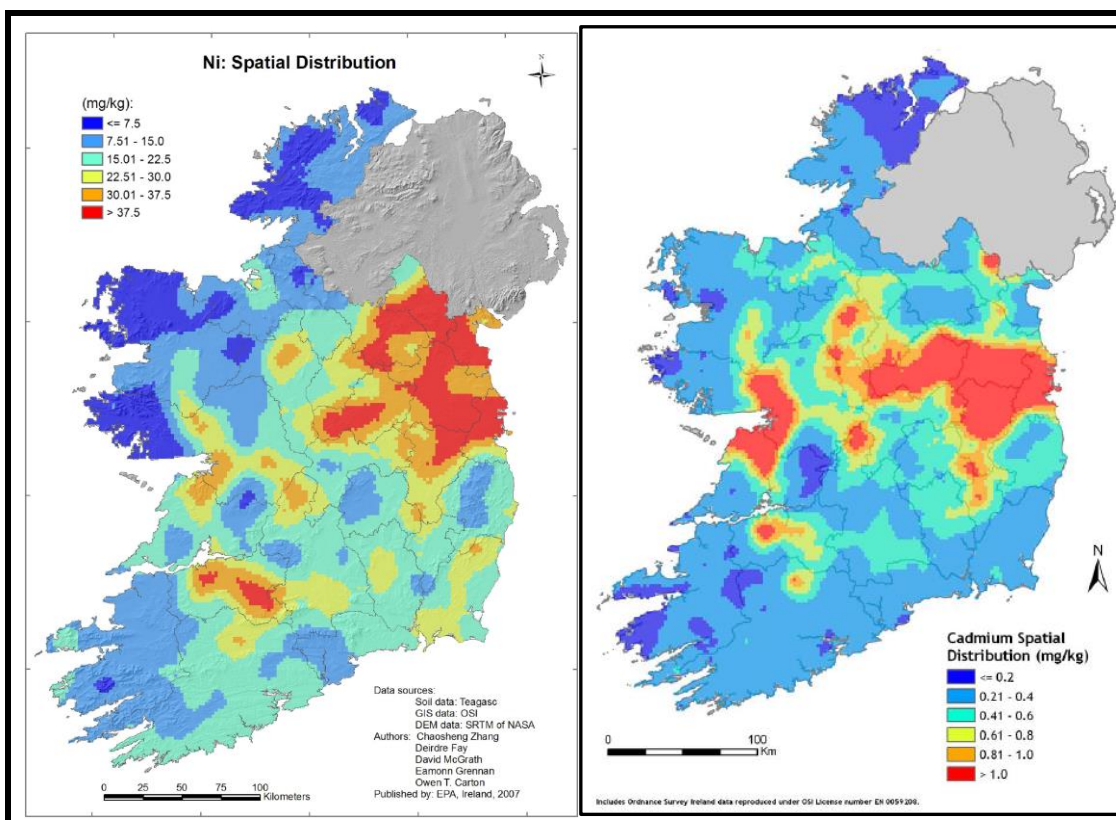


Figure 8.2 – Spatial Distribution of Cadmium and Nickel

There are large areas in the west and north-west of Ireland which are unsuitable for reuse of wastewater sludge, due to groundwater vulnerability and soil types. Groundwater is most at risk where the subsoils are absent or thin and, in areas of karstic limestone, where surface streams sink underground at swallow holes. Use of wastewater sludge is not normally permitted in areas of extreme groundwater vulnerability, shown in red on Figure 8.3 overleaf.

8.5 Other Potential Restrictions

The agricultural use of wastewater sludge may be further restricted by the proximity of land to Natura 2000 sites and areas which may be impacted by flooding. This is assessed in more detail in the Strategic Environmental Assessment and Natura Impact Assessment of the NWSMP.

8.6 Overall Availability of Agricultural Land

The restrictions in agricultural use of wastewater sludge, due to groundwater vulnerability and naturally occurring cadmium and nickel levels, reduce the overall area of agricultural land, potentially available, from approximately 4.45 million hectares to 2.54 million hectares, i.e. 54% of agricultural land. These areas are shown on Figure 8.4. This area would be further reduced to approximately 108,000 hectares if only land used for animal fodder cereals was used. Further limitations are required on use of sludge in areas within or adjacent to Natura 2000 sites or areas prone to flooding. This will be reviewed on a case-by-case basis as part of the assessment of suitability of landbanks to ensure that there are no significant impacts.

The quantity of wastewater sludge produced in 2014 was 53,543 tonnes dry solids. Based on a typical phosphorus content of 1.7%, the application rate would be approximately 3.5 tonnes per hectare. Therefore the land requirement for agricultural reuse would be 15,300 hectares. It is expected that the quantity of sludge may increase to 75,150 tds per annum by 2020 if full compliance with wastewater discharge licencing is achieved. This would increase the land requirement to 21,500 hectares. The most sustainable, cost effective and beneficial outlet for

wastewater sludge in Ireland, subject to appropriate treatment, is reuse on land, with agricultural landuse primarily on land used for animal fodder production.

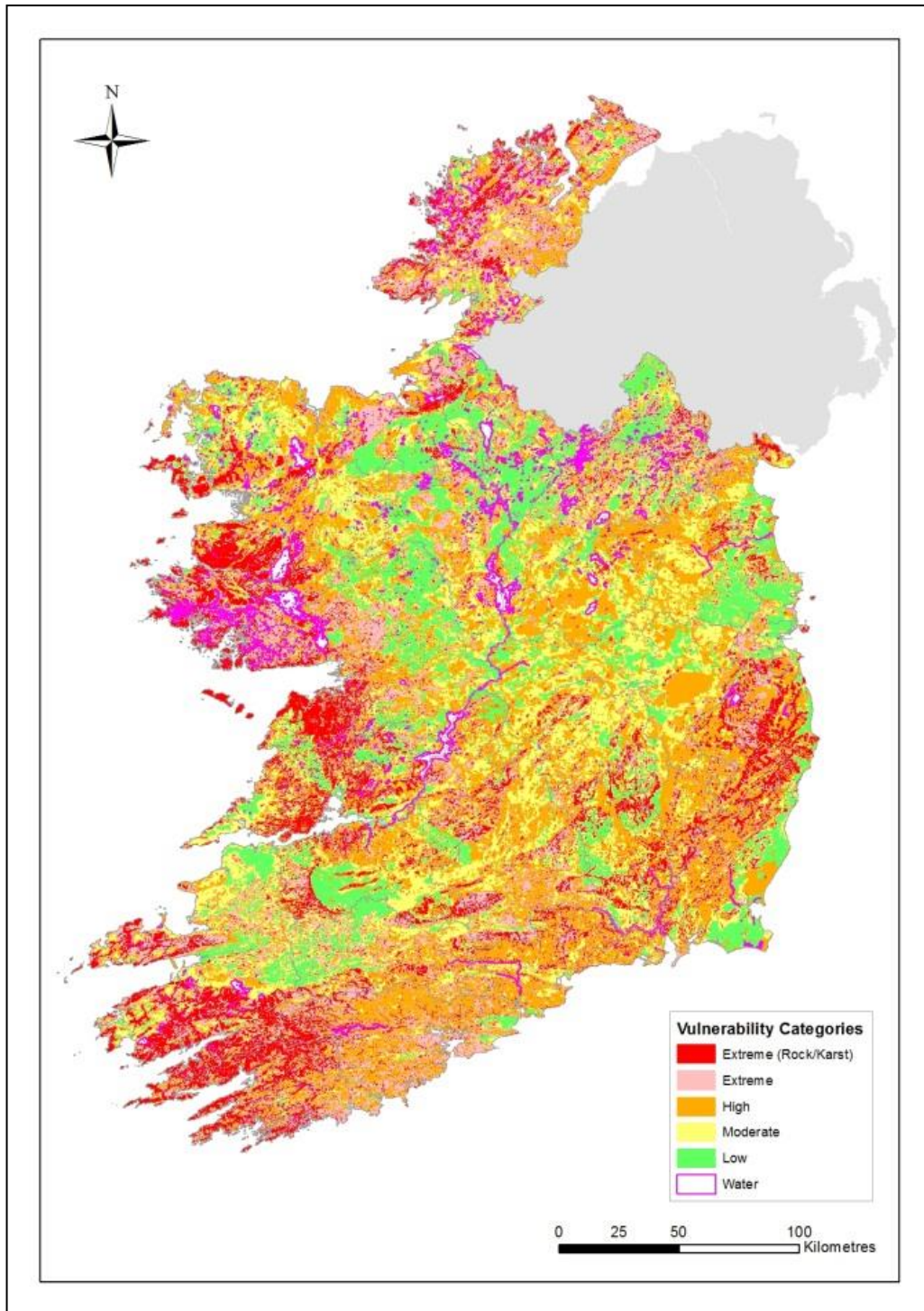


Figure 8.3 - National Groundwater Vulnerability Map from Geological Survey of Ireland



Figure 8.4 – Agricultural Areas Potentially Suitable for Use of Sludge

8.7 Reuse in Non-Agricultural Land

There are options for reuse of wastewater sludge in non-agricultural land. This includes use in energy crops, forestry and land remediation. There are limited ongoing options for both forestry and land remediation. It is recommended that this is reviewed on an ongoing basis to identify potential outlets. This includes liaising with Bord na Mona, Coillte and private forestry operations to identify any potential outlets.

