Autumn 2022

Regional Water Resources Plan- Eastern and Midlands

Study Area 9 Technical Report

Tionscadal Éireann
Project Ireland
2040

Data disclaimer: This document uses best available data at time of writing. Some sources may have been updated in the interim period. As data relating to population forecasts and trends are based on information gathered before the Covid-19 pandemic, monitoring and feedback will be used to capture any updates. The National Water Resources Plan will also align to relevant updates in applicable policy.

Baseline data included in the RWRP-EM has been incorporated from numerous sources including but not limited to; National Planning Framework, Central Statistics Office, Regional Spatial and Economic Strategies, Local Authority data sets, Regional Assembly data sets and Irish Water data sets. Data sources will be detailed in the relevant sections of the RWRP-EM. 2019 was selected as the base year to align with the planning period (2019-2025) of the NWRP.

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Introduction and Background

1 Introduction – Study Area 9

This is the Technical Report for Study Area 4 which applies the Options Assessment Methodology, as set out in the National Water Resources Plan Framework Plan (Framework Plan), the final version of which was reviewed by the authors of this Technical Report Prior to finalisation of this Technical Report. This document should be reviewed in conjunction with the Framework Plan and the Regional Water Resources Plan – Eastern and Midlands (RWRP-EM), which explain key concepts and terminology used throughout the report.

This Study Area includes the Greater Dublin Area, which comprises of a single Water Resource Zone covering County Dublin and parts of Counties Meath, Wicklow and Kildare. This Technical Report includes:

- The summary of Identified Need in this Study Area including Quality, Quantity, Reliability and Sustainability
- Options considered within the Study Area
- The range of approaches to resolve Identified Need
- Development of an Outline Preferred Approach for the Study Area; and
- The adaptability of our Preferred Approach.

The Preferred Approach for this Study Area feeds into the regional Preferred Approach detailed in the RWRP-EM.

1.1 Summary of Our Options Assessment Methodology

In Chapter 8 of the Framework Plan, we described the Option Assessment Methodology that will be used to develop a national programme of proposed solutions for all of our water supplies. The objective of these solutions is to resolve the needs identified through the Supply Demand Balance (SDB), Water Quality, Reliability and Sustainability assessments. These needs will be discussed in further detail in this report. In the RWRP-EM, we apply this methodology to the Eastern Midlands Region shown in Figure 1.1.

As outlined in Section 1.9.4 of the Framework Plan, the regional boundaries have been delineated for the purpose of delivering the National Water Resources Plan. As a national plan sources outside the delivery region may be considered to meet need within a particular region.

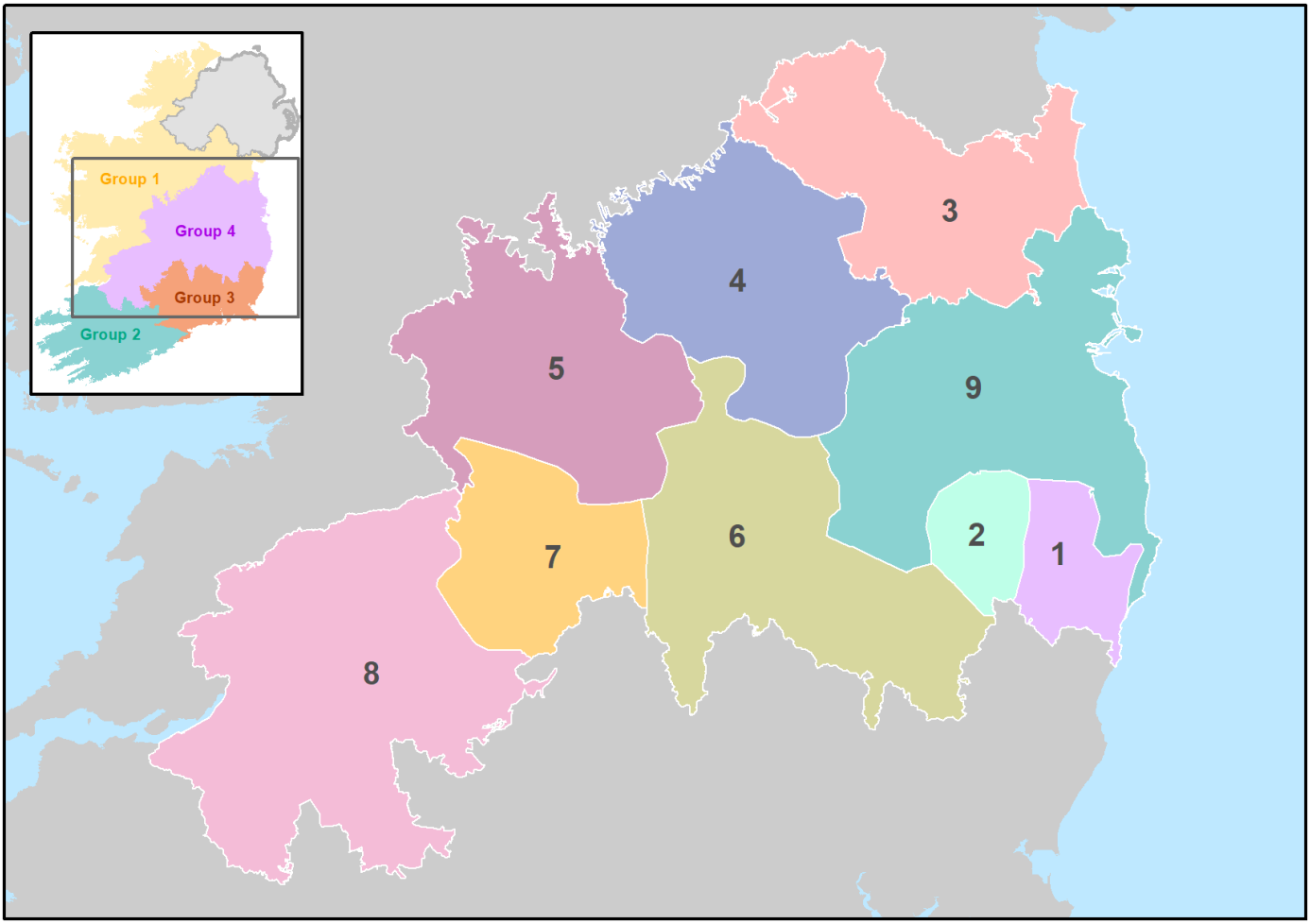


Figure 1.1 Overview of Study Areas within the Eastern and Midlands Region.

This Technical Report is for Study Area 9 (SA9), which consists of a single Water Resource Zone (WRZ). Within this Study Area, the Preferred Approach has been developed following the process shown in Figure 1.2 and as outlined in Section 8.3 of the Framework Plan.

In this document, Option codes are labelled using the following naming convention: SA9-00X

- TG4 refers to Regional group 4 or the Eastern and Midlands Region.
- SA refers to the Study Area within which the option is located.
- 00X refers to the individual option number.

It should be noted that assessments and preferred approaches and solutions at this stage are at a plan level. Environmental impacts and costing of projects are further reviewed at project level. No statutory consent or funding consent is conferred by inclusion in the national plan. Any projects that are progressed following this plan will require individual environmental assessments, including Environmental Impact Assessment and Appropriate Assessment (as required), in support of planning applications (where a project requires planning permission) or in support of licencing applications (for example, for new abstractions). Any such applications will also be subject to public consultation.

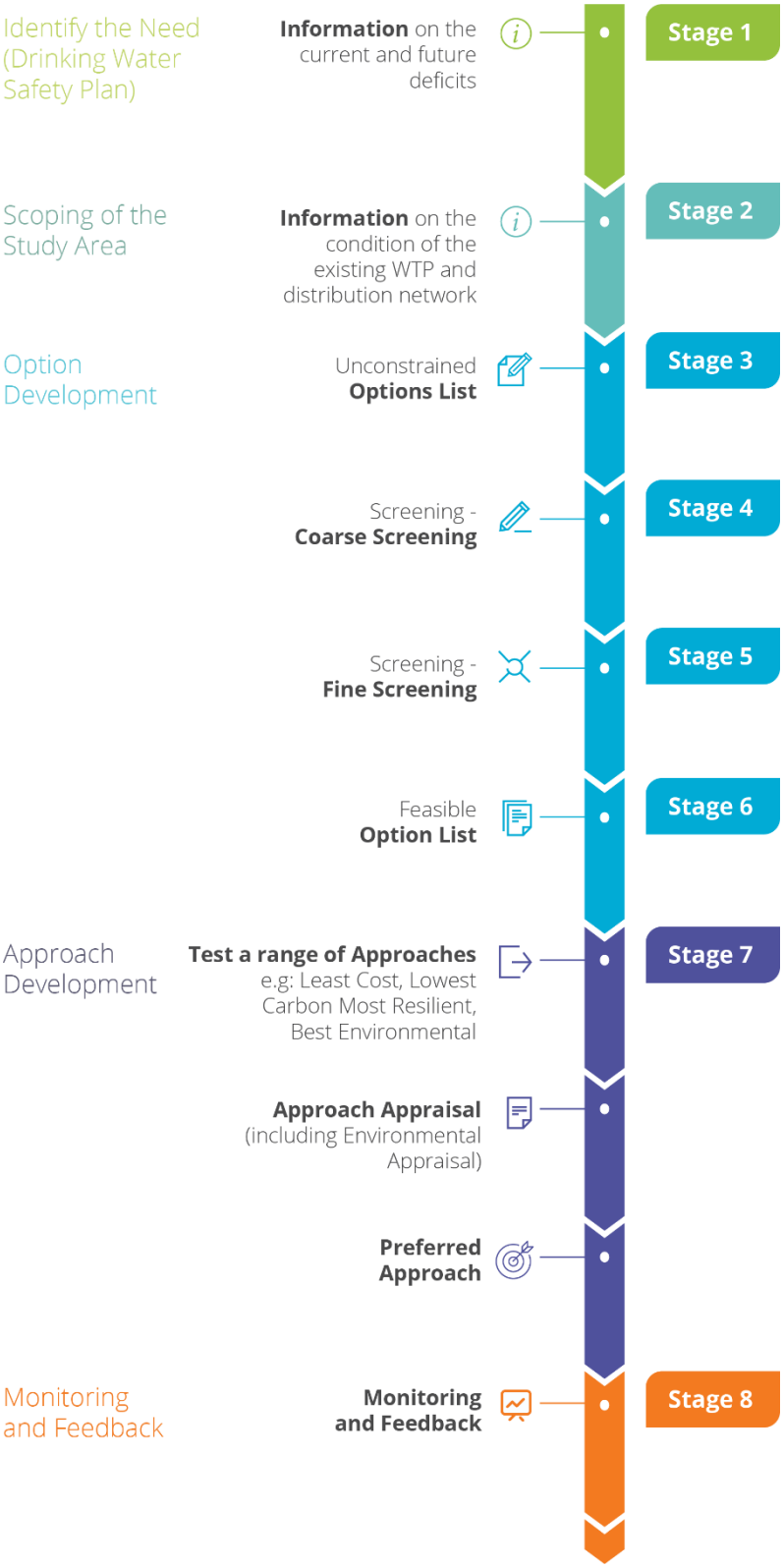


Figure 1.2 Option Assessment Methodology Process

1.2 Introduction to the Study Area

Study Area 9 consists of a single Water Resource Zone covering County Dublin and parts of Counties Meath, Wicklow and Kildare, supplying a population of approximately 1.7 million via approximately 8,500 kilometres of distribution network. The Study Area is summarised in Figure 1.3 and Table 1.1. The area consists of Dublin City and also a number of principal settlements, including: Bray, Wicklow, Blessington, Leixlip, Newbridge, Naas, Clonee and parts of Ashbourne.

