



5

**Solutions –
Our
Approach**

5.1 Introduction

Irish Water faces significant challenges in terms of the Quantity, Quality, Reliability and Sustainability of the public supplies across the country.

Irish Water must ensure that our water supplies become more sustainable over time, therefore we need to ensure that solutions to our supply issues consider the broader environment within which we operate. This means:

- Continuous abstraction from source alone is not a sustainable approach to meet ever increasing demand in the long term. Therefore, where feasible we must cater for increased growth requirements in the first instance by driving an aggressive leakage reduction programme combined with strong promotion of water conservation measures in homes and businesses; and
- Irish Water fully adhere to the World Health Organisation (WHO) principle that the starting point for good clean drinking water is source protection, rather than relying on ever more complex and costly treatment for sources that are deteriorating due to inadequate protection. Irish Water will achieve this by developing and implementing Water Safety Plans across all of our supplies.

Sustainability must therefore be at the core of our approach to developing appropriate solutions to meet future water demand. Solutions should therefore fit into one of Irish Water's three pillars; Lose Less, Use Less and Supply Smarter as set out in the Framework Plan and summarised in Figure 5.1.



Lose Less – reducing water lost through leakage and improving the efficiency of our distribution networks;

Use Less – reducing water use through efficiency measures; and

Supply Smarter – improving the quality, resilience and security of our supply through infrastructure improvements, operational improvements and development of new sustainable sources of water.

Figure 5.1 Three Pillars to Address the Key Challenges

Together these pillars will enable us to optimise our capital and operational solutions to achieve the best outcomes and react to emerging issues.

5.2 Lose Less: Leakage Reduction

Leakage is the loss of water from the distribution network. Leakage can occur from fractures and bursts, smaller holes and pinholes in pipe walls, leakage at joints, valves, service connections and other fittings and as a result of overflows at storage reservoirs.

Only a tiny proportion of leaks within our distribution networks come to the surface as visible leaks. Most water leakage is absorbed into the ground or escapes into sewers and drains, so cannot be seen at ground level.

The **Lose Less** pillar includes the actions which will improve our understanding of leakage, ways to reduce it and the tools required to help us to find and fix leaks. Activity to reduce leakage from the public distribution network was historically undertaken by Local Authorities and is now managed by Irish Water. Our supply network is built from a variety of pipe materials of different ages and differing quality control during construction. Good network and water-use information, expert knowledge, specialist equipment and rigorous management is therefore required to reduce and control leakage. As our water mains network ages, leakage will increase if we do not continue to invest in fixing leaks leading to a Natural Rate of Leakage Rise (NRR).

In order to address leakage Irish Water are committed to a National Leakage Reduction Programme which includes measures such as pressure management, active leakage control (ALC) and targeted water mains replacement. The National Leakage Reduction Programme incorporated advice from industry specialists and authors of the European Commission produced reference document 'Good Practices on Leakage Management WFD CIS WG PoM'¹.

Our National Leakage Reduction Programme will be a major intervention to support growth over the timeframe of the NWRP. It aims to reduce our leakage through:

- Establishing over 4,500 district meter areas to enable us to monitor flows and identify areas of suspected high leakage;
- Establishing our Find and Fix activities to deliver active leakage control;
- Undertaking large-scale targeted water mains replacements;
- Valve and control replacement;
- Implementing pressure management controls; and
- Delivering the 'First Fix Free' initiative to address leaks on pipes, within the boundary of domestic properties where the customer has responsibility.

As operational data and understanding of asset performance of our networks improves Irish Water expect to be able to make further improvements.

In late 2018, Irish Water developed a Leakage Management System (LMS) which will help us to assess leakage trends in a uniform way across our supplies and to manage active leakage control activities. We are continuing to embed the system and develop its calibration, but it is already, and will continue to, help us to understand leakage across our distribution networks. We are also looking at emerging acoustic technologies and intelligence systems to allow us to optimise our active leakage control activities, and non-destructive testing technology.

5.2.1 Three Step Leakage Reduction

Irish Water will take a three (3) step process to reduce leakage both nationally and within the Eastern and Midlands Region:

STEP 1: Sustainable Economic Level of Leakage

The SELL concept is built on the principle that when the total costs of producing water (including environmental and social) are greater than the cost of reducing leakage, there is a natural driver to further reduce leakage to achieve equilibrium. In other jurisdictions, the industry regulators for water supply set leakage reduction targets for the individual water utilities based on SELL, the Sustainable Economic Level of Leakage. As utilities have achieved or are approaching SELL, through progression along their leakage reduction glidepath, regulators are setting the challenge for some to go beyond SELL.