8.7.1 Energy Crops

Wastewater sludge can be used as a fertiliser to increase yields of bioenergy crops that are harvested as sources of non-fossil fuel. There has been limited uptake of the Bioenergy Scheme managed by the Department of Agriculture, Food and the Marine which has been providing grant incentive for bioenergy crops since 2007. From 2007 to 2014, in the region of 3,400 hectares of energy crops were established under the Bioenergy Scheme as further detailed in Table 8.2. In the early years of the scheme, there was a strong preference for planting miscanthus and in recent years the preference has switched to willow. Due to the low uptake of the current schemes, the Department of Agriculture, Marine and Food are currently reviewing options for the future.¹²

Table 8.2 - Planting figures for the Bioenergy Scheme

Year	Miscanthus	Willow	Total Area Planted	Total Expenditure
	(Hectares)	(Hectares)	(Hectares)	€m
2007	617	64	681	0.654
2008	775	128	903	1.077
2009	709	168	877	1.09
2010	159	185	344	0.594
2011	78	130	208	0.357
2012	64	99	163	0.258
2013	12	62	74	0.178
2014	0	103	103	0.087
Total	2414	939	3353	4.32

Teagasc has reported that there is a potentially larger market for up to 67,000 ha of energy crops to meet Ireland's 2020 renewable energy targets. However, given the rate of uptake of the existing grant schemes, the actual area of land growing energy crops is not expected to increase substantially, unless additional incentives are provided.

While there are many advantages in the use of wastewater sludge in the fertilisation of energy crops, there are also some obstacles. The production of energy crops is not considered to be agriculture and as such the exemption from licencing under the Waste Management Act which apply to agricultural use, does not apply and separate permissions are required under waste legislation to allow the sludge to be used. It is considered that recycling to energy crops is unlikely to become a significant sludge disposal route, unless existing legislative restrictions are amended. Irish Water will liaise with the Department of Housing, Planning, Community and Local Government in relation to the current legislation and any potential changes to address the current restrictions. The production of energy crops may have impacts on the catchment hydrology with potential indirect impacts on Natura 2000 sites particularly where there is

¹² Reference: Dáil Debates, 24th June 2015, Written Answer No. 149

sensitivity to water levels within the Natura 2000 site. These potential impacts must be considered where the use of wastewater sludge is proposed.

8.8 Thermal Processes

The main alternative outlet for wastewater sludge is incineration. Other thermal processes, including gasification and pyrolysis, are currently being developed internationally and are expected to be available on a commercial scale in the next 5-10 years. There are significant capital and operating costs associated with all thermal processes and as such they are only likely to become a preferred option if reuse in agriculture or non-agricultural landuse are not available. As detailed in Section 8.2, the cost of removing the agricultural outlet for sludge has been estimated at €200 million over a 10 year period based on incineration as the alternative outlet.

In other jurisdictions, incineration of wastewater sludge is carried out in commercial incinerators for general waste or in stand-alone wastewater sludge incinerators. There is substantial capital investment required for construction of a wastewater sludge incinerator and this is not currently being considered by Irish Water. However, the proposed feasibility study for alternative options for sludge disposal will consider thermal processes in more detail. There are a number of existing and proposed waste incinerators in Ireland which may offer an alternative outlet for wastewater sludge. The main disadvantages of incineration are the loss of the nutrient and organic value of the sludge, the requirement for disposal of ash and the cost. There are, however, some advantages, including energy recovery and certainty of outlet. The environmental sustainability of incineration can be improved by recovery of phosphorus from the sludge stream prior to incineration.

8.9 Landfill

The use of landfill for disposal of wastewater sludge is effectively banned by the Landfill Directive due to the requirement to set limits on the acceptance of biodegradable organic waste. At present, the only sludge which is landfilled is from Shannon Town in a dedicated facility due to the potential presence of high heavy metal levels in this sludge. The quantity of wastewater sludge going to landfill in 2005 was 10,292 tonnes. This had reduced to 361 tonnes by 2014. Landfill is not considered to be a sustainable outlet for wastewater sludge and will only be considered as a short-term emergency outlet where reuse options are not available.

8.10 Other Recovery Reuse Options

The main recovery options for wastewater sludge are energy recovery and phosphorus recovery (as struvite) and its use as a fertiliser where organic and nutrient content are of beneficial use. Phosphorus recovery is normally only viable for larger anaerobic digestion facilities and will be reviewed on a case by case basis for new or upgraded anaerobic digestion facilities. In conjunction with the expansion and upgrading of the Ringsend (Dublin) plant, consideration of struvite recovery will be possible when the sludge characteristics are determined post commissioning. Similarly there are options for phosphorus recovery from ash where mono-incineration is used for sludge disposal. There has been research into recovery of other constituents including precious metals. However, these recovery options are not currently viable.

9 Options Assessment and Alternatives

9.1 General

The options in relation to wastewater sludge management relate mainly to the approach to its treatment, transport and disposal. This was formerly assessed on a county by county basis. However, due to the large variation in the size and layout of each county, this is no longer considered appropriate. Similarly, assessing sludge management on a regional basis, i.e. east/midlands, north/west and southern is not considered appropriate, as there is currently significant movement of sludge between regions.

The main criteria in selection of options are as follows:

- Environmental impact – emissions to air, water and land, climate change impact and energy use;
- Social impact – potential nuisance (e.g. odour, noise, traffic), public perception and food safety;
- Financial impact – life cycle costs, energy cost and recovery, reliability of technology.

These impacts cannot be considered in isolation as any option selected, for treatment, transport or disposal, must be economically, environmentally and socially acceptable. The sustainability of any option and the risks associated with it are a combination of all potential impacts. A graphical view of the impacts and connections is shown in Figure 9.1 below.

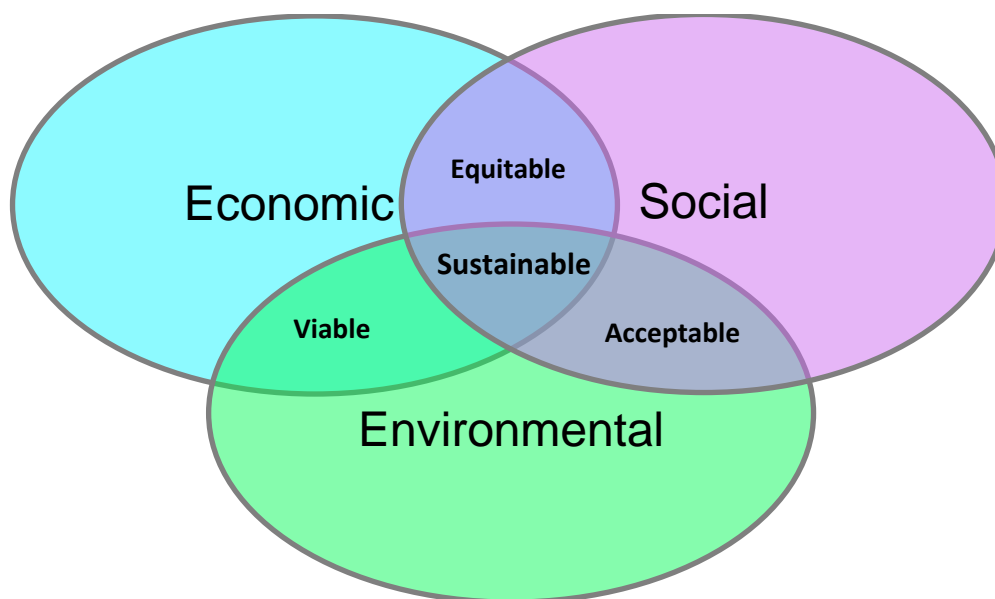


Figure 9.1 – Options Assessment Criteria

9.2 Options for Sludge Management

A range of options are available for sludge management which need to be considered to identify the optimum solution for each wastewater treatment plant site. A summary of options for sludge treatment and reuse is included in Table 9.1 below. Section 5 considers the types of treatment processes available and the advantages and disadvantages of each. Section 6 considers the transportation strategy and Section 8 considers the available outlets for wastewater sludge. The level of treatment, sludge outlets and the transportation strategy need to be considered in tandem in order to ensure that the optimum solution is selected.

Table 9.1 – Summary of Options and Alternatives

Options	Main Issues to be Considered
<p><u>Liquid Sludge</u></p> <ul style="list-style-type: none"> • Transfer unthickened sludge to satellite • Thicken on site and transfer thickened sludge to satellite • Thicken and dewater on site and transfer dewatered sludge cake to Sludge Hub Centre for treatment • Onsite sludge thickening, dewatering and treatment • Onsite sludge reed bed 	<ul style="list-style-type: none"> • Capital and operation cost of thickening / dewatering versus transport • Distance to suitable satellite / hub for dewatering / treatment • Access to site and traffic impacts • Suitability of site for on-site treatment
<p><u>Sludge Cake</u></p> <ul style="list-style-type: none"> • On-site dewatering and treatment • Transfer sludge cake to designated Sludge Hub Centre for treatment • Transfer sludge cake to off-site private sludge treatment facility 	<ul style="list-style-type: none"> • Capital and operation cost of on-site treatment versus transport to Sludge Hub Centre / off-site treatment • Distance to suitable Sludge Hub Centre • Distance to suitable private sludge treatment facility
<p><u>Sludge Treatment</u></p> <ul style="list-style-type: none"> • No treatment • Mesophilic Anaerobic Digestion • Mesophilic Anaerobic Digestion with pre- or post-pasteurisation • Thermophilic Anaerobic Digestion • Thermophilic Aerobic Digestion • Composting • Alkaline Stabilisation • Thermal Drying • Thermal treatment with or without energy recovery 	<ul style="list-style-type: none"> • Final outlet for sludge • Capital and operation cost of treatment • Value of energy recovery • Environmental sustainability
<p><u>Sludge Outlet</u></p> <ul style="list-style-type: none"> • Reuse on agricultural land / non-agricultural crops • Use in land remediation • Thermal treatment with or without energy recovery 	<ul style="list-style-type: none"> • Capital and operation cost of reuse on land versus thermal treatment • Distance to suitable land bank for reuse / remediation • Environmental sustainability

There is a large variation in type of treatment, sludge infrastructure and population densities in areas being served by wastewater treatment plants operated by Irish Water. As such, the particular requirements for each plant must be assessed individually, taking into account the environmental, social and financial impacts, prior to carrying out any capital upgrades or operational changes.