Study Area 9 is predominantly urban in nature, and the existing supplies are generally located in the less developed areas. Some of these sources were developed in the late 19th century, and urban development has occurred around them in the intervening years.

Of the 12 WTPs in the region, 7 are surface water sources, with the remaining 5 groundwater supplies. The largest WTPs in the area abstract surface water from the River Liffey, Vartry, Dodder and Barrow catchments. The rivers Liffey, Vartry and Dodder rise in the Wicklow Mountains, and there are reservoirs fed by the rivers from which the supply is stored or taken. The River Barrow rises in the Slieve Bloom mountains and is dependent on baseflow from groundwater recharge in the Kildare Gravels during winter and spring to sustain supplies over the summer and autumn periods. The two abstractions from the River Liffey at Poulaphouca and Leixlip contribute 85% of the water to this WRZ.

Dublin City and the area towards Wicklow are underlain by the dark Calp limestones and granites which are moderately to poorly productive and have limited aquifer potential. Kildare has varied underlying geology, and is prominent for its large gravel aquifer in the Curragh overlying the limestone bedrock. Kildare provides groundwater supply to two of our WTPs.

Table 1.1 also provides an overview of the risk of failure against the Quality, Quantity, Reliability, Potential Sustainability criteria. A further breakdown of these scores is provided in Section 2.

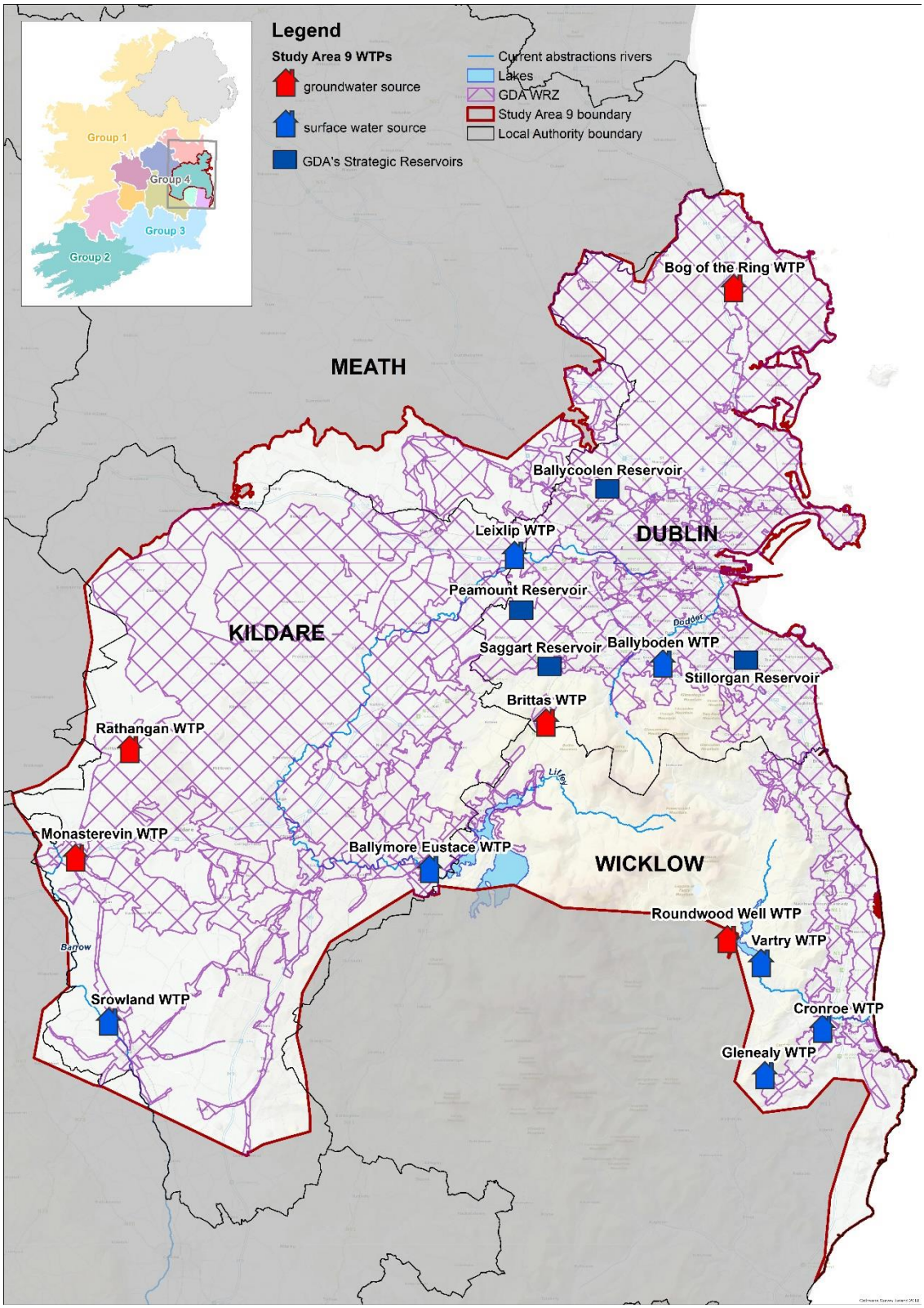


Figure 1.3 Study Area 9

Table 1.1 SA9 Overview

Greater Dublin Area	**Total Population**	1,702,245	**Total Network Length (km)**	8,474	**Number of Water Resource Zones**	1
Counties in Study Area	Dublin, Meath, Kildare, Wicklow					
Principal Settlements	Dublin city and suburbs, Swords, Bray, Naas, An Uaimh (Navan), Malahide, Droichead Nua (Newbridge), Celbridge, Greystones-Delgany, Balbriggan, Wicklow, Maynooth, Portmarnock, Ashbourne, Kildare, Dunboyne, Ceanannas Mór (Kells), Newtownmountkennedy					
Number of Water Sources	12	**Surface Water Sources**	7		**Groundwater Sources**	5

Water Treatment Plant	Source	WTP Capacity (m^3/day)	Quality	Quantity	Reliability	Potential Sustainability
Glenealy WTP	Stream at Barnbawn	180	●	●	●	●
Roundwood Well WTP	Groundwater	360	●	●	●	●
Cronroe WTP	Vartry River	1,200*	●	●	●	●
Brittas WTP	Groundwater	120	●	●	●	●
Monasterevin WTP	Multiple Groundwater	3,200	●	●	●	●
Rathangan Wellfields WTP	Multiple Groundwater	5,000	●	●	●	●
Srowland WTP	Barrow Abstraction	38,000 (22,500)**	●	●	●	●

Bog of the Ring Water WTP	Groundwater	3,000	●	●	●	●
Leixlip WTP	River Liffey	265,000 (230,000)***	●	●	●	●
Ballyboden WTP	Dodder River	14,000****	●	●	●	●
Vartry WTP	Vartry River	75,000	●	●	●	●
Ballymore Eustace WTP	River Liffey	400,000 (310,000)*****	●	●	●	●

***** Cronroe WTP has the capacity to treat 1.2Ml/d, however, the WTP is currently not in use due to a planning constraint. The WTP cannot operate in when the Vartry WTP is in operation. The WTP is to be maintained and used to provide supply to the local popualtion in the event of an outage at the Vartry WTP.

**Srowland WTP has the capactiy to treat 38Ml/d, however output is constrained to 20Ml/d due to condition of the existing plant. Works are underway to upgrade the WTP, however, these upgrades will take a number of years to complete.

*******The design capacity of the Leixlip WTP is 255Ml/d however max output is limited to 230Ml/d due to condition of the existing plant. Works are underway to upgrade the WTP.

******** The design capacity of the Ballyboden WTP is 15Ml/d however max output is limited to 7 Ml/d due to condition of the existing plant. Works are underway to upgrade the WTP, however, these upgrades will take a number of years to complete.

********* The design capacity of Ballymore Eustace WTP is 400Ml/d, however sustainable output is 310Ml/d due to network contrainsts.

2 Scoping the Study Area

2 Scoping the Study Area

In this chapter we summarise the current and future issues with water supplies in Study Area 9, in terms of water quality, quantity, reliability and sustainability.

To identify the issues and corresponding need with the water supplies in this Study Area, and to inform the nature, scale and scope of the solutions that we need to consider to meet them, we have assessed:

- The **water quality** that we can supply;
- The **water quantity** that we can supply;
- The **reliability** of our existing supplies; and
- Additional information that impacts the long-term **sustainability** of our sources or infrastructure.

2.1 Water Quality

We assess the water quality investment needs of our water supplies by assessing the performance of our assets against the barriers set out in Chapter 5 of the Framework Plan. As set out in Chapter 5 of the Framework Plan, Irish Water is developing scientifically robust datasets to assign risk. Irish Water are utilising the well-established 'Failure Mode Effect Analysis' which provides a step-by-step approach for identifying all possible failure modes that can result in a hazardous event. Once identified, we assess risk against the existing controls (Barriers), which we have in place for source protection within our water treatment plants and networks. This Barrier Assessment process highlights where there is a deficit or potential for future deficit in these controls or treatment process elements.

The barriers are an internal gauge and the initial desktop assessments of barrier performance for SA9 are summarised in Table 2.1.