As this is Ireland's first NWRP, the target for leakage reduction has been set as SELL. Irish Water aim to achieve the National SELL target by 2034, recognising that current leakage levels are unacceptably

high. SELL targets will be continually reviewed through the five-year water resources planning cycles. As we progress towards SELL targets, Irish Water will continually review and proactively target further leakage reductions.

Details of the SELL assessment process can be found in Appendix H of the Framework Plan. During the development of the Framework Plan separate SELL targets were developed for the Greater Dublin Area (GDA) and the rest of Ireland. These national SELL Targets are set out in Table 5.1.

STEP 2: Go Beyond SELL

Further to the initial SELL targets considered in the Framework Plan, Irish Water has set additional leakage targets with the objective of reducing leakage levels to 21% of total demand for larger WRZs (WRZs where demand is greater than 1,500 m³/d).

STEP 3: Appropriate Leakage Level (ALL)

As the 2034 SELL targets approach, Irish Water’s knowledge of the condition and responsiveness of our networks to leakage reduction activities will have improved and we will set further leakage reduction targets on the basis of Appropriate Level of Leakage (ALL) for each supply. This will require WRZ level and site-specific assessments. These assessments will require data which is not yet available to Irish Water and as such these targets will be developed approaching 2034.

5.2.1.1 Step 1: SELL Targets

Estimated leakage levels for 2019 and target SELL for 2034 are presented in Table 5.1. In 2019 the national leakage level was 739 MI/d. SELL Targets aim to reduce this to 525 MI/d by 2034 requiring a national leakage reduction of 213 MI/d. The national leakage level target SELL will be met by leakage reductions both within the GDA and within all WRZ’s outside of the GDA. This will include WRZs within and outside of the Eastern and Midlands Region.

Table 5.1 Leakage Levels and Target SELL (MI/d)

	Leakage Level (MI/d)	Target SELL (MI/d)	Leakage Reduction Required (MI/d)
	2019	2034	
GDA leakage level	215	131	84
Leakage level for Non-GDA WRZ’s (Nationally)	524	395	129
National leakage level	739	526	213

In 2019 the leakage level in the GDA was 215 MI/d. In order to meet the 2034 GDA leakage target a leakage reduction of 84 MI/d will be required within the GDA (Table 5.1).

The 2019 leakage level for non-GDA WRZ’s was 524 MI/d. In order to meet the 2034 SELL target a reduction of 129 MI/d is required (Table 5.1). Of the 129 MI/d leakage reduction required nationally, for WRZ’s outside of the GDA, a leakage reduction of 22.5 MI/d will be made in WRZ’s within the Eastern and Midlands Region (Table 5.2). The remaining 106.5 MI/d will be achieved across the South West, North West and South East Regions (Table 5.2).

Table 5.2 Leakage Levels and Target SELL Steps (Ml/d)

	National Leakage Reduction (Ml/d)					National Sub Totals
	GDA	Non-GDA WRZs				
		Eastern and Midlands Region	South West Region	South East Region		
Step 1: SELL Target	84	22.5	106.5*		213	
Step 2: Beyond SELL	0**	35.5	107.5*		143	
			National Total		356	
Step 3: Post 2034 Appropriate Leakage Level	TBC pending future data availability					

*Target reduction across the South West, South East and North West Region with the regional split to be calculated during development of the subsequent regional plans.

**Leakage Targets in GDA achieve 21% leakage in 2034.

5.2.1.2 Step 2: Beyond SELL

Further to the initial SELL targets, considered in the Framework Plan, Irish Water has set additional leakage targets with the objective of reducing leakage levels to 21% of total demand for larger WRZs (WRZs where demand is greater than 1,500m³/d). For the Eastern and Midlands Region these additional targets equate to a net leakage reduction of 35.5 Ml/d across the region. Irish Water has also set a target of 107.5 Ml/d split across the South West, South East and North West Regions. The regional split of this target will be decided upon development of the associated Regional Plans.