9.3 Existing Infrastructure

9.3.1 Sludge Hub Centres and Sludge Treatment Centres

The development of sludge management infrastructure and activities over the last 15 years has been outlined in Section 7. The construction of sludge treatment infrastructure at a large number of locations has implications for the future management of sludge. There are thirteen sites where thermal drying has been put in place, seven of which also have anaerobic digestion. Three sludge treatment sites have anaerobic digestion and pasteurisation.

9.3.2 Satellite Dewatering Sites

There are currently over 100 wastewater treatment plants reported as taking sludge imports. However, only 16 of these sites, including fourteen of the existing Sludge Hub Centres, have complete facilities to operate as effective satellite dewatering sites. It is considered that where a wastewater treatment plant accepts more than 8,000m³/year of liquid sludge, that a separate sludge acceptance facility is justified. It is expected that an additional 40 to 50 sites will continue to accept sludge as further detailed in Section 7.4. The receipt of sludge at these sites requires balancing, with controlled discharge, to the inlet works of the site.

9.4 Liquid Sludge Options

The first level of sludge treatment relates to volume reduction, i.e. thickening and/or dewatering. Further details are included in Section 6.3. In order to ensure that sludge transport costs are minimised without impacting on the wastewater treatment process or the final sludge treatment process, the volume of sludge storage and method of thickening selected are significant. An economic balance is needed between volume reduction and transport costs.

In general for WWTP's over 5,000 PE, dewatering is economically justified and in many cases it is justified for WWTP's over 3,000 PE. There are 177 No. WWTP's reported as having sludge dewatering installed. In general, existing wastewater treatment plants with a current PE over 3,000 have dewatering in place. There are a number of WWTP's with a PE of less than 2,000 with dewatering. It may be more cost effective to transfer liquid sludge from these WWTP's than to continue to dewater sludge on site.

The following requirements need to be assessed when considering the sludge storage, thickening and dewatering requirements:-

- Site location relative to satellite and hub centres;
- Site access;
- Sludge production rates in treatment process;
- Storage capacity within treatment process;
- Minimum storage requirements in line with Section 6.4;
- Emission limit values and current level of compliance;
- Potential nuisance (odour, noise, traffic);
- Current staffing arrangement.

An assessment of shortfalls in existing sludge infrastructure was undertaken in 2015 using workshops with the Local Authorities in relation to 411 wastewater treatment plants. Based on these workshops, 78 WWTP's were identified as requiring upgrades in sludge storage, thickening /or dewatering plant. Based on the information from the workshops, it has been estimated that a further 112 WWTP's also require upgrading of existing sludge infrastructure. The cost of upgrading the WWTP's identified as having shortfalls has been assessed. Implementation of these upgrades will be undertaken on a phased basis with priority given to WWTP's causing non-compliance in effluent standards due to shortfalls in sludge infrastructure and WWTP's with disproportionately high cost for sludge treatment, transport or dewatering due to inadequate facilities on the site.

9.5 Site Selection for New Infrastructure

The selection of sites for new infrastructure must consider a number of factors including environmental, planning, economic, technical and site availability factors. Due to the wide range of needs and circumstances associated with each project, the specific criteria and methodology for site selection will be developed on a case by case basis. The specific requirements in relation to Satellite Dewatering Sites and Sludge Hub Centres are considered in Section 9.6 and 9.7 respectively. In general the location of new or upgraded sludge facilities including Sludge Storage Facilities must consider the following environmental siting criteria:-

- Avoid, as far as possible, siting sludge infrastructure (including expansion to WWTP, sludge hub or satellite dewatering site) or related infrastructure in areas protected for landscape and visual amenity, geological heritage and/or cultural heritage value. Where this is unavoidable, an impact assessment should be carried out by a suitably qualified practitioner and appropriate mitigation and/or alternatives must be provided.
- Avoid siting sludge infrastructure or related infrastructure in proposed Natural Heritage Areas (pNHAs), Natural Heritage Areas (NHAs), Statutory Nature Reserves, Refuges for Fauna and Annex I Habitats occurring outside European designated sites.
- In order to protect habitats which, by virtue of their linear and continuous structure (e.g. rivers and their banks) or their contribution as stepping stones (e.g. ponds or small woods), are essential for the migration, dispersal and genetic exchange of wild species, these features will be protected as far as possible from loss or disruption through good site layout and design.
- To protect river habitats and water quality, ensure that no sludge facility, including clearance and storage of materials, takes place within a minimum distance of 15 m measured from each bank of any river, stream or watercourse.
- Ensure Sustainable Drainage System (SuDS) is applied to any sludge facility and that site-specific solutions to surface water drainage systems are developed, which meet the requirements of the Water Framework Directive and associated River Basin Management Plans.
- Avoid development of sludge infrastructure in flood risk areas. Reference should be made to the *Planning System and Flood Risk Management for Planning Authorities* (DECLG/OPW 2009) and the National Flood Hazard Mapping (OPW) while referring to the relevant Flood Risk Management Plan (FRMP).
- Ensure riparian buffer zones (minimum of 15 m) are created between all watercourses and any sludge facilities to mitigate flood risk. The extent of these buffer zones shall be determined in consultation with a qualified ecologist and following a Flood Risk Assessment. Any hard landscaping proposals shall be located outside of these buffer zones.
- To protect river habitats and water quality (including physical habitat and hydrological processes/regimes), ensure that no sludge facilities, including clearance and storage of sludge materials, takes place within a minimum distance of 15 m measured from each bank of any river, stream or watercourse.
- Avoid geologically unsuitable areas including karst where practicable, and areas susceptible to subsidence or landslides. Due consideration should be given to the primary water source of the area and the degree of surface water/groundwater interaction.
- Impact from a transport perspective will be assessed including road access, network, safety and traffic patterns to and from the proposed sludge facility in accordance with road design guidelines and/or relevant LA guidelines in relation to roads.
- Existing WWTP sites and brownfield sites should be considered for any expansions for sludge facilities. Opportunities to integrate sludge treatment with sites that produce sludge needs to be considered ensuring maximum efficiency of sludge processing.
- Ensure strict protocols are applied to prevent the spread of Invasive Alien Species.

Irish Water will carry out Appropriate Assessment Screening as required on proposed projects and any associated works, individually or in combination with other plans or projects, to ensure there are no likely significant effects on the integrity (defined by the structure and function) of any Natura 2000 site(s) and that the requirements of Articles 6(3) and 6(4) of the EU Habitats Directive are fully satisfied. In projects where the only potential impact is on the final effluent discharges, Appropriate Assessment Screening is undertaken by the EPA as part of the wastewater discharge licensing process. Irish Water will also ensure that in carrying out activities associated with management of wastewater sludge, we are in compliance with our obligations under the Birds and Natural Habitats Regulations 2011-2015.

9.6 Selection of Satellite Dewatering Sites

Existing and potential future suitable satellite dewatering sites have been identified in Section 7.4. It is proposed to use spare dewatering capacity and under-utilised infrastructure where possible. The number of sites to be used as satellites will require review and updating as loads to existing wastewater treatment plants vary. In particular, if the quantity of septic tank sludge imports increase, the number of satellite dewatering sites may need to be increased.

The following requirements need to be assessed when considering a WWTP as a satellite:-

- Site location;
- Site access;
- Spare capacity or space (WWTP and sludge);
- Emission limit values and current level of compliance;
- Potential nuisance (odour, noise, traffic);
- Current staffing arrangement.

9.7 Selection of Sludge Hub Centres

Sludge Hub Centres provide final treatment of sludge prior to disposal. In general, these sites also act as satellite dewatering sites. The sludge management plans prepared for each Local Authority identified suitable locations within the local authority area for development of a Sludge Hub Centre. Fifteen Sludge Hub Centres have been developed to date with an additional five temporary sludge hubs and four sludge treatment sites with no imports. As detailed above and in Section 7.3, an additional 2 – 3 sludge hubs are recommended, in addition to upgrade of existing sludge hubs where necessary, in order to cater for all wastewater sludge generated. It is not considered that additional sludge hubs will be required to cater for sludge from septic tanks. However, it is recommended that the capacity of sludge hubs takes into account potential future imports of septic tank sludge.

The location of Sludge Hub Centres will be generally in line with the recommendations of the previous sludge management plans prepared for the individual Local Authorities, with new sludge hubs proposed at Fingal North Dublin WWTP and Tralee. Sites used as temporary sludge hubs in Tuam, Longford and Navan should be upgraded to permanent sludge hubs with sites currently excluded from taking imports at Waterford City and Cork City reviewed to assess whether these sites can be considered as Sludge Hub Centres, including identification and assessment of possible alternative sites.

9.8 Selection of Treatment Options to Produce Biosolids

The treatment processes identified in the *Code of Good Practice for Use of Biosolids in Agriculture* are detailed in Section 5. These treatment processes have all been demonstrated to achieve 99.9999% (or 6 log) reduction in indicator pathogens and are therefore acceptable. New processes which are proven to achieve the same levels of reductions may also be considered by Irish Water in the future. Only processes with this capability are permissible.