Table 2.1 Quality: Barrier Scores

Quality: Barrier Scores				
Water Treatment Plants	**Barrier 1: Bacteria & Virus**	**Barrier 2.1: Maintain chlorine Residual in the Network**	**Barrier 3 Protozoa (Crypto) Asset Potential**	**Barrier 6b THM's Leading Indicator**
Glenealy WTP	●	●	●	●
Roundwood Well WTP	●	●	●	●
Cronroe WTP	●	●	●	●
Brittas WTP	●	●	●	●
Monasterevin WTP	●	●	●	●

Quality: Barrier Scores				
Water Treatment Plants	**Barrier 1: Bacteria & Virus**	**Barrier 2.1: Maintain chlorine Residual in the Network**	**Barrier 3 Protozoa (Crypto) Asset Potential**	**Barrier 6b THM's Leading Indicator**
Rathangan Wellfields WTP	●	●	●	●
Srowland WTP	●	●	●	●
Bog of the Ring Water WTP	●	●	●	●
Leixlip WTP	●	●	●	●
Ballyboden WTP	●	●	●	●
Vartry WTP	●	●	●	●
Ballymore Eustace WTP	●	●	●	●

Score	Irish Water Asset Standard Assessment
●	Low Risk
●	Medium Risk
●	
●	High Risk

The colour coding within the outline assessment indicates the severity of the potential risk of barrier failure. It should be noted that the table is not an indicator of non-compliance with the European Union (Drinking Water) Regulations 2014 as amended (Drinking Water Regulations), but an internal Irish Water assessment of the asset capability standard compared with the asset standard set out in Section 5.7 of the Framework Plan. The assessment provides an indication of the need to invest in areas of our asset base (human and structural) through resource planning, to ensure that we can address potential risks or emerging risks to our supplies.

Based on the barrier assessment, 11 of the 12 WTPs in the Study Area are considered to be at high risk of failing to achieve the required standards in relation to chlorine residuals in our networks (Barrier 2.1) and effectiveness of our Protozoa removal processes (Barrier 3). However, in some cases our desktop assessments can over-estimate risk, particularly when there is little available data on the catchment characteristics of our raw water sources. As our "Source to Tap" Drinking Water Safety Plan (DWSP) assessments, which are a requirement under the Recast Drinking Water Directive (2020), are developed

for each water supply, the barrier scores for all of our supplies will be updated and become more reliable.

It should be noted that the “quality need” identified through the Barrier Assessment is not an indicator of compliance with the Drinking Water Regulations. It is an assessment of the need to invest in areas of our asset base (human and structural) through resource planning, to ensure that we can address potential risks or emerging risks to our supplies.

At present the Vartry supply is on the EPA Remedial Action List (RAL) and Irish Water is currently constructing a new WTP to remove this WTP from the RAL. IW is also currently progressing, a number of immediate corrective actions in relation to this supply while we deliver the 25 year NWRP and the subsequent projects it identifies (in line with the “interim solution” approach outlined at Section 8.3.7.6 of the Framework Plan). The relevant projects are summarised in Table 2.2 .

Table 2.2 Critical Water Quality Requirements SA9

Critical Water Quality Requirements	Progress
1. **Vartry Water Treatment Plant:** Development of a new WTP at the existing Vartry site, to treat 75Ml/d to the standards required under the Drinking Water Regulations	**Complete Nov 21**
2. **UV treatment Vartry Water Treatment Plant:** Installation of temporary UV treatment at the existing Vartry Water Treatment Plant to ensure the provision of safe water supply while works at the new plant are ongoing.	**Complete**
3. **Leixlip Water Treatment Plant Upgrade: Leixlip WTP comprises two treatment streams the old WTP and the new WTP. Phase 1 works** comprised filter and process upgrades , including UV treatment installation at the old WTP. Further phases of upgrades include, replacement of distribution pumps, new sludge treatment, electrical upgrade and CFC treatment upgrades of the old and new WTPs.	**Phase 1 Complete** **Phase 2 Works Underway**
4. **Stillorgan Covered Reservoir:** Construction of 150 ML of covered storage capacity at the existing Stillorgan Reservoir site to replace open storage	**Complete**
5. **Ballyboden Covered Reservoir:** Construction of 16ML of covered storage to replace open storage at Ballyboden Water Treatment Plant	**Complete**
6. **Rationalisation of Glenealy and Roundwood Well WTP:** Rationalisation and decommissioning of Glenealy WTP and Roundwood Well WTP to ensure a secure supply to the customers in the area.	**Design Stage**
7. Development of Drinking Water Safety Plans for our water supplies	**Underway**

In summary, in relation to water quality, Irish Water will:

- Continually update Barrier Performance issues in the WRZ which have the potential to impact on drinking water quality in the region;
- Improve these assessments through the development of DWSPs for all of our supplies;
- Address the priority risks identified on the EPA Remedial Action List (noting that steps have already been taken, and are ongoing, to address these risks); and
- All residual need (grey dots) in relation to water quality will be brought through our options assessment process.

Box 1 Leixlip Water Treatment Plant

An area of the Water Resource Zone was on the EPA Remedial Action List due to deficiencies at the Leixlip Water Treatment Plant.

The treatment plant consists of two separate plants: the new plant commissioned in 2014, and the old plant constructed in the early 1970's. There has been significant under investment in the older plant for a long period, with the last major upgrade of the facility taking place over 20 years ago. Irish Water have identified significant upgrade works for the facility. However, as both plants operate at above capacity continuously, it is not possible to take both plants out of service to carry out permanent repairs.

On 22 October 2019, following a fault in part of the treatment process, the Leixlip supply was put on a Boil Water Notice as directed by the HSE. The fault was rectified and following an extensive assessment of areas impacted, flushing of the network and sampling to ensure compliance, the boil water notice was lifted on 25 October 2019.

A further Boil Water Notice was put in place on 4 November 2019 due to deterioration in raw water quality in the River Liffey due to a heavy rainfall event. This resulted in increased organic load entering the plant, exceeding removal capacity in the processes leading to an increase in the turbidity (cloudiness) of the treated water. Although all treated water samples taken during this period were fully compliant with the Drinking Water Regulations, as turbidity increased, the WTP was subject to a precautionary Boil Water Notice until 12 November 2019. It should be noted that at all times water deployed from this WTP was compliant with the drinking water regulations. Each Boil Water Notice impacted over 600,000 customers.

Irish Water has carried out a significant number of upgrades to the WTP since 2019. Details of the works completed are listed below

- **The sand within the rapid gravity filters in the old plant has been replaced, which will improve the solids removal process reducing turbidity levels in the treated water.**
- **A UV treatment system (Barrier 3) has been installed in the old plant, addressing risk in the event of a rise in turbidity of the water.**

These works are now complete and the WTP is no longer on the EPA RAL. However further commissioning works are ongoing to ensure the future resilience of the WTP.

2.2 Water Quantity – Supply Demand Balance

Irish Water assesses the water quantity investment needs of our supplies by developing SDB calculations for each of our water supplies as outlined in Chapter 3, 4 and 6 of the Framework Plan. The calculations are used to assess the amount of water available in our supplies and compare that to the current and forecast demand for water in accordance with Figure 2.1 as noted in Section 4.3.2.3 of the Framework Plan due to its size and complexity, the non-domestic demand forecast for the GDA was developed by independent economic analysts. Annex C of this Technical Report provides a summary report outlining the development of the non-domestic demand forecast for the GDA.

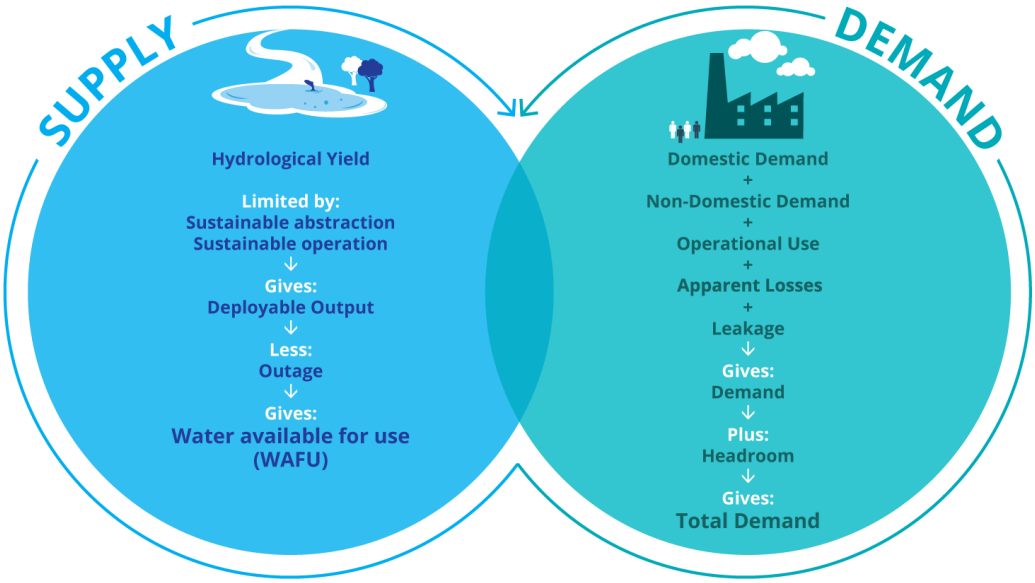


Figure 2.1 Supply Demand Balance

We assessed the baseline SDB for this WRZ and developed 25-year forecasts of supply and demand, in accordance with Figure 2.1.

The SDB assessments were carried out for each of the weather event planning scenarios (Normal Year Annual Average, Dry Year Annual Average, Dry Year Critical Period, Winter Critical Period) which are described in Chapter 2 of the Framework Plan. The SDB deficits in SA9 manifest in the following ways:

1. **Inappropriate standards and levels of risk for a strategic water supply:** As water supply is essential for public health, Irish Water must ensure appropriate standards of supply and be able to cope with drought conditions, peak events, and maintenance of assets. This requires adequate reserve capacity in our supplies to provide a 1 in 50 Level of service. At present, not all supplies within this Study Area meet the required levels of reserve capacity. However, due to the lack of historical monitoring, particularly in relation to groundwater supplies, some of the deficits may be data driven.
2. **Day to day operations:** Currently this water resource zone is reliant on our existing assets performing beyond their sustainable operational capacity, and we often depend on treated water storage to meet short term deficits. As treated water storage should be reserved to ensure continuity of supply during incidents on our networks, our dependence on this to meet normal demand further highlights vulnerability in the region. Urgent maintenance works are difficult to

plan and carry out when the existing infrastructure is continuously operating at maximum capacity. An example of this is the filter upgrades which were urgently required at the Leixlip Water Treatment Plant. The upgrades were deferred for a number of years in order to maintain output from the treatment plant as there was no spare capacity elsewhere in the system to meet demand.

A summary of the SDB deficit, for the Dry Year Critical Period, across the Water Resource Zone is summarised in Table 2.3. The supply demand balance for each water resource is detailed in Appendix L of the Framework Plan. As outlined in Section 4.3.3 of the Framework Plan, Sustainable Economic Level of Leakage (SELL) forecast of 84Ml/d reduction in leakage by 2034 was determined for the GDA and this has been built into the SDB. Further to a review of leakage targets carried out by the leakage reduction team the leakage targets for the GDA were revised to 92 Ml/d and these revised targets were also built into the SDB. Therefore, the deficits outlined in Table 2.3 are the deficits in supply after leakage targets are achieved.