5.2.1.3 Step 3: Appropriate Leakage Level (ALL)

As discussed above, as we approach the 2034 targets, our knowledge of the condition and responsiveness of our networks to leakage reduction activities will have improved and as we move towards 2034 we will set further leakage reduction targets on the basis of Appropriate Level of Leakage (ALL) for each supply. This will require WRZ Level and site-specific assessments. These assessments will require data which is not yet available to Irish Water and as such these targets will be developed as we move closer to 2034.

5.2.2 Leakage Targets and Demand Forecasting

The SELL leakage targets for the GDA are incorporated into the Supply Demand Balance (SDB). Leakage reductions are applied to the SDB by reducing the Demand component of the calculation. For this reason, the future estimated Deficit will reduce as a lower Demand is subtracted from the available supply. It is acknowledged that if these leakage targets are not met then the solution (Preferred

Approach) to the supply Deficit will not fully meet the Demand. For this reason, we are working to meet these targets now, in advance of the solution (Preferred Approach) reaching Project stage.

For WRZs outside of the GDA, 3 MI/d of leakage targets have been applied to the SDB. These leakage targets have been prioritised based on:

- Size of supply demand deficits
- Existing abstractions with sustainability issues
- Observed impacts during the 2018 drought

Planned leakage reductions across the Eastern and Midlands Region (built into the SDB) include the following reductions:

- SA3 - 356 m³ per day through net leakage reduction in Athboy, Bailieboro, Navan Mid Meath and Trim
- SA4 - 251 m³ per day through net leakage reduction in Ballymahon and Mullingar Regional
- SA5 – 570 m³ per day through net leakage reduction in Birr, South Roscommon and Athlone
- SA6 - 823 m³ per day through net leakage reduction in Carlow North, Clogh- Castlecomer, Portlaoise, Portarlinton and Tullamore
- SA8 - 978 m³ per day through net leakage reduction in Ennis, Shannon/ Sixmilebridge, and Limerick City.
- SA9 – 84,000 m³ per day through net leakage reduction

The remaining 19.5 MI/d of leakage reductions (required to achieve 22.5 MI/d of leakage reductions within the Eastern and Midlands Region) are not incorporated into the SDB. Where leakage reductions have not been incorporated into the SDB any leakage reduction achieved will result in a reduction to the expected future Demand. In this scenario the solution (Preferred Approach) to the supply Deficit within each WRZ, Study Area or the Region may be capable of providing more water than is needed. In this scenario, this will enable us to modify the solution to reduce the quantity of water required to be delivered or if it coincides with greater than expected growth it will open up available water for this increased demand.

In order to ensure that the solutions (Preferred Approaches) which we develop (Section 6-8) remain appropriate in the scenario of reduced leakage and static demand we have carried out a Sensitivity Analysis of our solutions (Preferred Approaches). This has allowed us to understand impact of leakage reductions on the proposed solution (Preferred Approach) and whether it would still be valid under a reduced leakage scenario. This process allows us to balance the delivery of the solution (Preferred Approach) between the Lose Less pillar (Section 5.2) and Supply Smarter pillar (Section 5.4). The Supply Smarter Options usually involves new or upgraded water sources and treatment plants. At Project Level these are delivered on a modular basis. For example, if we build a new water treatment plant we assess the demand profile of that supply over 25 years and then deliver the capacity in modules to align with demand increase. Therefore, if we meet or exceed our leakage targets and the demand is less, we do not build the last modules of the new water treatment plant, thus balancing supply with demand.

5.2.3 Challenges in Meeting Leakage Reduction Targets

While the optimum economic solution is to reduce leakage as quickly as possible and we aim to go above and beyond our SELL targets there are a number of wider considerations that may impact delivery including;

- Data improvements which are necessary to improve visibility of active leakage control efficiency and key parameters such as background leakage.
- Existing and or future budget constraints.
- The availability of skilled and trained resources to undertake find and fix activity. It is not feasible to significantly increase the level of resource for a short duration. To do this would risk driving inefficiency into the leakage management process.
- There are planning constraints to consider in relation to shut offs when carrying out repairs, to maintain supply and pressure to customers.
- Repairs carry a social cost and impact particularly in relation to traffic delays, therefore spreading the impact over time manages this impact.
- Technology and innovation improvements which are likely to improve active leakage control efficiency over time, and a number of trials in areas such as permanent acoustic sensors/smart networks may offer more cost-effective solutions in the near future.

5.2.4 Leakage Reduction in Athlone Town

Box 5.1 presents an example of the work being carried out to reduce leakage in the Eastern and Midlands Region.