Studies of biosolids treatment options have indicated that advanced anaerobic digestion provides the most economically feasible option and the lowest carbon footprint for sludge treatment. There are greenhouse gases produced by anaerobic digestion with carbon dioxide produced when the methane is used for energy recovery. However, the energy produced off-sets the impact of producing greenhouse gases. There is a further potential impact if the methane produced is allowed to leak. Anaerobic digestion installations should be inspected to ensure that all methane is captured. Advanced anaerobic digestion has been shown to be the most economic option, irrespective of the final outlet, and recent upgrades of existing wastewater treatment plants have been undertaken in numerous locations in the EU using this approach where the final outlet is either to land or incineration.

The most commonly used method of sludge treatment at present is thermal drying. As detailed in Section 9.3, there are thirteen sites where thermal drying has been put in place. The capital and operating cost of thermal drying is high relative to other sludge treatment options. However, due to the uncertainty associated with the agricultural outlet, where operational thermal drying plants are in place, it is recommended that these processes be retained for the short to medium term. Where an upgrade is proposed for a Sludge Hub Centre, the options for sludge treatment should be reassessed and consideration given to advanced digestion only. A review of all sites with thermal drying is also recommended to assess whether anaerobic digestion is feasible to either replace or supplement the existing thermal drying plant. Options for co-digestion with organic waste should also be considered in order to improve the energy recovery and economic feasibility of anaerobic digestion facilities. This will be considered at Sludge Hub Centres and off-site facilities.

The most commonly used method of sludge treatment, after thermal drying, is lime stabilisation. While this is an accepted method of sludge treatment, the audit of sludge management activities has identified a significant variation in the adequacy of the treatment being provided, particularly at off-site installations. The main issues identified were inadequate dosing of lime and inadequate monitoring of temperature and pH during treatment. Due to the difficulties in controlling off-site activities, it is proposed that off-site treatment of sludge by lime stabilisation is phased out as soon as alternatives can be developed.

Off site anaerobic digestion and composting facilities have also been assessed as part of the sludge management audit and the facilities inspected are considered to provide a high level of treatment and quality control. These may be retained on the basis of regular audit and confirmed compliance.

There are fourteen wastewater treatment plants in Ireland with anaerobic digestion currently in operation, including the Drogheda WWTP, shown on Figure 9.2. Nine of these sites use the biogas produced for electricity production and the biogas is used for sludge thermal drying in a further two sites. Over 50% of sludge was anaerobically digested in 2014. However, further treatment is needed in order to provide an acceptable biosolids product for reuse. The proportion of sludge anaerobically digested is expected to increase to approximately 65% when upgrades, currently underway, are completed. It is recommended that the number of sites with anaerobic digestion is increased to nineteen sites, with the biogas produced used for energy recovery in all cases.

It is recommended that new Sludge Hub Centres should include the provision of advanced anaerobic digestion where this is assessed as the most economically and environmentally sustainable option. Due to the size of the proposed new North Dublin WWTP, consideration should be given to the inclusion of thermal drying to reduce the sludge volume. This may be provided for in phasing of the wastewater treatment plant development based on economic assessment.



Figure 9.2 – Drogheda Wastewater Treatment Plant

9.9 Selection of Outlets

The main outlet for treated wastewater sludge is currently agriculture. As detailed in Section 8, this is considered to provide a sustainable solution provided the sludge is treated appropriately with the required quality control. Extensive research has been undertaken both in Ireland and internationally on the use of wastewater sludge in agriculture. These studies have shown that, subject to suitable quality controls, wastewater sludge is safe to use in agriculture and has considerable economic, environmental and security of outlet benefits. Use in agriculture can require strategic storage of sludge biosolids when the outlet is unavailable due to seasonal or other factors. These storage facilities require assessment for environmental impacts in the same way as other infrastructure.

However, it is considered desirable to promote alternative outlets in order to provide flexibility and to reduce the dependence on use of agricultural land for sludge reuse. Further research into alternative reuse outlets will be undertaken to assess options. This will include a financial evaluation and consideration of wider environmental impacts including biodiversity, water, soils, human health and food safety. Irish Water will incorporate alternative outlets into its Standard Operating Procedures for sludge management, as appropriate once any such outlet is developed.

The main alternative outlet currently in use in Europe is incineration. There are commercial incinerator facilities currently in place and under development in Ireland which may provide a suitable alternative for some of the wastewater sludge produced by Irish Water. A feasibility study is proposed to consider options for thermal treatment of sludge including incineration.

Other outlets such as use as a fuel in industry have been researched in Ireland previously with no reliable outlet identified to date. However, this is still considered a viable option in the future as companies strive to meet renewable energy targets. The main industrial outlet is use in the cement industry and further evaluation of this potential outlet is proposed. The use in cement

kilns has the advantage of potential full reuse of the sludge with energy recovery and no ash for disposal.

9.10 Potential Impacts and Mitigation Measures

There are potential impacts on receptors in relation to sludge management activities. These impacts require detailed assessment for any proposed projects. However, the potential impacts and mitigation measures, which are assessed in the SEA report, are as follows:-

- Biodiversity, Flora and Fauna;
- Population and Human Health;
- Food Production and Safety;
- Soils, Geology and Hydrogeology;
- Water;
- Air Quality and Climatic Factors;
- Material Assets;
- Cultural Heritage;
- Landscape.

All of these impacts, including temporary effects during implementation of new measures or projects, will need to be considered in advance of any upgrade works at any individual site. The potential impact on any Natura 2000 site will need to be considered for any project by undertaking an Appropriate Assessment. In projects where the only potential impact is on the final effluent discharges, Appropriate Assessment screening is undertaken by the EPA as part of the wastewater discharge licensing process. In each case, mitigation measures proposed must be complied with. If the appropriate assessment identifies potentially significant impact which cannot be mitigated, the project will not proceed.

Furthermore, in recognition of wider issues relevant to protection of biodiversity in Ireland, that do not fall under the remit of the Habitats Directive, e.g. ecological networks, disturbance of habitats and species etc. Irish Water undertake that in carrying out activities associated with management of wastewater sludge from Irish Water operated WWTP, Irish Water will ensure that they are in compliance with their obligations as a the public water authority under the Birds and Natural Habitats Regulations 2011-2016.

9.11 Risk Assessment of Current Sludge Outlet

The current outlet for wastewater sludge in Ireland is almost exclusively agriculture. The NWSMP has identified reuse on land as the preferred outlet currently and for the medium term. However, the current dependence on a single disposal option, i.e. reuse on agricultural land, is susceptible to policy, regulatory and/or perception changes.

Risk	Mitigation
Stakeholder perception leading to loss of agricultural outlet	<ul style="list-style-type: none"> • Stakeholder consultation – NWSMP/SEA and one-to-one engagement • Quality assurance procedures
Public perception – due to real or perceived issues	<ul style="list-style-type: none"> • Public consultation • Quality assurance procedures
High cost if incineration only option for disposal	<ul style="list-style-type: none"> • Consultation with incinerator operators to assess options and costs
Environmental liabilities – potential pollution of soil and receiving waters	<ul style="list-style-type: none"> • Quality assurance and auditing of contractors
Potential short-term need for export of sludge if agriculture not available	<ul style="list-style-type: none"> • Ongoing consultation with stakeholders to reduce likelihood of short-term loss of agricultural outlet

It is recommended that secondary options are investigated further in order to reduce current dependence on agricultural disposal. This will be achieved in the short to medium term through solids reduction as a result of advanced anaerobic digestion, where viable.

Another risk to the disposal outlet is the expected increase in dairy cattle following the end of milk quotas in 2015. The Irish agricultural sector has set a target of 50% increase in output by 2020. This will lead to a substantial increase in animal slurry and industrial sludge from the dairy industry. Land used for dairy is not considered a suitable future outlet for wastewater sludge, taking a realistic view of industry perceptions. Any additional sludge from agriculture or agricultural industries is likely to put pressure on the current outlets for wastewater sludge to agriculture.

9.12 Risk Assessment of Landspreading

The potential risks associated with landspreading include, but are not limited to the following:-

- Risk to availability of agricultural outlet;
- Risk to agricultural produce;
- Risk to Natura 2000 sites;
- Persistent organic pollutants, pathogens and metals content in sludge;
- Pharmaceuticals and personal care products content in sludge;
- Industrial discharges to WWTP's impacting sludge quality;
- Illegal discharges to WWTP's impacting sludge quality;
- Landfill leachate acceptance at WWTP's impacting sludge quality.

9.12.1 Risk to Agricultural Produce

The use of wastewater sludge in agriculture for food production and must take into account food safety with regard to microbiological and chemical risk to human health. Microbiological risk is addressed in treatment with chemical risk by careful monitoring of the product in addition to source control of industrial discharges. There is also a risk that adverse perception of Irish agricultural produce, where wastewater sludge is used, may impact the agricultural sector financially. The agri-food and drink sector is a significant part of the economy in Ireland, accounting for 7.2% of Ireland's economy-wide gross value added (GVA), 12.3% of Ireland's exports and 8.8% of total employment (DAFM 2014). Further details on the baseline for the agri-food and drink sector are included in Section 5.2.3, Food Production and Safety.