Table 2.3 WRZ SDB Dry Year Critical Period Deficits

Water Resource Zone Name	Population	Estimated Maximum Deficit m3/day					
		2019	2025	2030	2035	2040	2044
Greater Dublin Area	1,702,245	-132,190	-138,899	-116,695	-140,925	-164,280	-182,991

The target 1 in 50 level of service in the region were applied in each case, along with the corresponding requirements for reserves, indicating that our supplies are operating with a cumulative SDB deficit of approximately 132 Ml/d. As a result, water supplies in this area come under pressure, particularly in drought conditions, and there are ongoing reliability issues.

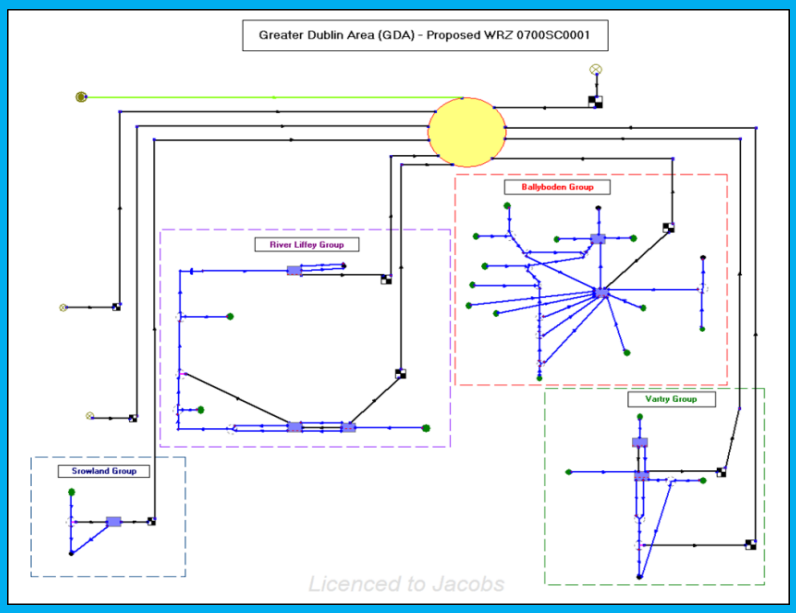
This situation will further deteriorate over time due to climate change-driven reductions in water resources, together with increased demand due to population growth. If we do nothing, the SDB deficit is projected to increase to approximately 183 Ml/d by 2044, as explained below.

Our ongoing activities to improve the Supply Demand Balance in SA9 are prioritised as:

- New WTP at Vartry which will provide additional supply to the network. The construction phase of this project is complete and the commissioning phase was successfully completed prior to the finalisation of this report.
- Srowland extension project will increase the number of customers we can supply from Srowland WTP allowing us to realise the existing spare capacity at the WTP. The construction phase of this project is complete and the commissioning phase is ongoing
- Ongoing leakage management including active leakage control, pressure management and find and fix activities, under the Leakage Reduction Programme to meet target levels of Leakage
- Water Conservation measures, including information campaigns and initiatives, and Water Conservation Orders during drought periods

Due to the complexity of the interconnected water sources in this region, we have developed a water resource model, to assess the combined deployable output of the individual supplies for our required 1 in 50 year Level of Service target as set out at Section 2.3.3 of the Framework Plan. A summary of this model is contained in Box 2.

Box 2 Aquator Model of the GDA WRZ



As the GDA WRZ is a complex network consisting of nine individual water supplies, the supply has been modelled using a water resource planning tool known as Aquator. The Aquator model enables us to assess the deployable output for the combined supplies for all weather conditions (normal, dry, drought and winter), for an appropriate level of service.

The Aquator model simulates all of the existing and planned sources within the GDA WRZ to assess the capability of these resources to supply increasing levels of demand, and determines the deployable output from our sources for a target level of service.

The Aquator model was used to develop the deployable output for the following scenarios:

- **2019 with current capabilities,**
- **2022 with planned works implemented, and**
- **2055 with climate change impacts applied.**

The results for these scenarios were incorporated to determine the deployable output for intermediate years. The baseline model considers all abstractions operating as per current arrangements. To understand the sensitivity of our current supplies to external factors such as climate change and potential tighter abstraction legislation, we have also run these various scenarios through the model (see Section 2.4).

2.3 Water Supply Reliability

The benefits of having sufficient water supplies in terms of quality and quantity are lost if we cannot distribute the water we produce effectively around our networks. We also need sufficient treated water storage to enable us to respond to planned or unplanned outages on our trunk main and distribution networks.

In 2015, Irish Water commissioned a study of the existing water supply asset base in the GDA region in order to assess resilience, flexibility and security of supply. The study used a hydraulic model to assess, at water resource zone level, options to resolve shortfalls in both the security of supply under normal operation and resilience under a range of potential failure conditions. The exercise identified key points of weakness on the existing supply, where lack of ability to transfer water, combined with highly vulnerable assets, have the potential to result in supply failure in a water resource zone.

The study identified a number of critical requirements for upgrades to the existing asset base, including storage and trunk main requirements. Progress to date on these projects is summarised in Table 2.8

Table 2.8 SA9 Critical Infrastructure Projects and Need Identification

Critical Requirement	Progress
1. **Replacement of the Vartry Tunnel:** The 150 year old unlined gravity tunnel connects the Vartry WTP to the trunk main network that distributes the water from the plant across Wicklow and south Dublin. The tunnel was inspected in 2006, and over 50 points of collapse were identified. A collapse of the tunnel when it was in operation would have resulted in water outages to a population of approximately 200,000.A new pipeline from Vartry to Callowhill was constructed to replace the tunnel.	**Completed 2019**
2. **Security of supply from Ballymore Eustace to Saggart:** Treated water is conveyed from BME WTP to Saggart reservoir via 2 no. trunk mains; the concrete culvert and a 1,600mm dia. pressurised pipeline. The mains were constructed in 1940 and 1982 respectively. Both mains are required to operate at near maximum capacity every day to ensure supply to the city and a burst or incident in either main would result in an interruption to supply to a significant number of customers. Therefore an additional main or replacement of one main is required to ensure security of supply to our customers.	**Assessment Complete**
3. **Improved connectivity between Srowland to Ballymore Eustace supplies:** There is insufficient connectivity between the Srowland and Ballymore Eustace supplies, which currently limits the deployable output from Srowland Water Treatment Plant. This exacerbates the current supply demand balance issues in the region. Works including the provision of a new main, booster pump stations and the upgrade of pipework which will allow Irish Water maximise output from Srowland WTP are ongoing.	**Construction Complete – Commissioning Ongoing**
4. **Increased storage at the existing Saggart Reservoir site:** At present there is insufficient storage at the Saggart Reservoir site, which is at the high point in the supply network. The volume of water being transferred through the sites is such that the incoming flow from BME runs across the base of the existing tank and straight into the bulk trunk mains. Any	**Construction Ongoing**

Critical Requirement	Progress
interruption to deployable output from BME WTP or along the two trunk mains between BME and Saggart, would result in immediate interruptions to water supply for up to a population of 800,000. Works on a new 100ML covered storage were completed in May 2022.	
4. **Increased Trunkmain Transfer Capacity to Dublin City:** At present there is limited capacity in the trunkmain network from the strategic reservoirs located in outer Dublin that supply the inner City areas. A number of the existing mains are operating above their design capacity and when project growth and development are applied these mains will be under increased loading that will have a significant impact on operations and the ability to supply new customers. Additional main to provide approximately 30 – 40Ml/d to the city from the strategic reservoirs. This main is required to service the existing deficit and development and regeneration areas in the inner Dublin City, North and South Lott's and Coastal areas.	**Assessment Complete**
7. Critical network upgrades and controls: Identification of priority network upgrades, new control valves and pressure controls are required across the region, including Merrion Gates to Sean Moore Road trunk main, Ballycoolin to Kingstown trunk main, Saggart to Stillorgan trunk main and the North City high pressure main.	**Assessment Complete**
8. Distribution Network Repairs and Upgrades: a rolling programme of active leakage control, pressure management, find and fix and network upgrades in the GDA was identified as a critical requirement. These works are currently being progressed through the leakage reduction programme.	**Activity Ongoing**

In summary, there are significant asset reliability issues across the distribution network within the water resource zone. Some priority projects to address these issues have been delivered as part of the last investment cycle or are being progressed as part of the current investment cycle. The entire suite of critical works will be needed over the next five to seven years. In addition, a continuous programme of repairs, upgrades and leakage reduction is being progressed as part of the National Leakage Reduction Programme.

2.4 Water Supply Sustainability

The water supplies within the GDA region were developed over the past 160 years, with the first major water supply, Vartry Water Treatment Plant, constructed in the mid-1850s. The largest supplies of water come from the River Liffey and were developed and expanded between the 1940s and the early 2000s.

As outlined at Section 3.7.2 of the Framework Plan, the Government is currently developing new legislation dealing with water abstractions. As this legislation is still being developed, we do not have full visibility of the future regulatory regime. We have therefore not progressed through a theoretical licencing process on a site by site basis and cannot reliably include an estimation of sustainable abstraction within the SDB calculations. Instead, we use the hydrological yield, water treatment capacity and bulk transfer limitations in our calculation of DO. This assessment procedure is set out at Appendix C of the Framework Plan, and in line with a precautionary approach.

To understand the potential impact of the abstraction legislation on the SA9 Greater Dublin Water Resource Zone supplies, we have compared the compensation flows based on current operational agreements that are included within our water resources model against those that may be allowed by other jurisdictions' application of UKTAG guidance. We have then adjusted the compensation flows within our model accordingly and assessed the resultant deployable output.

Based on this initial desktop assessment, the potential impact of regulatory changes at our existing abstraction sites is summarised in Table 2.9. However, under the proposed regulatory regime, these compensation flow quantities will be adjudicated by the EPA who will have additional data available to them We have assumed given the need to maintain supplies that a transition to new abstraction and compensation flow quantities would likely take place in the medium term.

Table 2.9 Comparison of Current and Potential Future Compensation Flow Requirements

Description	GDA sources				
	Poulaphouca (Upper Liffey)	Leixlip (Middle Liffey)	River Vartry	River Barrow	Bohernabreena Reservoir (Dodder)
Current compensation flows (Ml/d)	130	173	5	99	0
Potential future compensation flows (Ml/d)	130	232	13	99	9

The impact of this potential change of compensation flow requirements on projected SDB deficit is summarised in Table 2.10. These changes are relative to the existing flow and asset baseline and do not account for climate change.