Box 5.1 – Leakage Reduction in Athlone Town

The aim of our National Leakage Reduction Programme is to improve the water network and fix leaks across the country. This improves the reliability of supplies and delivers a more sustainable network. Irish Water have been working with our partners to reduce leakage in Athlone town which was experiencing regular interruptions in their water supply in 2018 as a result of operational challenges.

To establish a solution to the problem Irish Water worked closely with Westmeath County Council, our regional contractors, GMC utilities and the local community. In order to reduce leakage a multi-strand project was designed which included:

- Improving District Meter Area data through public meter upgrades
- Renewing water pipes through Backyard Service replacement programme
- Implementing our Find and Fix of Leaks
- Engaging with our customers through the First Fix Free scheme
- Replacing water mains

The District Meter Area improvement programme involved the installation or replacement of 107 meters across the district. This improved understanding of water flows across the district helping to direct Find and Fix crews to the highest priority areas. The data collected allowed the program of work to be efficient and provides a long-term source of valuable data on water use within the district.

The Backyard Service Replacement focused on reducing leakages from older properties where water connections were historically installed at the rear of the property. Such connections were commonly made of iron or lead and due to aging now represent a significant source of leakage. The programme enabled 751 water connections to be fixed leading to savings of 1.6 million litres per day. In addition to this water quality was also improved.

In order to reduce leakage and improve water quality 23 km of watermains were replaced across Athlone. In addition to this, 217 leaks were repaired through the Find and Fix scheme and 143 leaks were repaired through the First Fix Scheme. In combination this led to a saving of over 3 million litres of water per day.

The collaboration of each of the stakeholders was essential for the success of the project. For example, Westmeath County Councils knowledge of the local network was key to the delivery whilst the engagement of the community and their support during the completion of the works was vital to the success. Athlone Town now benefits from a more reliable water supply and improved water quality a benefit which will continue in the future.

5.3 Use Less: Water Conservation

Irish Water is committed to helping all of our customers to become more efficient in their water use. Research commissioned by Irish Water has shown that the broad perception among the general public is that we have an abundant water supply and that the need for water conservation is confined only to periods of extreme dry weather, as we have seen in recent years. We also know that low understanding of personal individual consumption, combined with high levels of leakage within the water supply network, and the misconception that Irish Water is not addressing the significant and complex leakage challenge, are further barriers to behavioural change. The **Use Less** pillar focuses on activities to help us to understand water use habits, influence behaviour, encourage change and to promote the use of water efficient devices and appliances.

Irish Water are committed to a behavioural change campaign that will educate and inform the end users about their individual water consumption and the challenges of providing a sustainable treated water supply in order to encourage water conservation. This will require investment and ongoing research.

Presently Irish Water is actively promoting water conservation in schools, business and communities through activities including:

- National and Local Media Campaigns;
- Targeted Sectoral campaigns;
- Green Schools;
- Water Stewardship Scheme (see Box 5.2);
- First Fix Free Scheme; and
- Development of an online water conservation application which will provide tips on how to conserve water in the home.

Irish Water also works with stakeholders to support policy change such as developing water efficiency standards in Building Regulations and social housing. More details of these activities can be found in the Framework Plan.

The ability to reduce demand (based on technology, behaviour and metering) is uncertain and sensitive to the situational context and the awareness of need. Technology offers benefits, but the changeover rates to new technologies are uncertain. Monitoring regimes need to be designed and maintained to understand significant changes that have been made and their result on water use. It is therefore difficult at this time to assess the potential benefit of water conservation activity in Ireland. Also, due to the funding mechanisms for water services, findings from water efficiency measures developed in the UK cannot be directly applied to Ireland. Over the coming years our ability to quantify the impact of these initiatives in terms of reduction in water use will improve as our data and intelligence systems become more refined. We will also work with our Innovation Team to review the potential for pilot studies to understand the potential benefits and outcomes for conservation measures such as rainwater harvesting and grey water reuse.

In order to address water conservation Irish Water has considered water conservation in our Domestic and Non-Domestic forecasts. Whilst Irish Water recognises that occupancy rates are falling within households, which typically leads to an increase in demand, we have held our per-capita consumption rates as static across our supplies when calculating our future forecasts. This means that increased per capita consumption growth will need to be addressed through water efficiency. An allowance for non-domestic growth has been made for towns and cities identified as strong growth areas in Project 2040². For other areas, it is assumed that there will be no significant increase in non-domestic demand. Where demand increases Irish Water will try to facilitate the growth via efficiency improvements and water conservation.