The Strategic Environmental Assessment considers these risks in further detail. The mitigation measures currently in place and the additional monitoring, reporting and quality control procedures proposed by Irish Water will further mitigate against risk to agriculture. There are particular restrictions in place in relation to use of wastewater sludge in production of fruit and vegetable crops with use of wastewater sludge not allowed for 10 months prior to harvesting or during the growing period. Grassland may not have wastewater sludge applied for three weeks prior to grazing or harvesting. There are particular concerns in the agricultural industry in relation to the use of wastewater sludge in dairy production. Irish Water acknowledges this concern and proposes to voluntarily restrict use of wastewater sludge on lands to be used for dairy for future contracts. Other crops such as crops for animal feed are considered more suitable, low risk and less likely to cause public concern.

9.12.2 Risk to Natura 2000 sites

Special Areas of Conservation (SAC) are designated under the EU Habitats Directive (92/43/EEC) and Special Protection Areas are designated under the Birds Directive (2009/147/EC). There are 423 cSAC sites, 1 proposed cSAC and 165 SPA sites in Ireland. Further details on these sites can be found in the Natura Impact Statement for the NWSMP. The risks to Natura 2000 sites have been assessed in detail in the SEA and Appropriate Assessment for the NWSMP. The environmental reports on these assessments include mitigation measures

and details of further assessments required in relation to site specific issues. It is noted in the Natura Impact Statement that the NWSMP is a national plan and as such the assessment is focussed at a national strategic level. As such, it will be necessary to assess risks to particular Natura 2000 sites on a case by case basis in relation to particular sludge management activities.

9.12.3 Persistent organic pollutants, pathogens and metals content in sludge

The pathogen content and metal levels in treated sludge are monitored regularly in accordance with the Code of Good Practice for Use of Biosolids in Agriculture. As Irish Water requires full treatment of all sludge, the levels of pathogens in treated sludge have been measured at consistently low values. Due to low levels of industrial discharges in Ireland, the metals levels in wastewater sludge are consistently low. There have been significant decreases in metal levels in sludge in Europe since measurements commenced in the 1980's. This is largely due to source control on industrial discharges and reductions in heavy industry. Irish Water has commenced a programme of more extensive licencing of trade discharges with tighter emission controls. As detailed in Section 10.3, Irish Water considers source control to be preferable to end-of-pipe treatment to minimise the risk of specific pollutants (e.g., metals, persistent organic pollutants, pharmaceutical products, etc.) in the biosolids and is actively pursuing targeted source control as part of our strategy for protecting the water environment.

Monitoring of persistent organic pollutants is undertaken based on the requirements of the *Code of Good Practice for Use of Biosolids in Agriculture*. There has been extensive international monitoring and research in this area in recent years. To date, there are no limits or recommendations for levels of organic pollutants specifically relating to wastewater sludge used in agriculture. It is proposed that research and recommendations in this area are reviewed regularly, with additional analysis undertaken if necessary, to mitigate against any risk to soils or health due to the presence of organic pollutants. The proposed update of the *Code of Good Practice for Use of Biosolids in Agriculture* will review current monitoring and limits for organic pollutants and make recommendations for any further monitoring or limits required to mitigate against the potential risks. There are limits set in Regulation (EC) No. 850/2004 on persistent organic pollutants as listed in Annex IV of the regulations. An EU funded study¹³ on the levels of selected compounds in sludge has found that the levels of POP's are generally significantly below the limits set in relation to Regulation 850/2004.

9.12.4 Pharmaceuticals and personal care products content in sludge

Monitoring of pharmaceuticals and personal care products content in sludge is not normally undertaken in Ireland. There has been extensive international monitoring and research in this area in recent years.

¹³ Occurrence and Levels of Selected Compounds in European Sewage Sludge Samples JRC 2012

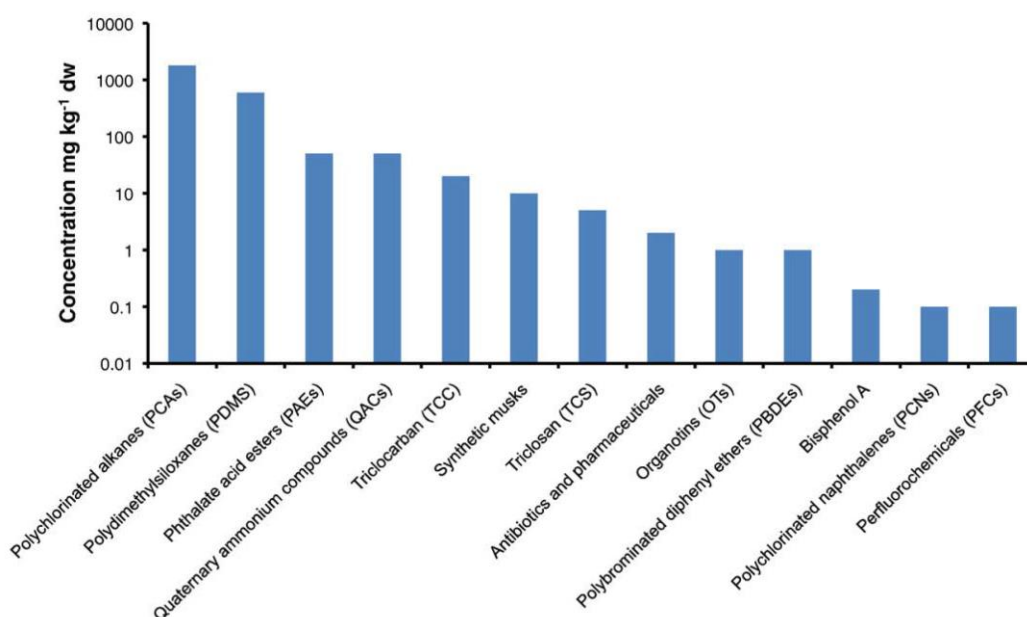


Figure 9.3 –Typical Concentrations of Selected ‘emerging’ contaminants in wastewater sludge (mg/kg dm)¹⁴

To date, there are no limits or recommendations for levels of emerging contaminants for sludge used in agriculture. It is proposed that research and recommendations in this area are reviewed regularly to mitigate against any risk to soils or health due to the presence of contaminants.

Clarke and Smith¹¹ in their review of international research in relation to organic contaminants, note that most risk assessments demonstrate that use of biosolids does not place human health at risk from the organic contaminants studied. They recommend that this is reviewed on an ongoing basis to ensure the long-term sustainability and security of the beneficial agricultural route for biosolids management.

9.12.5 Industrial discharges to WWTP’s impacting sludge quality

Industrial discharges from a wastewater catchment are generally to the sewer network but may also be discharged via tanker. All industries require either a Trade Effluent Licence (Section 16) or an IPPC Licence to discharge to the sewer network. Irish Water is currently reviewing all Section 16 and IPPC Licences. As part of this review, limits will be set on all relevant parameters taking into account the potential impact on wastewater sludge. Ongoing monitoring and controls are required, at both the WWTP and the industrial discharge point, to mitigate against any risk to the wastewater sludge produced. Work is ongoing to ensure that appropriate control and monitoring regimes are in place for discharges to the sewer network.

9.12.6 Leachate acceptance at WWTP’s impacting sludge quality

Landfill leachate is frequently discharged to wastewater treatment plants for treatment. This is either directly to the WWTP via tanker or to the sewer network. It is a requirement of the Wastewater Discharge Licence for any WWTP accepting leachate, that the toxicity of the leachate is assessed and the quantity is controlled. In order to ensure that the WWTP and sludge are not impacted, the leachate must be analysed to assess nutrient and metal content. Ongoing monitoring and controls are required to mitigate against any risk to the wastewater

¹⁴ Reference: 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

sludge produced and work is ongoing to ensure that appropriate control and monitoring regimes are in place for all leachate discharges.

9.12.7 Illegal or non-compliant discharges to WWTP's impacting sludge quality

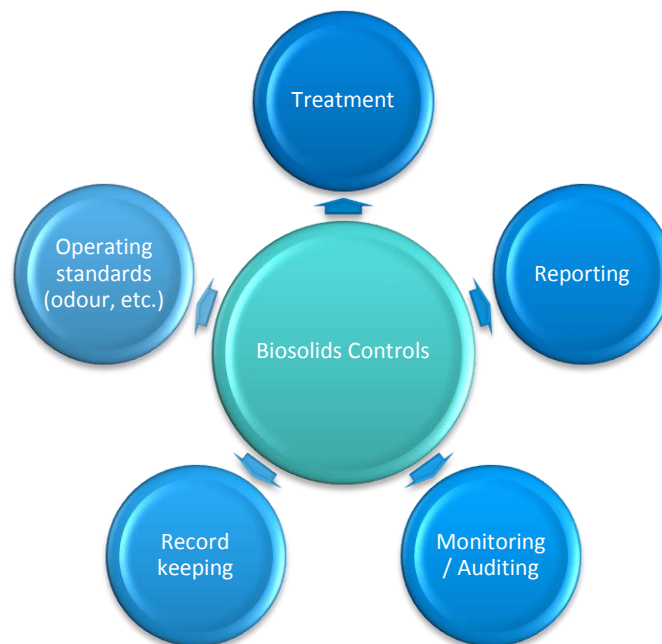
There is the potential for illegal or non-compliant discharges to a WWTP from a number of sources. Non-compliant discharges are non-domestic discharges, i.e. industrial, commercial or leachate, which are not in compliance with the limits set. Illegal discharges are where discharges are made to the sewer network with no licence in place. There are a number of measures in place to mitigate against the potential impacts of these types of discharges. This includes monitoring at source of significant industrial discharges, monitoring of the influent to and effluent from the wastewater treatment plant, process monitoring and visual inspections. Irish Water is committed to establishing a properly resourced unit tasked with controlling discharges to the networks.