Table 2.10 Potential Change to the SDB Based on Potential Abstraction Reductions

Description	GDA
Change in SDB[1] (m^3/d)	-90,000

Groundwater abstractions will need to conform to the proposed new abstraction licencing regime. These abstractions will be assessed in two ways:

- Impacts on the groundwater bodies from which they abstract; and
- Impact of the groundwater abstraction on the base flow in surface waterbodies.

As noted in Section 3.2.2 of the Framework Plan, producing robust desktop assessments of water availability from our existing groundwater abstractions is very difficult. Ideally, yield estimates would be based on a three-dimensional assessment of the geology within the vicinity of the supply, supplemented

[1] Based on potential changes to the projected 2044 Dry Year Critical Period (DYCP) scenario

with long term records on pumping and drawdown of water levels over many years. Irish Water does not have this type of information available for most of our groundwater supplies and while we will aim to complete site-specific studies of groundwater availability, this may take many years.

On an interim basis Irish Water has developed an initial assessment for existing abstractions based on best available information. For more information, please see Appendix C Supply Assessment and Appendix G Regulatory and Licensing Constraints of the Framework Plan. Over the coming years, Irish Water will work with the environmental regulator EPA and the Geological Survey of Ireland, to develop desktop and site investigation systems to better understand the sustainability of our groundwater sources. We are not in a position to estimate changes to the groundwater availability until better data is available.

In summary, when considering the requirements of the Water Framework Directive (WFD), some of our schemes may be subject to reductions in abstraction, especially during drought periods. While we have developed a potential understanding of the impact of the legislation we cannot reliably include an estimation of sustainable abstraction within the SDB calculations.

However, we do use our sustainable abstraction estimations to assess the sensitivity of the Preferred Approach as set out in Chapter 7 of this Technical Report. This assessment determines whether the Preferred Approach is adaptable to change across a range of potential future scenarios and verifies our ability to adapt and increases our resilience to future changes.

When the new Legislation on abstraction of water has been enacted and regulatory assessments completed if an abstraction is confirmed to be affecting a waterbody status the Supply Demand Balance will be updated as outlined in the monitoring and feedback section of the RWRP, Section 9.2.2. All future abstractions considered through the Framework Plan options assessment are validated for sustainability, including options to increase abstraction at existing sites.

2.5 Water Resource Zone Needs Summary

The GDA water resource zone has significant issues in relation to quality, quantity, reliability and sustainability of the existing water supply, which must be addressed as part of the preferred approach to future water resources planning, summarised in Table 2.12.

Table 2.12 Summary of Need Quality, Quantity, Reliability, Sustainability

Quality	Upgrades required to all WTPs
Quantity	Net leakage reduction of 92,429 m^3/d in the region over next 15 years as realistic achievable and sustainable saving over current baseline Interim additional supplies of 116.5 Ml/d required within GDA Region within the next 10 years Additional supplies of 183 Ml/d within GDA region beyond the 10 year horizon

Reliability (In addition to projects in progress)	Upgrades to critical asset base, including: upgrade of the trunk main between Ballymore Eustace and Saggart Continued network upgrades and improvements in the bulk and distribution networks
Sustainability	Based on our initial desktop assessment, the volumes of water abstracted The volumes of water abstracted and compensation flows provided at Vartry WTP, Leixlip WTP, Ballyboden WTP, BME WTP and Srowland WTP may not meet sustainability guidelines during dry weather flows. However, under the proposed regulatory regime, this will be adjudicated by the EPA. Over the coming years, Irish Water will work with the environmental regulator EPA and the Geological Survey of Ireland, to develop desktop and site investigation systems to better understand the sustainability of our groundwater sources.

All of these needs will be considered within our options assessment process and the development of the Preferred Approach.

Further details of planned, live and recently completed projects are available on our website see: https://www.water.ie/projects-plans/our-projects/.

3

Solution Types Considered in Study Area 9

3 Solution Types Considered in Study Area 9

In this chapter, we summarise the type of solutions we have considered to address identified need for treated drinking water supply in Study Area 9 – Greater Dublin Area Water Resource Zone

As outlined in Chapter 7 of the Framework Plan, we consider measures across the following three pillars: **Lose Less**, **Use Less** and **Supply Smarter** in forming our list of unconstrained options, which are assessed for short, medium and long-term solutions. For the SA9 Greater Dublin Area as part of our unconstrained options, the following options have been reviewed.

3.1 Leakage Reduction

The Leakage reduction measures across the public water supply considered for SA9 Greater Dublin Area are based on what we assess to be both achievable and sustainable and include:

- Ongoing leakage management, including active leakage control, pressure management and Find and Fix activities, to offset Natural Rate of Leakage Rise (NRR); and
- In the SA9 GDA, 92 Ml/d nett leakage savings have been set into our planning based on realistic stretch targets. These leakage targets have been built into the Supply Demand Balance for SA9.

3.2 Water Conservation

At present, Irish Water is conducting pilot studies in relation to water conservation stewardship in businesses and is actively pursuing Conservation Education Awareness Campaigns and partnerships. During drought conditions in 2018 and 2020, a Water Conservation Order was implemented in order to protect our water supplies and reduce pressure on the natural environment during this period. We will continue to promote 'Water Conservation Activities', collecting and monitoring data over a number of years to assess the benefits. As part of the Framework Plan, we have not applied reductions to the SDB deficit for unquantifiable water conservation gains. However, we do assume that any gain will offset consumer usage growth factors.

3.3 Supply Smarter

The supply options to provide a long term sustainable treated drinking water supply for the GDA considered as part of the options development are unconstrained by distance from GDA and include:

- Groundwater options, across the region, extending as far as supplies in Tullamore and Carlow
- Upgrades to our existing treatment plants
- Surface water options extending as far as Limerick
- Impoundment options in the Dublin and Wicklow Mountains

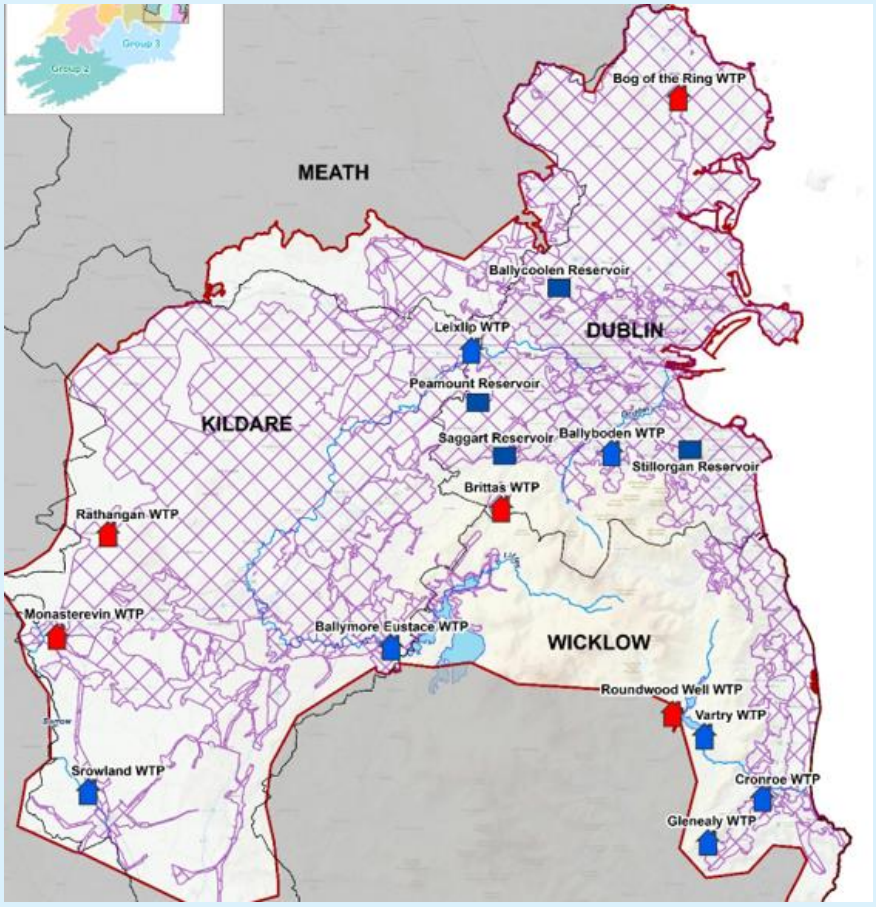
- Treated effluent recycling options
- Industrial water reuse options
- Other smaller supplies
- Desalination options in in North County Dublin and South County Dublin
- Network connectivity and transfers from other water resource zones

3.4 Other Considerations in terms of supply solutions

A greater number of water source types or treatment plants may increase the resilience of a supply, as it reduces impact of individual failures or outages. However, additional resilience from a combination of new options is only enabled if the range of options individually are able to contribute to a substantial percentage of the water requirements of the WRZ. Within this RWRP, we do consider combinations of smaller supply options as potential solutions to addressing the large GDA water supply deficit. However, such combinations do not perform well against the resilience criteria. Box 3 below provides an overview of how we manage our supplies in the GDA and outlines why larger supply options are critical to improving the resilience of the overall supply.

Box 3 – Outage and Resilience within the GDA

The majority of supply in the GDA is provided from our large WTPs, Leixlip WTP, Ballymore Eustace WTP and Vartry WTP. These WTPs provide supply to our customers through our key strategic reservoirs; Ballycoolen, Peaumout, Saggart and Stillorgan. In the case of an outage at any of our large WTPs the strategic reservoirs can be used to balance supply across the network and maintain supply to our customers. A schematic of our WTPs and our Strategic Reservoirs is provided below along with two examples of how we manage our supplies.



Example 1

From 2019, output capacity at Vartry WTP was reduced by 20Ml/d to approximately 55Ml/d due to deterioration in the old WTP. Prior to 2019, Vartry WTP had an output capacity of 80 Ml/d and provided supply to areas of Wicklow and South Dublin directly. The plant also provided supply to customers in Dublin city via the Stillorgan Reservoir where water from the Vartry WTP was mixed with treated water from Ballymore Eustace WTP. To manage the impact in reduction in output from Vartry WTP, supply to the areas of Wicklow and South Dublin were maintained and the volume of water provided to Stillorgan Reservoir from Vartry WTP was reduced. Output from Ballymore Eustace WTP was increased to balance the required supplies at Stillorgan Reservoir. In 2021, output capacity at the old Vartry WTP was required to be further reduced to approximately 42Ml/d, due to increased deterioration of the old WTP, and this was managed by increasing supply to our strategic reservoirs from Ballymore Eustace WTP and Leixlip WTP. Construction of the new Vartry

WTP is now complete and we are currently in the process of commissioning the plant. Once the new Vartry WTP is operational we can increase our supply to Stillorgan from the Vartry WTP to 75Ml/d

Example 2

On the 4th November 2019, Leixlip supply was put on a precautionary Boil Water Notice due to deterioration in raw water quality in the River Liffey following a heavy rainfall event. This resulted in increased organic load entering the plant, exceeding removal capacity in the processes leading to an increase in the turbidity (cloudiness) of the treated water. The Boil Water Notice was in place until 12 November 2019.