Box 5.2 - Water Stewardship in the Eastern and Midlands Region: Supporting the business community through Irish Water's Water Stewardship Programme

Irish businesses use around 510 million litres of water every day, to put that in context the city of Limerick requires about one-tenth of that at 51 million litres per day. Measures that support business to be more efficient and sustainable in how they use water make a real difference to safeguarding our national supply. Irish Water is working closely with business stakeholder groups to raise awareness of our Water Stewardship Programme to support businesses to lower water consumption and reduce operating costs while protecting the environment. Small changes such as identifying water waste on site, setting a baseline for water use, raising awareness amongst staff and customers, or upgrading to water efficient devices can make a big difference to water efficiency and also to save money for businesses.



One of the programmes developed by Irish Water is Certified Water Steward training which is tailored to every size of business with a shorter SME programme and more in-depth training for medium to large businesses. The programme is the first of its kind globally and accredited internationally by the European Water Stewardship Standard. It has been made possible thanks to the funding from Irish Water and Skillnet Ireland via the Department of Further and Higher Education, Research, Innovation and Science and it is a clear demonstration of Ireland's growing reputation and leadership actions on water stewardship and climate action.

Over 1000 new water conservation projects have been implemented by graduates to date and three sites have progressed to EWS/AWS international water stewardship certification. Overall, 70% of businesses are introducing Annual Water Stewardship Targets as a result of the programme and 100% would recommend the training to other businesses.

What Green Credentials are on Offer to the Eastern and Midlands Business Community?



We are offering three different opportunities for businesses of all sizes to enhance their green credentials:

1. Water Conservation Pledge

- We are inviting businesses to commit to making changes that will conserve water.
- Businesses can share their pledge badge on social media to show they are taking action.

2. Sustainable Water Partner Training

- Businesses are invited to take free online water stewardship training and learn about the importance of safeguarding this critical resource.
- Businesses can share their new Sustainable Water Partner badge on marketing materials/social media and add it to their green credentials.

3. Certified Stewardship Training

- Achieve international best practice certification. The programme is accredited by the European Water Stewardship Standards (EWS).
- Funded Programme by Irish Water and the Lean & Green Skillnet with the support of Skillnet Ireland and the the Department of Further and Higher Education, Research, Innovation and Science.
- Save water and money. The programme will provide you with the knowledge and skills to reduce water consumption and operating costs at your site.
- Protect the environment. You will learn the key principles of water stewardship and the actions required to improve your environmental performance.
- The programme is the first of its kind globally and is fully supported by the EPA, Origin Green, Ibec, Chambers Ireland, Industrial Development Authority Ireland (IDA), (Sustainable Energy Authority of Ireland) SEAI, Bord Iascaigh Mhara (BIM) and Enterprise Ireland.
- Origin Green accept our certification as part of their sustainability credential.

What does CWS Training deliver?

Module 1 - Introduction to water stewardship - the business case

Module 2 - Water mapping of your business

Module 3 - Water conservation and quick wins at your site

Module 4 - Developing a strategy and action plan

Optional workshops/webinars - Mentoring and support for the development of your Water Charter as well as providing peer to peer learning opportunities.

Develop a water charter for your site assessment - The charter will capture the business case for action, your site's water map, water saving opportunities and an agreed action plan. To achieve certification, participants will be expected to present this charter to senior management and get approval for implementation.

How has the water stewardship programme supported the Eastern and Midlands Region?

Testimonials from our Eastern and Midlands Certified Water Steward Graduates

	About	Benefits of CWS	Wins
	Dalata Hotel Group PLC is a hotel company which owns and operates hotels across Ireland and the UK. It is the largest hotel operator in Ireland.	The Certified Water Steward Programme involves staff from the ground level up and allows you to change culture from within	This programme allows us to identify leaks quickly through our water meters reading and through the graphs that we have
	Intel Corp. engages in the design, manufacture, and sale of computer products and technologies. Intel Ireland's Leixlip campus, located in County Kildare, began operations in 1989.	The ability to meet peers from other industries and get their input was a key benefit	The Certified Water Steward programme demonstrates our commitment to water conservation

5.4 Supply Smarter

The **Supply Smarter** pillar actions to proactively engage in the protection of our natural water resources, improve the performance and resilience of existing supplies, improve interconnectivity within our supply networks, increase the amount of water available for use, improve compliance, address the environmental impacts of existing abstractions and mitigate the impacts of climate change. We support this through asset maintenance, operations and by delivering process optimisation and training. The key option types for infrastructure improvements under the **Supply Smarter** pillar are listed in Figure 5.2.