10 Quality Assurance, Monitoring and Reporting

10.1 Introduction

There are a number of statutory requirements for monitoring and reporting of sludge management activities. However, in order to ensure that the risks and perception issues are addressed, it is recommended that an independently audited quality assurance system is put in place for sludge management activities. An annual audit of sludge management activities will be undertaken on behalf of Irish Water pending a fully developed quality control scheme. Separate Standard Operating Procedures (SOP's) and control procedures are being developed by Irish Water to ensure that the whole process from source control of pollutants, through sludge treatment and reuse is controlled and monitored. Full monitoring and reporting is required for each step of the process to ensure a quality assured biosolids product.

On-site management of sludge activities has the potential to impact the final effluent discharges from the wastewater treatment plant. This may be due to operational issues or inadequacies in infrastructure. It is proposed that Irish Water Standard Operating Procedures will address the requirements for sludge management at individual WWTP's. The requirements for upgrading existing infrastructure, to ensure that there is no impact on final effluent quality, are considered in Section 6 and 7. New infrastructure will be developed in line with Standard Specifications currently being developed by Irish Water.



10.2 Background Data Collection

There has been a requirement for Local Authorities to keep a register of all sludge since 1996 (Waste Management Act) with additional specific requirements in S.I. No. 148/1998 - Waste Management (Use of Sewage Sludge in Agriculture) Regulations, 1998. Data collected in sludge registers, in addition to site data with regard to existing infrastructure and quantities of sludge removed has been used to inform the assessment of sludge infrastructure requirements. Ongoing data collection is proposed to confirm capacity requirements as solutions are developed.

10.3 Source Control

Irish Water advocates the application of source control principles to commercial and industrial discharges to sewer. Building on work previously initiated by each local authority Irish Water are establishing a wastewater source control capability which is developing an ongoing process for the appraisal of existing discharges and discharge licence conditions. Using this source control approach, standardised conditions will be applied to discharge to sewer licences based on the nature of the discharger's activity, the capacity of the receiving network and the capability of the wastewater treatment plant to remove pollutants.

In the case of industries licenced to discharge by the EPA, arrangements are in place between Irish Water and the EPA for exchange of information and the setting of licence conditions and the removal substances which could compromise the WWTP process or the further reuse of sludge. This engagement with the EPA also allows for a time-based review of existing licences or where new or revised limits are deemed necessary.

Irish Water recognises that end-of-pipe treatment is often not the optimal way to remove specific pollutants (e.g., metals, persistent organic pollutants, pharmaceutical products, etc.); in such cases, treatment at source is the most economic to all involved. Ensuring specific pollutants are managed at source also minimises the impacts of industrial pollutants on the quality of wastewater sludge.

10.4 Audit of Current Wastewater Sludge Management

An independent audit of wastewater sludge management was undertaken in 2015 in order to assess the current levels of compliance, identify any issues and make recommendations for improvements. The audit included an assessment of sludge treatment facilities, both on Irish Water WWTP's and off-site treatment facilities, an audit of off-site sludge storage facilities and an audit of sludge reuse activities.

The audit of sludge treatment facilities has indicated that the anaerobic digestion & pasteurisation and composting facilities, operated on or off site, are generally well controlled and operated. These operations offer good value for money and it is anticipated that they will be used on an ongoing basis. However, the audit identified a number of concerns over the operation of lime stabilisation facilities.

The issues identified in the lime stabilisation facilities were as follows:-

- Inadequate quantity of lime dosed;
- Frequency of pH and temperature monitoring;
- Recording systems for pH and temperature monitoring;
- Frequency of pathogen monitoring.

Due to the number of these facilities and the difficulty in monitoring the quality of the operations, it is proposed that future lime stabilisation is restricted to Irish Water owned sites. It is also proposed that more detailed minimum requirements are set for the use of lime stabilisation in the future with the use of off-site lime eliminated as soon as possible.

The CEN Standard *CEN/TR 15809 Characterization of sludges – Hygienic aspects – Treatments* recommends a minimum lime dose of 0.3kg CaO per kg dry sludge to ensure full treatment. The monitoring and recording systems for pH, temperature and pathogens were inadequate at a number of sites. Where inadequate monitoring of the sludge treatment process has been identified, the relevant contractor must detail how this situation will be rectified.

The audit of sludge storage facilities identified some issues with facilities lacking the relevant permissions, structural integrity certificates and/or safety signage in place. Where issues have been identified, the relevant contractor must detail how this situation will be rectified. All

wastewater sludge storage facilities must be registered in accordance with S.I. No. 32/2010 - Waste Management (Registration of Sewage Sludge Facility) Regulations 2010. Sludge storage at a wastewater treatment plant or a waste licenced facility is excluded from this requirement for registration. Irish Water is now proposing that such off-site storage is addressed in conjunction with the upgrading of plants and sludge treatment, with strategic storage sites to be developed to the required standard.

The audit of reuse of sludge included a review of nutrient management plans produced and an on-site assessment of the implementation of the nutrient management plan. There were some issues identified in the control of landspreading with uncertainty in relation to the quantity of sludge spread. In general, nutrient management plans were not updated following any changes to quantities spread or crop types. Currently there are limited checks by Local Authorities that the plans are followed.

It is proposed to develop an independently assessed quality assurance scheme in relation to sludge management. Until this scheme is in place, an annual audit of sludge management activities will be undertaken on behalf of Irish Water. In addition future contracts relating to sludge management will include Key Performance Indicators which contractors will be assessed against on an ongoing basis.

10.5 Asset Register

Data on sludge treatment infrastructure was provided in 2013 by Local Authorities for approximately 700 existing wastewater treatment plants. Data was also collected on sludge volume and % dry solids. A project to audit all Irish Water infrastructure at water and wastewater treatment facilities has commenced. This project includes sites surveys of all wastewater assets, including sludge treatment, with full details of all assets detailed in an asset register. The project will take a period of 2-3 years and will be used to inform infrastructure needs. The data which will be gathered in relation to sludge management will include the following:-

- Identify any access issues to site;
- Identify any space available on site for upgrade / expansion;
- Identify space in sludge dewatering buildings for upgrade/expansion;
- Type, number and volume of liquid sludge storage tanks;
- Type of sludge thickening;
- Type and capacity of sludge dewatering;
- Number and size of existing sludge skips;
- Detail any other on-site sludge storage;
- Type and capacity of liquid sludge acceptance facilities;
- Type and capacity of sludge cake acceptance facilities;
- Details of any other sludge treatment processes (e.g. anaerobic digestion, thermal drying etc.);
- Details of ancillary sludge transfer equipment, instrumentation etc.

10.6 Reporting Sludge Data

There is a requirement under S.I. No. 148/1998 - Waste Management (Use of Sewage Sludge in Agriculture) Regulations, 1998 as amended by S.I. 267 of 2001 for the Local Authority to establish and maintain a register, known as the 'sludge register' to record information relating to use of wastewater sludge in agriculture including the following:-

- (a) the quantities of sludge produced and the quantities supplied for use in agriculture in their functional area,
- (b) the composition and properties of the sludge having regard to the parameters referred to in Part II of the Schedule;

- (c) the treatment which the sludge has undergone having regard to the types of treatment referred to in article 2;
- (d) the name and address of each recipient of the sludge and the location of each site where the sludge is to be used.

Irish Water is required to report annual sludge data to the EPA. This report includes quantities of sludge produced, types of treatment and final disposal locations.

A template for reporting of data for sludge contracts has been developed to collate a more accurate database of sludge produced at the existing wastewater treatment plants. Contractors providing sludge management services for Irish Water, under framework contracts, have been completing these spreadsheets since mid-2014. New reporting templates for Design Build Operate contracts have been developed and are being introduced on a phased basis nationally. These new reporting templates will improve the accuracy of data collected in relation to sludge.

10.7 Monitoring and Reporting of Sludge Data

Monitoring and reporting of sludge data is undertaken at wastewater treatment plants, sludge treatment and storage facilities and at the final reuse location. The final reuse including statutory monitoring of all sludge and soil, is current undertaken by contractors acting on behalf of Irish Water. These contractors provide sludge data directly to Local Authorities for inclusion in the Sludge Register. In addition, all contractors report directly to Irish Water. Data reported to Irish Water includes all sludge treatment, transport and final reuse locations including all statutory analysis data and additional data where required in particular contracts.

Irish Water is currently developing systems to allow online reporting of all sludge data by contractors. This will include all data required for the local authority sludge registers. In parallel, a national database of data reported in Annual Environmental Reports for all licenced wastewater treatment plants has also been developed. The development of online reporting systems including geographical data in relation to sludge disposal sites and central recording of all sludge and soil analysis is considered an essential element of the quality assurance procedures for wastewater sludge management. The online reporting system will be used to check landspreading areas for environmental sensitivity. The data from Annual Environmental Reports prepared by each of the Local Authorities will be used to cross-check reporting submissions by contractors.

10.8 Monitoring of Impacts of Sludge Disposal

In accordance with S.I. 267 of 2001, all reuse of sludge in agriculture must be carried out in accordance with a Nutrient Management Plan. Particular limits on nutrient addition to land are set by S.I. No. 31/2014 - European Union (Good Agricultural Practice for Protection of Waters) Regulations, 2014. The purpose of these Regulations was to give further effect to several EU Directives, including Directives in relation to protection of waters against pollution from agricultural sources ('the Nitrates Directive'), dangerous substances in water, waste management, protection of groundwater, public participation in policy development and water policy (the Water Framework Directive). This legislation, in combination with specific requirements of the *Code of Good Practice for Use of Biosolids in Agriculture* provides for protection of surface waters, groundwaters and drinking water abstractions.