During this period IW endeavoured to reduce output at Leixlip WTP with the objective of;

- reducing the impact of the boil water notice by reducing the number of customers supplied from Leixlip, and
- reducing the risk of non-compliant water leaving the WTP by reducing the pressure on the WTP.

To facilitate this, output at Ballymore Eustace WTP was increased by an average of 28 Ml/d, to its maximum capacity, over the 6 day period. As Vartry WTP and Ballyboden was already operating at max capacity during this period no further increase in output could be provided by these plants. The other WTPs in the GDA are currently unable to provide supply to the strategic reservoirs.*

Therefore, the reduction in supply from Leixlip WTP was limited to 28Ml/d. Further analysis of the event indicates if we had been in a position to sustainably reduce output from Leixlip WTP by 45Ml/d we would have been able to significantly reduce the impact of the boil water notice to our customers and we could have potentially avoided the requirement of this boil water notice.

*Once the network improvement works at the Srowland WTP are complete we will be able to transfer some supply from Srowland to Saggart Reservoir.

These examples illustrate the requirement of another large source of treated water for the GDA with the ability to transfer water to our strategic reservoirs. While small WTPs on the outskirts of the GDA can provide supply to customers locally, thus reducing demand on our large WTPs, such options will not increase the resilience of the overall supply as there will be significant challenges transferring small quantities of water over long distances to our strategic reservoirs. Another disadvantage of a combination of small options, is that the unit costs of production of treated water within these small supplies are also significantly greater than the large supplies.

These examples also illustrate the requirement for spare capacity in supply and demonstrate why we apply an outage allowance in our supply demand balance. The outage allowance is critical to

ensure there is enough supply in the system to provide a 1 in 50 level of service to our customers and reduce the risk of a boil water notice or a water outage.

4 Option Development SA9

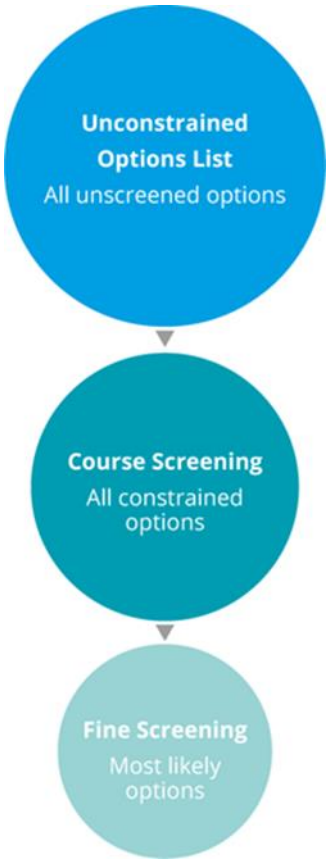
4 Option Development for Study Area 9

This chapter describes how our options assessment methodology was applied to produce a Feasible Options list to meet the identified needs.

The purpose of our options assessment process, as outlined in Chapter 8 of the Framework Plan, is to consider the widest practicable range of solutions to resolve identified need within a given area. A screening criterion is then applied to filter out any options that are not feasible, based on sustainability (environmental and social impacts), resilience or deliverability. As sustainability is at the heart of our plan, environmental and social assessment criteria are included at the earliest stages of the screening process. At the outset of the process, some fundamental rules are applied even before screening begins to ensure the protection of the environment. For example, having regard to WFD objectives, Irish Water does not allow for any inter-catchment raw water transfers due to the high risk of transferring invasive non-native species (INNS) between catchments and with WFD objectives.

The options assessment screening process involves the following:

- Developing a long list of unconstrained options – Unconstrained Options constitute all of the possible solutions, which either fully or partly resolve a water supply deficit, regardless of any cost, environmental or social constraints. In developing the Unconstrained List, we identify options that are applicable to meet the needs of the study area;
- Coarse Screening – We filter the unconstrained options using a coarse screening assessment where we remove any options that fail to meet desktop assessment criteria under: Resilience, Deliverability and Flexibility or Sustainability (Environmental and Social Impacts); and
- Fine Screening – We filter the remaining options from the coarse screening exercise through a fine screening assessment, which includes 33 detailed questions, related to environmental objectives identified for the SEA (including biodiversity, the water environment and requirements under climate change adaptation) as well as Resilience, Deliverability and Progressibility.



The coarse screening and fine screening questions, and the associated scoring criteria, are included in Chapter 3 and Appendix A of the Study Area Environmental Report.

4.1 Developing a List of Unconstrained Options

At the start of our screening process, we conduct a specialist desktop review of groundwater bodies and surface water catchments. This allows us to understand potential additional availability at existing water abstractions or to identify any potential new water sources within the Study Area, as summarised in Table 4.1.

Table 4.1 Desktop Assessments for Unconstrained Options

Existing and New Ground Water sources	A Hydrogeologist conducts a desktop groundwater availability assessment of all potential aquifers and aquitards within, and within a reasonable distance of, the study area.
Existing and New Surface Water sources and Conjunctive Use Options	A Hydrologist carries out a desktop surface water availability assessment of all potential catchments and waterbodies within, and within a reasonable distance of, the study area.
Water Treatment upgrades, Desalination, Rationalisation and Effluent Reuse Options	An Engineer reviews any potential increases in capacity at existing water treatment sites and any potential conjunctive use or effluent reuse options

Based on these desktop assessments, Irish Water developed an initial list of unconstrained options for new supplies and increases and upgrades to existing supplies and assets. An unconstrained options review workshop was then held with our Local Authority Partners to identify any additional unconstrained options that may be available based on local knowledge. A total list of unconstrained options was then compiled.

For SA9, 106 Unconstrained Options were identified to address need. These unconstrained options were not limited by cost, distance from the area or feasibility. These options are summarised in Table 4.2 and shown spatially in Figure 4.1.

Table 4.2 SA9 Unconstrained Options

No of Options	Option Type
21	Groundwater
34	Surface water
13	Cross Study Area Supply
7	Conjunctive use
11	Desalination plant
10	Waste water re-use
7	Tactical improvements
2	Operational changes
1	Resilience

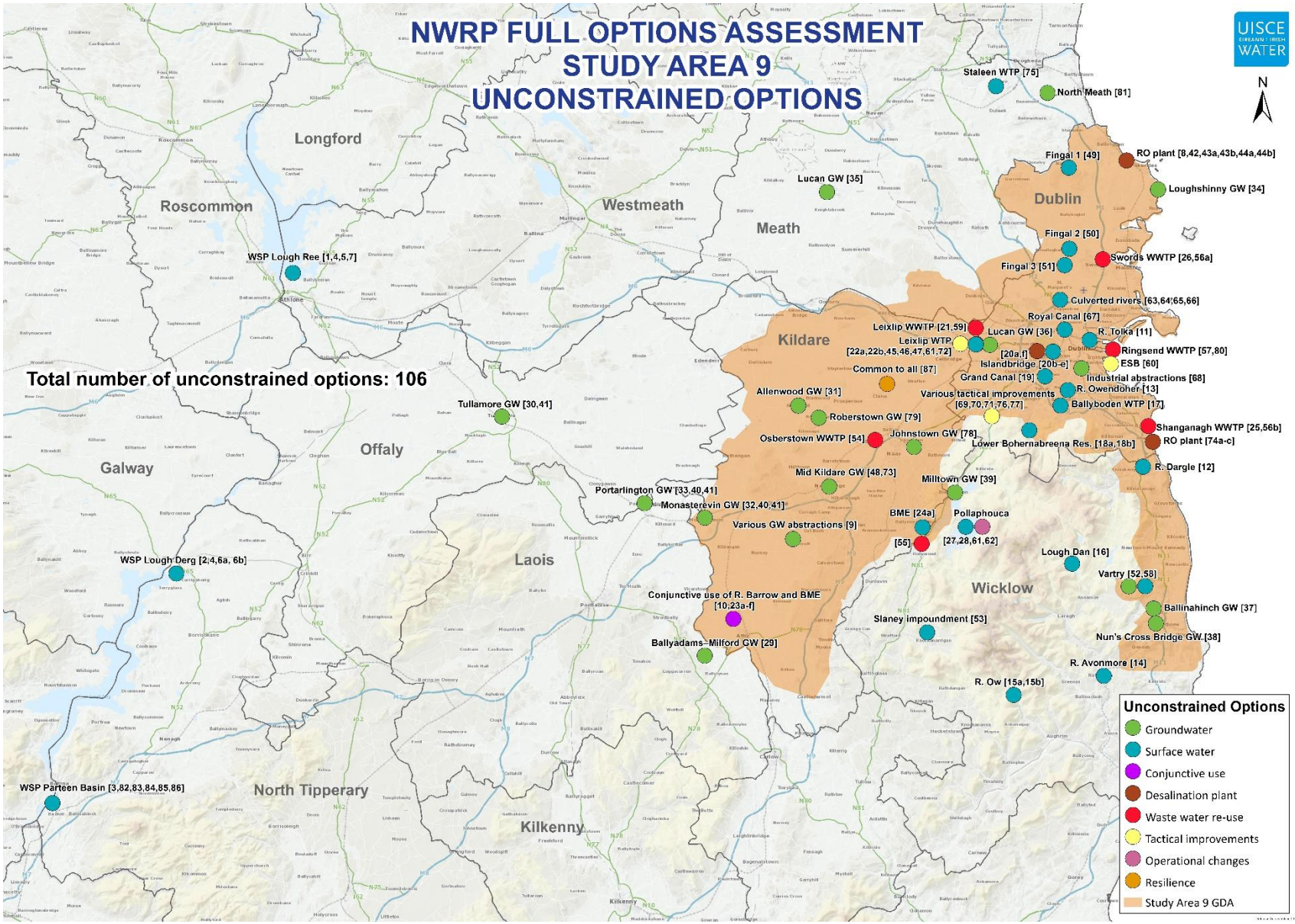


Figure 4.1 SA9 Unconstrained Options

The 106 options were filtered through our screening process to eliminate those with potentially unviable environmental impacts or feasibility issues.

4.2 Coarse Screening

The 106 identified Unconstrained Options were assessed through Coarse Screening against the criteria of:

- Resilience;
- Deliverability and Flexibility;
- Sustainability (Environmental and Social Impacts).

The Coarse Screening process is summarised in Chapter 8 of the Framework Plan. The Coarse Screening assessments were conducted by a specialist team, including Engineers, Hydrologist, Hydrogeologist, Ecologists and Environmental Scientists.

46 Unconstrained Options were rejected at this stage as they were found to be unviable in relation to one or more assessment criteria.