As well as reducing leakage and improving water efficiency, we must develop our infrastructure to improve interconnectivity and storage, and create a more robust, smarter system. Our water supplies in some areas often come from small local rivers, which can have an environmental impact. We must therefore look at all of our water sources from rivers and lakes to groundwater so that we can reduce our reliance on these rivers. This will also allow us to take climate change into account.

All options are considered at the 'Unconstrained' stage in the process (Section 6) including technical assessment of transfers across Water Resource Zones (WRZs), and interactions with private Group Water Schemes, i.e. cumulative assessment of abstractions from the same source, and Options which consider connecting to Group Water Schemes.



Fig 5.2 Option Types

Irish Water's currently have 231 surface and groundwater sources located within the Eastern and Midlands Region. Each source needs to be utilised, managed and maintained sustainably in order to protect the source for future use. There are also 201 Water Treatment Plants in the Eastern and Midlands Region. Development and growth over the years means that some water treatment plants are undersized, treating water in quantities far beyond what they were originally designed for and so investment is needed to upgrade these facilities.

As part of our **Supply Smarter** pillar we are currently carrying out the following activities:

- Capital Investment and Improved Operations
- Source Protection and Catchment Management Activities
- Data Acquisition and Improvement

We are currently implementing an investment programme in our water supply infrastructure which includes water treatment plant upgrades to improve the Level of Service (LoS) we can provide to our customers. We have numerous water supply improvement projects and programmes in progress, to improve both the quality and quantity of drinking water. We publish details of planned, live and recently completed projects on our website. For more information please visit www.water.ie.

Irish Water recognises the importance of source protection in ensuring the security and sustainability of our water supplies and are currently working with key stakeholders to promote this concept. In recognition of the importance of multi-stakeholder engagement and collaboration in managing shared natural resources, Irish Water have formed a group of Environmental Protection Agency (EPA), Geological Survey Ireland (GSI), National Federation of Group Water Schemes (NFGWS), Department of Housing Local Government and Heritage (DHLG) and Independent experts to provide steering on the strategy, objectives and high-level activities needed to ensure the concepts of the three pillars are consolidated.

Irish Water are actively involved in source protection projects to trial catchment scale interventions for example to reduce the risk of pesticides causing exceedances in water supplies.

As Irish Water are at the initial stages of resource planning we are relying on the best available data, surrogate data and trends from neighbouring jurisdictions in the development of the draft RWRP-EM Supply Demand Balance. We have identified the data improvements which will be required to support best practice in the future and have invested in systems to manage it. Overtime we will build on the existing database improving our understanding which will be fed into the Supply Demand Balance. Detailed explanations of our current data approaches and future plans can be found in the Framework Plan.

Irish Water will also look at the waste produced from our Water Treatment Plants (known as residual waste) to reduce the impact of this waste on the environment through the circular economy approach and nature-based solutions.

5.5 Summary

In this section we have outlined the activities which we are already undertaking and plan to undertake in the future under our three-pillar approach to Lose Less, Use Less and Supply Smarter, to reduce the supply demand deficits across the public water supply.

Across the Eastern and Midlands Region Irish Water are committed to:

- Carrying out ongoing leakage management including active leakage control, pressure management and find and fix activities to offset Natural Rate of Leakage Rise (NRR).
- Continuing household and business water conservation campaigns, initiatives and education programmes.
- Implementing legally enforceable Water Conservation Orders, as required, in drought periods in order to protect the environment and our public water supplies.

5.6 References

1. Good Practices on Leakage Management WFD Common Implementation Strategy Working Group Programme of Measures. [Available at: <https://op.europa.eu/en/publication-detail/-/publication/3ff6a13c-d08a-11e5-a4b5-01aa75ed71a1/language-en>] [Access date: 01/11/2021].
2. Project Ireland 2040 – National Planning Framework (Feb 2018). Available at: [<https://www.gov.ie/en/publication/774346-project-ireland-2040-national-planning-framework/>]. [Access date 01/05/2021].