Irish Water intends to liaise with the Department of Housing, Planning, Community and Local Government (formerly the Department of the Environment, Community and Local Government) in relation to a review of the *Code of Good Practice for the Use of Biosolids in Agriculture* to take into account current legislation and any recommendations for wastewater sludge quality parameters and any additional sampling of persistent organics or emerging pollutants. It is proposed that any updated COGP would be incorporated into Standard Operating Procedures

for Irish Water and would include recommendations for assessment of environmental sensitivity of lands to be used for landspreading. The Standard Operating Procedures will also include a template for Nutrient Management Plans and a requirement to consider environmental impacts, WFD objectives and the potential to impact on the European Sites in both in the Nutrient Management Plan and the Standard Operating Procedures.

Irish Water will liaise with the EPA Catchment Science and Management Unit and Teagasc to ensure that WFD objectives are met in developing the template for Nutrient Management Plans. The Programme(s) of Measures in the second round of River Basin Management Plans will be reviewed upon their adoption and integrated into Irish Water's Standard Operating Procedures where appropriate. Each 5-year update of the NWSMP will take into account the WFD Objectives and Programmes of Measures in place. Contractors appointed to carry out sludge management on behalf of Irish Water will be required to comply with Irish Water's Standard Operating Procedures.

Ongoing research in relation to the composition of treated wastewater sludge has identified the presence of persistent organic pollutants, pharmaceuticals and personal care products which needs to be considered. Standards for monitoring of wastewater sludge in the EU and international research will be reviewed regularly as a basis for identifying additional monitoring of sludge or soil samples required.

10.9 Quality Assurance

It is proposed that future sludge treatment and reuse contracts for Irish Water will be required to comply with a quality assurance procedures currently being developed by Irish Water. Compliance with the Code of Good Practice for Use of Biosolids in Agriculture is currently a requirement of Irish Water contractors. In order to ensure that all sludge treatment and reuse complies with this, annual auditing of contractors activities is proposed. The timing of the audit will be planned to allow auditing of landspreading activities during spreading periods.

In order to ensure that there is consistency and traceability in reporting of sludge reuse, it is proposed that GIS systems will be used to record the destination of all sludge. This will also facilitate reviewing the suitability of lands considered sensitive for the purposes of land spreading. Teagasc has recently developed an online nutrient management planning system which must be used by farmers participating in the Glas scheme. There is a potential synergy with Teagasc in nutrient management planning for wastewater sludge and reporting of the location and quantity of sludge on a field basis. Irish Water intends to engage further with Teagasc to assess the potential of availing of this synergy.

11 Review Research and Opportunities

11.1 Introduction

Ongoing research is being carried out internationally into options for reuse of wastewater sludge. Emerging and innovative technologies may provide new cost-efficient and effective solutions to wastewater sludge management. Research in relation to new technologies for wastewater sludge is typically concentrated on larger scale installations and may not be transferrable to smaller scale installations, which are representative of Ireland. However, research into technologies that provide sustainable outlets with low-energy consumption, energy recovery and recovery of nutrients may nevertheless provide future options for wastewater sludge management in Ireland.

11.2 Irish Water Research and Innovation Policy

Irish Water has developed a Research and Innovation Policy. This Research and Innovation Policy sets out the following objectives:-

- Supporting a key business objective of customer service;
- Complying with EU WFD standards and efficiencies in both capital investment and operating costs;
- Addressing current and emerging issues across Irish Water networks;
- Delivering benefits in efficiency, customer service and water or environmental quality in Irish Water's business plan;
- Identifying ways to work with CER to ensure that innovative solutions can be deployed in a timely manner;
- Identifying innovation needs based on both bottom-up issues and top-down strategic drivers.

The Research and Innovation Policy will be delivered through collaboration with: (1) academic institutions (DCU, UCD, NUIG, CIT, DIT, UL, NUJA, etc.), (2) research bodies (Environment Protection Agency (EPA), Enterprise Ireland (EI), Science Foundation Ireland (SFI), The Greenway), (3) other organisations (WRc plc, UKWIR, Aqua Publica Europea), (4) participating in EU Networks/Action Groups, EU Horizon 2020 and INTERREG funding programmes to pursue research and innovation opportunities and (5) engage with other water utilities (including Scottish and Northern Ireland (NI) Water) to develop research and innovative technologies, processes or systems for local application.

The Research and Innovation Policy will provide a focus for reviewing, trialling and testing innovation within Irish Water assets in the following areas: (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 and (6) climate change adaptation or infrastructure resilience.

11.3 Relevance of Innovation and Research Policy to Wastewater Sludge

There is significant potential for wastewater sludge to provide energy reduction and recovery and reduce the overall carbon footprint of Irish Water. The potential for nutrient recovery from wastewater sludge is currently limited. However, research in this area may make this more viable in the future.

11.4 Research in Wastewater Sludge Management

Due to the high cost of wastewater sludge management, there is ongoing research internationally in relation to wastewater sludge. Due to the energy and phosphorus content, sludge is viewed as a resource rather than as a waste product. The main areas of research in relation to wastewater sludge relate to the following:-

- Sludge reduction in wastewater treatment processes;
- Sludge volume reduction;
- Sludge quantity reduction;
- Energy recovery;
- Nutrient recovery;
- Precious metal and heavy metal recovery.

In many cases, new technologies are only suitable for very large wastewater treatment plants and have limited potential use in Ireland. However, via the Innovation Section of Irish Water, technologies which have been developed to commercial scale will be considered for use on Irish Water sites.

12 Financial Evaluation

12.1 General

The overall cost of sludge treatment is estimated by reference to:-

- Sludge transport;
- Sludge treatment (thickening and dewatering);
- Sludge treatment (stabilisation);
- Sludge reuse.

The estimated cost for sludge transport ranges from €8.00 to €25.00 per tonne, depending on the required travel distance and type of sludge. Based on transportation utilising satellite dewatering sites and full compliance, the annual sludge transport cost is estimated as €10 to €15 million per annum.

Sludge dewatering has a relatively high operational cost due to the labour, power, chemical and capital maintenance requirements. This is disproportionately high at smaller sites, due to high fixed costs, with the cost range estimated as <€2 to €25 per PE. The total national annual operating cost is estimated as €10 to €15 million.

The cost for sludge treatment and reuse varies depending mainly on sludge quantity and type of treatment. The cost for sludge treatment and reuse is approximately €400 per tonne dry solids produced in the wastewater treatment process, i.e. upstream of anaerobic digestion. The total estimated annual cost is €28 million per annum based on the 2014 sludge production. This is expected to increase to €35 to €38 million with full compliance with all wastewater discharge licences. There may be a further increase in cost if a higher level of treatment, such as thermal treatment, is required in order to effectively manage the wastewater sludge produced.

12.2 Cost of Proposed Improvements

12.2.1 Capital Costs

There are currently a limited number of liquid sludge reception facilities to enable the development of satellite dewatering sites. In order to reduce sludge transport costs, it is recommended that additional sites are developed as Satellite Dewatering Sites. The cost for a full liquid sludge acceptance facility ranges from approximately €400,000 to €1,500,000 depending on the volume of sludge proposed to be imported and any requirement for improvement to access roads, turning areas and upgrades to existing dewatering equipment.

The cost saving for transport of sludge to a satellite dewatering site versus transport directly to the proposed hub has been estimated. The cost savings range from less than €10,000 to over €100,000. Where the proposed volume of imports of sludge is less than 7,000 to 8,000 m³/annum, it is considered more cost effective to discharge sludge to a balancing tank, which will enable controlled discharge to the inlet works. The design of the balancing tank should allow for a future sludge screen and diversion of discharge directly to the sludge process, where feasible. The cost for provision of a balancing tank discharging to the inlet works is estimated to be €50,000 to €80,000.

The development of twenty new satellite dewatering sites is recommended with an additional 2 to 3 to be developed as part of recommended new Sludge Hub Centres. The cost for this is estimated to be **€12,000,000**. A further 40 sites should be provided with balancing tanks to allow controlled discharge of sludge. The cost for this is estimated to be **€2,400,000**. A detailed site assessment will be required in each case to assess suitability and a detailed cost estimate. The provision of balancing tanks for sludge acceptance will also allow for the acceptance of sludge from septic tanks.

The capital cost for the proposed Sludge Hub Centre infrastructure is estimated as **€85 million**. There are potential cost savings of **€2.5m per annum** in electricity generation with a further potential cost saving of **€2.0m per annum** for reuse. The cost for the Sludge Hub Centre proposed for the new North Dublin WWTP is not included as this is considered in the overall cost for that project.

12.2.2 Operation and Maintenance Costs

There are operation and maintenance costs associated with operation of the sludge acceptance facilities and supervision of deliveries. Over 100 wastewater treatment plants reported acceptance of imports of sludge in 2014. The diversion of this to certain specified WWTP's will reduce the overall level of supervision required. It is not certain what impact the current uncontrolled acceptance of sludge has on either operational costs or compliance. If sludge is accepted to a purpose built balancing tank, this will reduce the risks to wastewater treatment plant compliance and reduce the potential impact on the WWTP equipment.

There are potential cost savings of up to €1.5 million per annum if the proposed infrastructure is provided compared to the cost of transfer directly to the proposed Sludge Hub Centre. There is a potential to provide economic collection and treatment of DWWTS sludge where these are managed under a scheduled collection system, with potential synergies with the collection of sludge from smaller WWTP's under the control of Irish Water. However, the DWWTS sludge is not the responsibility of Irish Water and changes to current legislation and enforcement are likely to be required to support any change in the current practice of irregular desludging of DWWTS's.