The box below provides an example of a rejection justification for an option considered for the WRZ.

Example Rejected Option

Option A9-16

New Surface Water abstraction from the River Dan. Abstract and treat water from the River Dan in Wicklow before transferring to the GDA. Option proposed to provide 5 Ml/d in WCP

Rejection Reason

Option required the construction of a dam at Lough Dan for the provision of an additional supply of 5 Ml/d. The proposed operational regime would require the pumping of water from the lake to maintain Q95 flow in the channel downstream. The construction of a dam on the waterbody is likely to result in the waterbody not achieving good WFD status. Therefore this option did not meet the requirements of the Environmental, Resilience or Deliverability criteria.

The remaining 60 options were progressed to further assessment through the Fine Screening process. The rejected options are summarised in Annex A of this technical report. Annex A records the criteria against which the rejected options were assessed as having a “red” score for the purposes of the coarse screening exercise (as explained in more detail in Chapter 8 of the Framework Plan), and accordingly were not brought forward at the coarse screening stage. The options remaining after Coarse Screening are summarised by type in Table 4.3.

Table 4.3 SA9 Remaining Options after Coarse Screening

No of Options	Option Type
13	Groundwater
19	Surface water
6	Conjunctive use
7	Cross Study Area Supply
10	Desalination plant
3	Waste water re-use
1	Operational changes
1	Resilience

4.3 Fine Screening

The 60 remaining options were subject to a more detailed multi-criteria assessment (MCA) at the Fine Screening Stage using desktop assessments of performance against 33 specified questions relating to Sustainability (Environmental and Social Impacts), Resilience, Deliverability and Progressibility. These questions are set out in Appendix N of the Framework Plan. The assessment for each option was based on an objective assessment with uniform scoring criteria, based on best publicly available datasets.

At Fine Screening, a further 9 options were rejected based on the more detailed desktop assessments conducted at this screening stage. A summary of the rejected options is included in Annex B of this report. The remaining 51 options are considered to be feasible, based on Plan level assessment, and were brought forward to desktop outline design and costing. These “feasible options” are summarised in Table 4.4 and shown spatially in Figure 4.2.

Table 4.4 SA9 Remaining Options after Fine Screening (Feasible Options)

No of Options	Option Type
9	Groundwater
15	Surface water
7	Cross Study Area Supply
6	Conjunctive use
10	Desalination plant
2	Waste water re-use
1	Operational changes
1	Resilience

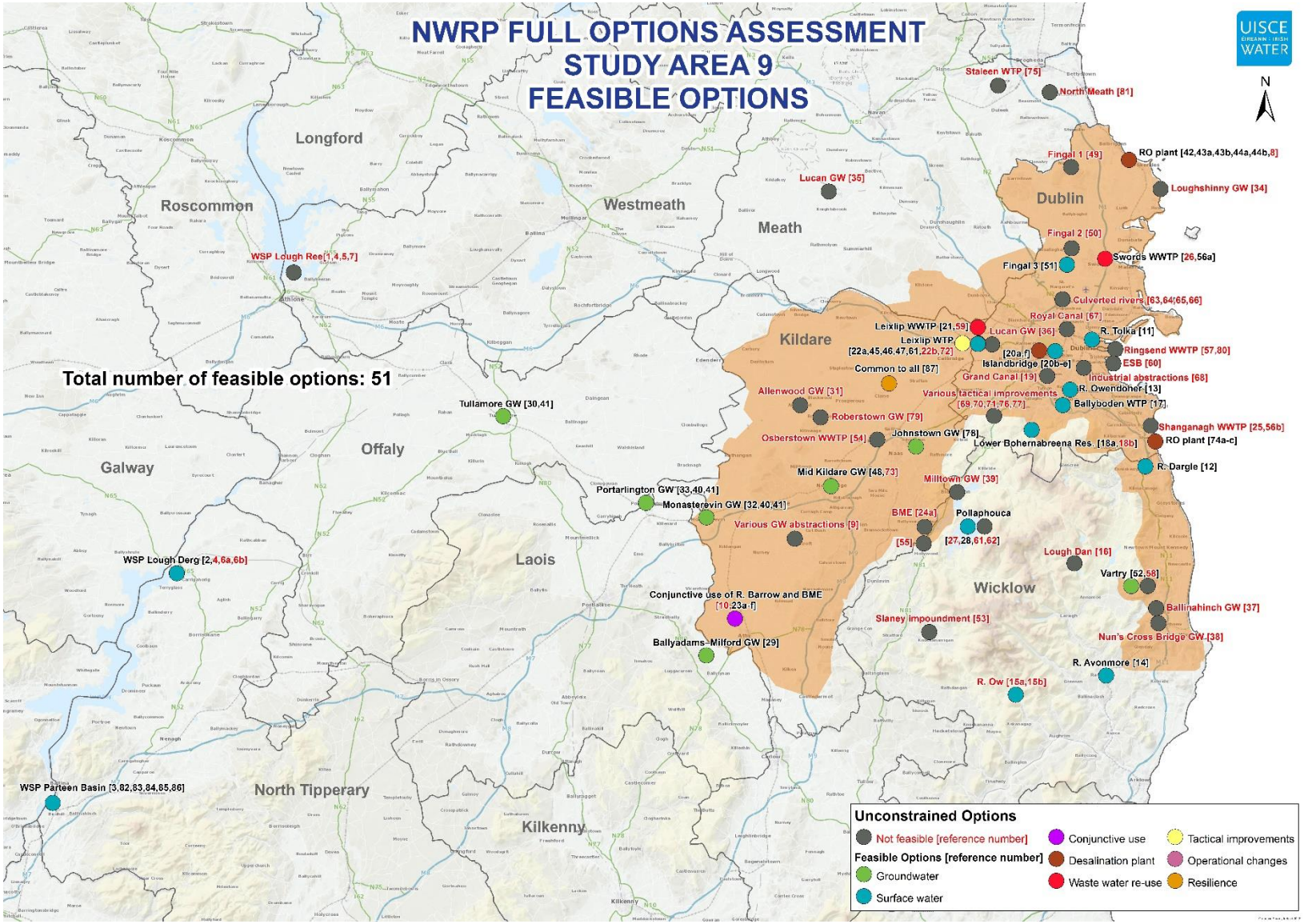


Figure 4.2 SA5 Spatial Overview of the Feasible Options

Of the 51 Feasible Options, only 3 are capable of meeting the deficit in its entirety, and 23 can contribute in excess of 25 Ml/d of additional capacity but not meet the full deficit. These include many options similar in location and concept but varying only in size. 13 of the Feasible Options are only capable of contributing less than 10 Ml/d (<1% of the deficit requirement). This reflects the lack of large feasible and sustainable water resources in the east of the Country. As can be seen in Figure 4.2 there are limited surface water or groundwater options available.

For the purposes of the NWRP, outline designs have been prepared at a desktop level for each feasible option (for use as part of comparative assessments between options). The outline designs include a high level inventory of option requirements, including capacities of plants, pipelines, pumps and treatment requirements. They include comparative budget costs estimates for required site level studies (including site level environmental assessments), Capital (CAPEX), Operational (OPEX), Environmental and Social (E&S) costs and Carbon Costs for use in the next stage of the assessment process.

4.4 Options Assessment Summary

The SDB deficit in the region ranges between approximately 132 Ml/d in 2019 during normal conditions, to a maximum of approximately 194 Ml/d in 2044 during dry conditions. During the options assessment stage, a total of 106 unconstrained options were assessed. Of these, 55 options were screened out for the reasons summarised in Table 4.5 and recorded in Annex B. Some of the options were screened out for multiple reasons. Unlike in other Study Areas, no options have been rejected on the basis of failure to meet the SDB deficit as in this Study Area the deficit is such that there are few options that can meet the deficit in its entirety, and a combination of options is likely to be required. However, a combination which contains a large number of small options is unlikely to be optimal in terms of resilience provided, see section 3.4 of this technical report.

Table 4.5 Rejected Options Summary

No. of Options	Reason for Rejection
3	Sustainability
2	Deliverability & Flexibility
26	Resilience & Deliverability & Flexibility
8	Resilience, Sustainability & Deliverability & Flexibility
16	Repeat Options and Operational Options which did not provide additional supply

The remaining 60 options were taken forward for fine screening. A further 9 options were rejected at fine screening stage as recorded in Annex B. The 51 remaining feasible options were taken forward for further assessment. For the purposes of the NWRP, outline designs have been prepared at a desktop level for each feasible option (for use as part of comparative assessments between options) as described above.

5 Approach Development

5 Approach Development

This chapter describes how we tested different combinations of the Feasible Options to develop a Preferred Approach to meet the needs we identified for the single Water Resource Zone in Study Area 9 Greater Dublin Area.

5.1 Approach Development

5.1.1 Introduction to Approach Development

The purpose of the NWRP is to examine all potential options that could be used to resolve issues within the water resource zone (unconstrained options) and then to eliminate those that are not feasible or that have identifiable environmental issues at a desktop level (options assessment screening). Of the remaining feasible options Irish Water's next step is to assess a number of approaches to resolve need across the Study Area. An approach is a way of configuring an option or options to meet the deficit focused on a particular outcome. For example, a "Least Carbon" approach would be the option or combination of options that would involve the least embodied and operational carbon load over the lifetime of the option. As part of the NWRP, Irish Water considers six approaches, as summarised in Table 5.1.

These six approaches have been outlined at Section 8.3.7 of the Framework Plan and were consulted on as part of the SEA Scoping consultation conducted between 9th November 2017 and 22nd December 2017. These approaches have been specifically chosen to ensure that the NWRP aligns with all the relevant Government Policies outlined in Table 5.1.

Table 5.1 The Six Approaches

Approaches Tested	Description	Policy Driver
Least Cost	Lowest Net Present Value (NPV) cost in terms of Capital, Operational, Environmental and Social and Carbon Costs.	Public Spending Code
Best Appropriate Assessment (AA)	Lowest score against the European Sites (Biodiversity) sub-criteria question: Score = 0 equates to no likely significant effects (LSEs). If, in our opinion, these 0 scoring options meet the deficit/ plan objectives, they are automatically picked as the Preferred Approach. Score = -1 or -2 equates to LSEs that can be addressed with general/standard mitigation measures. Score = -3 equates to LSEs that may be harder to mitigate or require significant project level assessment.	Habitats Directive
Quickest Delivery	Based on an estimate of the time taken to bring an option into operation (including typical feasibility, consent, construction and commissioning durations) as identified at Fine Screening This is particularly relevant where an option might be required to address an urgent Public Health issue.	Statutory Obligations under the Water Supply Act and Drinking

Approaches Tested	Description	Policy Driver
		Water Regulations
Best Environmental	This is the option or combination of options with the highest total score across the 19 No. SEA MCA sub-criteria questions	SEA Directive and Water Framework Directive
Most Resilient	This is the option or combination of options with the highest total score against the resilience criteria.	National Adaptation Framework and Climate Action Plan
Lowest Carbon	This is the option or combination of options with the lowest embodied and operational carbon cost.	Climate Action Plan

We then compare the options identified as the best performing within each of the six approach criteria (Least Cost, Best AA, Lowest Carbon etc.) against each other as outlined in Figure 5.1 to come up with a Preferred Approach that meets the objectives of the Framework Plan and aligns with all relevant Government Policy.