13 Conclusions and Recommendations

Wastewater sludge is currently being produced at over 1,000 wastewater treatment plants under the control of Irish Water. The total quantity of wastewater sludge generated in 2015, as reported to the EPA, was 58,387 tonnes dry solids (tds). Over 98% of this was reused in agriculture. The sludge produced includes primary, biological, chemical and septic tank sludge which undergoes further treatment prior to reuse in agriculture.

The quantity of wastewater sludge produced is expected to increase over the next 25 years as new and upgraded wastewater treatment plants are completed. The predicted sludge quantity in 2040 is 96,442 tds/annum. Additional wastewater sludge is produced in individual Domestic Wastewater Treatment Systems (DWWTS's), mainly septic tanks, some of which is currently accepted at Irish Water wastewater treatment plants. It is expected that the amount of DWWTS sludge accepted by Irish Water will increase over the duration of the NWSMP.

The design and operation of the sludge infrastructure can have a significant impact on the operation of the wastewater treatment plant main treatment process. Inadequate sludge management, in terms of either plant design or operation, including frequency of desludging, can potentially lead to breaches of emission limit values, odours and high operating cost. A desludging schedule is proposed for all WWTP sites taking into account the treatment process, sludge production and site location as part of new standard operating procedures (SOP).

The lifecycle cost for transport versus further on-site thickening, dewatering and/or treatment prior to final reuse has been reviewed to establish economically viable transport distances. This initial assessment of the recommended maximum transport distances varies with size of plant, distance to satellite centre and type of treatment process.

There is the potential to reduce the volume of sludge for transport by 20 to 25% by optimising sludge thickening at smaller wastewater treatment plants. There are a large number of sites with existing sludge storage tanks, where sludge thickening could be optimised by automating the decant process.

There are currently over one hundred WWTP sites reporting acceptance of imports of liquid sludge. However, only sixteen of these sites, including fourteen of the existing Sludge Hub Centres, are equipped to operate as effective satellite dewatering sites. The development of twenty new satellite dewatering sites is proposed to optimise sludge transport costs. A further forty sites should be provided with balancing tanks to enable controlled discharge of sludge imports to the treatment works.

An audit of sludge management activities has identified issues with the quality of lime stabilisation activities. The main issues identified were inadequate dosing of lime and inadequate monitoring of temperature and pH during treatment. It is proposed that off-site treatment of sludge by lime stabilisation will be phased out in the short-term and a minimum lime dose is specified in the meantime.

Studies of biosolids treatment options have indicated that advanced anaerobic digestion provides the most economically feasible option and the lowest carbon footprint for sludge treatment. It is proposed that the number of sites with anaerobic digestion will increase, with the biogas thus produced being used for energy recovery in all cases. Options for co-digestion with organic waste should also be considered in order to maximise energy recovery.

There are twenty sites currently operated as Sludge Hub Centres to provide final treatment of sludge prior to reuse. Fifteen Sludge Hub Centres were developed in line with county sludge management plan recommendations, with an additional five temporary sludge hubs and four sludge treatment sites with no imports. An additional 2 – 3 sludge hubs are proposed, in addition

to upgrade of existing sludge hubs, including temporary sludge hubs, where necessary, in order to cater for all wastewater sludge generated.

Thirteen of the existing Sludge Hub Centres include thermal drying treatment. A review of all sites with thermal drying is planned to assess whether anaerobic digestion is feasible on a cost basis to either replace or supplement the existing thermal drying plant. Due to the uncertainty associated with the agricultural outlet, operational thermal drying plants will be retained for the short to medium term where practical, even though they are likely to be incurring higher operating costs. This is to retain flexibility regarding reuse and disposal options, notwithstanding the high operating costs and energy usage. New Sludge Hub Centres will include the provision of advanced anaerobic digestion where this has been assessed as the most economically and environmentally sustainable option.

The current end-use outlet for wastewater sludge in Ireland is almost exclusively agriculture. The NWSMP identifies reuse on land as the preferred outlet in the short to medium term. Research and EU policy supports this option in the light of economic and environmental benefits. Nevertheless, Irish Water accepts that a policy based on a single reuse or disposal option is very susceptible to policy, regulatory and/or perception changes. Alternative options will be investigated on an ongoing basis in order to reduce our current dependence on agricultural reuse, in view of the risk of constraints on this outlet and to provide co-operation with the agricultural sector in the implementation of their quality assurance schemes. Irish Water will carry out a feasibility study into identification of viable alternatives, including detailed consideration of thermal treatments, during the 5-year cycle before the next review of the Plan.

There are risks associated with the landspreading of wastewater sludge, with particular concerns in recent years in relation to the risks associated with the presence of pharmaceuticals, personal care products and persistent organic pollutants. There has been extensive international monitoring and research in this area. To date, there are no limits or recommendations for limit levels of organic pollutants specifically relating to sludge used in agriculture. Standards for monitoring of wastewater sludge in the EU and international research will be reviewed on an ongoing basis to determine if additional monitoring of sludge or soil samples is required to mitigate against any potential impacts.

There are a number of statutory requirements in relation to monitoring and reporting of sludge management activities. However, in order to ensure that the risks and perception issues are addressed, it is proposed that an independently audited quality assurance scheme is put in place for sludge management activities. Pending this scheme, an annual audit of sludge management activities will be undertaken on behalf of Irish Water. Separate control procedures are being developed to ensure that the 'end to end' processes from source control of pollutants, through wastewater and sludge treatment to final reuse are effectively controlled and monitored.

Irish Water proposes to undertake a review and update of the National Wastewater Sludge Management Plan every 5 years. This review will assess the implementation of the proposed measures herein and make recommendations for new or updated measures.

Appendices

Appendix 1

Glossary and Abbreviations

Term	Description
AA	Appropriate Assessment
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. (See also MAD and TAD)
Ash	The inert residues from sludge processing
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 use in agriculture
Composting	The mixing of Nitrogen rich (sludge) and Carbon rich (wood chippings, straw, etc.) to ensure that predetermined quality targets are met.
DAFM	Department of Agriculture Food and the Marine
Dewatering	Means the conversion of liquid sludge to sludge cake. Cake is normally defined as being thick enough to be lifted using a shovel. Dry solids content typically ranges from 15% to 25% dry solids
DBO	Design Build Operate. This is a type of contract where a private contractor is appointed to design and construct a wastewater treatment plant and then operate the plant for fixed period of time up to twenty years.
DHPCLG	Department of Housing, Planning, Community and Local Government (formerly the Department of the Environment, Community and Local Government)
DS	Dry Solids Content. The weight of dry solids per unit weight of sludge expressed as a %.
DWWTS	Domestic Wastewater Treatment System
EC / EU	European Community / European Union
EPA	Environmental Protection Agency
EWC	European Waste Catalogue
Final effluent	Liquid discharge from a wastewater treatment plant to a receiving water, e.g. 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.
ha	Hectare
HACCP	Hazard Analysis Critical Control Point – HACCP methodology which is widely used in food safety management involves the identification and close monitoring of Critical Control Points throughout the treatment process to ensure the required quality standard is met.
Heavy metal	A term used to describe metals with a high atomic mass, some of which can be harmful to ecological and human health.
IW	Irish Water
LA	Local Authority
Lime stabilisation	Also known as alkaline stabilisation
MAD	Mesophilic anaerobic digestion; MAD is digestion undertaken at the temperature range 35°C ±3°C. This is the most commonly used type digestion in Ireland for wastewater sludge.
NWSMP	National Wastewater Sludge Management Plan
p.e.	Population Equivalent; 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
PTE	Potentially Toxic Element
Pyrolysis	The thermal degradation of waste in the absence of air. Sludge is heated to a high temperature in an oxygen-free atmosphere to produce fuel and a char product. May be used as a pre-treatment step to gasification.
SEA	Strategic Environmental Assessment
Sewage sludge	Also known as wastewater sludge. The term 'sewage sludge' is normally used in legislation.
S.I.	Statutory Instrument
Sludge Cake	Sludge which has been dewatered to the extent that it can be handled as a solid; dry solids content typically ranges from 15% to 25% dry solids
Sludge management	Sludge management refers to all activities from production of wastewater sludge at a treatment plant and sludge treatment through to storage, reuse and disposal of same
Satellite Dewatering Sites	Satellite Dewatering Sites act as 'intermediate centres' at which liquid sludge is dewatered, i.e. water is eliminated from sludge using mechanical dewatering to reduce sludge volume to reduce the number of traffic movements and cost of sludge transportation. Satellite Dewatering Sites are typically located at medium to large wastewater treatment plants.
Sludge Hub Centre (SHC)	A SHC is a centralised regional sludge treatment facility which provides for treatment of wastewater sludge to produce biosolids. Sludge Hub Centres accept imported sludge from the surrounding region for treatment. Sludge Hub Centres are typically located at large wastewater treatment plants and may include Sludge Storage Facilities.
Sludge treatment centre (STC)	A STC is a sludge treatment facility, located at a WWTP, which provides for treatment of wastewater sludge to produce biosolids with no importation of sludge from other WWTP's. A STC may include Sludge Storage Facilities.
Sludge Storage Facility	A Sludge Storage Facility is used for storage of treated sludge being used for landspreading 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..
TAD	Thermophilic anaerobic digestion; TAD is digestion undertaken at the temperature range 50 - 55°C.
Wastewater	Domestic and industrial effluents collected by the sewerage system. Also known as sewage.
Wastewater sludge	Organic by-product of the biological treatment of wastewater comprising a mixture of organic solids and water. Also known as sewage sludge
WSSP	Water Services Strategic Plan
WWTP	Wastewater treatment plant