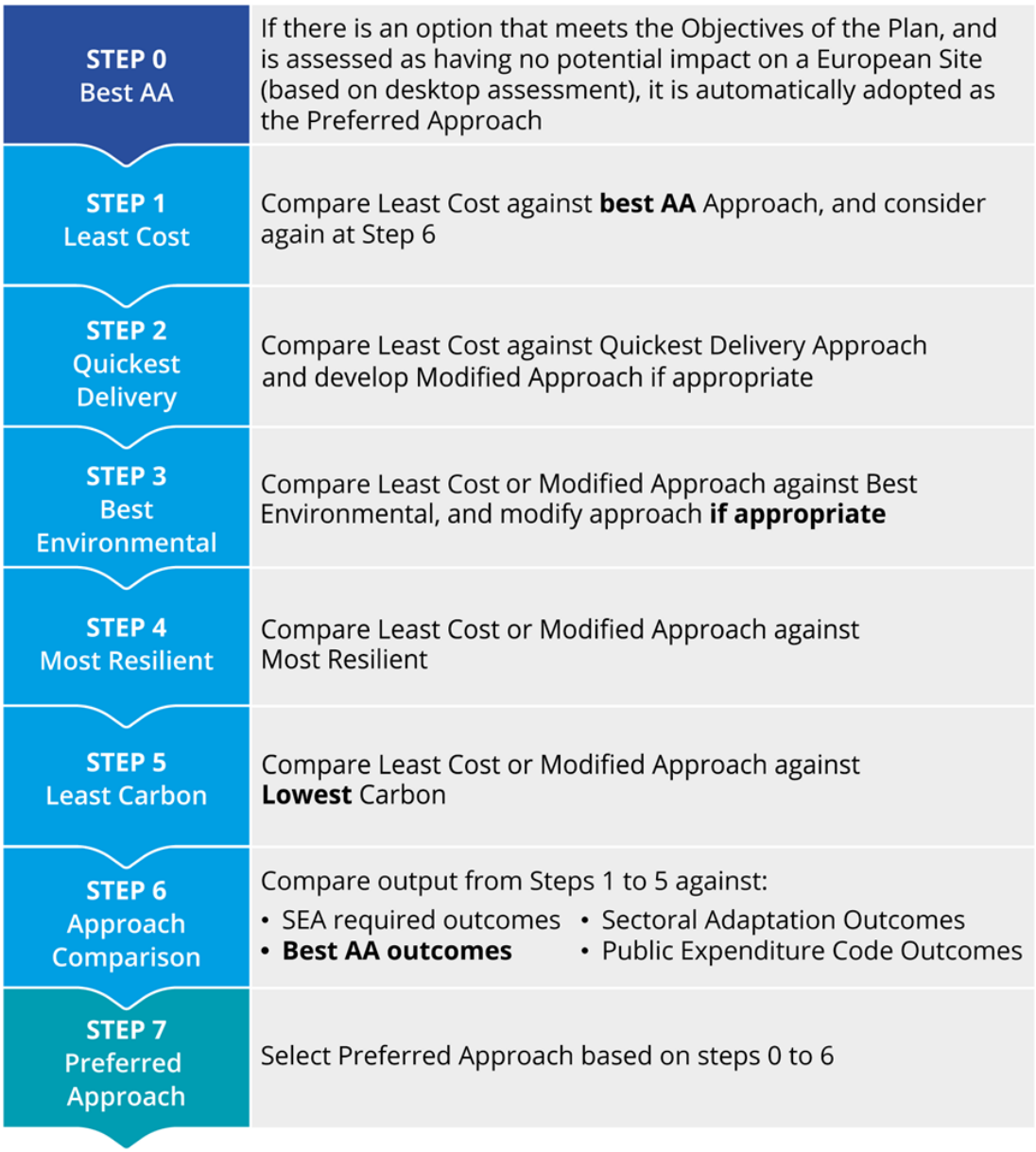


Figure 5.1 Figure of the 7 step assessment process

This methodology which is futured detailed in Chapter 7 of the RWRP -EM follows a process to develop the Preferred Approach for a Study Area across three stages;

- **Stage 1** – We assess the water resource zones individually to develop an initial Preferred Approach, the **WRZ Preferred Approach** for all of the supplies in the Study Area
- **Stage 2** – We assess whether there are any larger options that might resolve deficits across multiple WRZs within a Study Area. We then develop combinations of these options (SA Combinations).
- **Stage 3** – We assess the SA Combinations and the WRZ Level approach in order to determine the best performing combination. This is known as the Preferred Approach at SA Level.

At each stage of assessment as detailed above, we carry out an assessment of the cumulative and in-combination effects of the Preferred Approach as detailed in the SEA Environmental Report for the RWRP-EM and the Environmental Review for this Study Area.

Within Study Area 9 Greater Dublin Area there is only a single water resource zone so we have a single step assessment for the Preferred Approach within the Study Area. However, due to the scale of the deficit that needs to be resolved, the Approaches must consider combinations of individual Feasible Options.

5.2 Preferred Approach Development Process for Study Area 9

5.2.1 Stage 1 – WRZ Level Approach

As outlined in Section 4.4 of this technical report there are 51 feasible options. Table 5.2 outlines the 51 WRZ options for SA9, providing option reference numbers and detailing the estimated volume of supply they can provide. These solutions are presented as "Options" for the purposes of this plan; however, will be subject to their own regulatory, timing and budgetary constraints.

Note many of these options consider transfer of supply from outside the GDA for example SA9-81 provides supply to the GDA from a WRZ in Study Area 3.

Table 5.2 SA9 Feasible Options

Option Code	Feasible Options SA9 Greater Dublin Area Option Description	Approx. Additional Supply Ml/d
SA9-02	Option B from the Water Supply Options Working Paper.[2] A constant abstraction design concept. It involves abstraction and treatment on the eastern shore of Lough Derg, followed by approx 122km treated water transfer, in a configuration which could supply treated water to other communities on route.[3]	330
SA9-03	Option C from the Water Supply Options Working Paper[2] . A constant abstraction design concept. It involves abstraction and treatment shore of Parteen Basin Reservoir, followed by approx 165km treated water transfer, in a configuration which could supply treated water to other communities on route.	330
SA9-11	New SW abstraction from the River Tolka and new WTP	3
SA9-12	New SW abstraction from the River Dargle and new WTP	5
SA9-13	New SW abstraction from the River Owendoher and raw water transfer to Ballyboden WTP	2
SA9-14	New SW abstraction from the River Avonmore and new WTP	10
SA9-17	Rehabilitation of existing Ballyboden WTP	3
SA9-18a	Rehabilitation of existing Ballyboden WTP and de-silting of the existing Bohernabreena Lower Raw water reservoir to gain an additional yield	5

[2] [2] Water Supply Project Eastern and Midlands Region, Water Supply Options Working Paper, June 2015 - http://www.watersupplyproject.ie/wp-content/uploads/2015/05/150525WSP1_Options-Working-Paper_A011.pdf

[3] While this options is considered feasible at plan level. The Water Supply Project Eastern and Midlands Region Final Options Appraisal Report (FOAR), November 2016, confirmed (based on the results of Hydrodynamic Modelling) that the modelled abstractions from Lough Derg would have a significant impact on lake residence times* in prolonged dry summer conditions. The Lough Derg abstraction options were therefore considered, through project-level assessment, to have a high likelihood of significant impact on the aquatic ecology of the Lough, compromising the ability of those options to comply with the Habitats Directive. *A lake residence time is the amount of time taken for water (or some dissolved substance) introduced into a lake to flow out of it again, and is especially important in managing pollutants.

Option Code	Feasible Options SA9 Greater Dublin Area Option Description	Approx. Additional Supply Ml/d
SA9-20a	New 40 Ml/d abstraction from R.Liffey at Islandbridge downstream of the weir. The water at this location is brackish therefore the options also includes the provision of a Desalination Plant . Desalinated water to be distributed to Saggart reservoir for blending.	40
SA9-20b	New 20 Ml/d abstraction from R.Liffey at Islandbridge upstream of the weir. Option includes a new WTP at the site.	20
SA9-20c	New 20 Ml/d abstraction from R.Liffey at Islandbridge upstream of the weir. The 20 Ml/d raw water is proposed to be piped for treatment at Leixlip WTP.	20
SA9-20d	New 50 Ml/d abstraction from R.Liffey at Islandbridge upstream of the weir. Option includes a new WTP at the site. As the abstraction is greater than the environmental allowable abstraction at this location it is proposed to discharge treated wastewater from Ringsend WwTP directly downstream of the abstraction. Therefore a pipeline from Ringsend WwTP is also required as part of this option.	50
SA9-20e	New 50 Ml/d abstraction from R.Liffey at Islandbridge upstream of the weir. The 50 Ml/d raw water is proposed to be piped for treatment at Leixlip WTP. As the abstraction is greater than the environmental allowable abstraction at this location it is proposed to discharge treated wastewater from Ringsend WwTP directly downstream of the abstraction. Therefore a pipeline from Ringsend WwTP is also required as part of this option.	50
SA9-20f	New 40 Ml/d abstraction from R.Liffey at Islandbridge downstream of the weir. The water at this location is brackish therefore the options also includes the provision of a Desalination Plant. Desalinated water to be distributed to Ballycoolen reservoir for blending.	40
SA9-21	This option proposed to increase supply to the WRZ by effluent re-use form Leixlip WWTP for Non-Domestic Industrial use offsetting 15 Ml/d of potable water to be supplied to the GDA.	15
SA9-22a	This option proposed to increase supply to the WRZ by an increase of 20 Ml/d in the existing surface water abstraction from the River Liffey at Leixlip. The new abstraction will be offset by re-circulation of treated effluent from Leixlip WWTP to an outfall d/s of the abstraction which will require approximately 1.2km of new/upgraded network.	20
SA9-23a	This option proposes to increase the deployable output by 12 Ml/d, by increasing the existing surface water abstraction from the River Barrow at Srowland by 12 Ml/d during Winter Months conjunctive use with Ballymore Eustace WTP when there are periods of low flow within the River Barrow.	12
SA9-23b	This option proposes to increase the deployable output by 22 Ml/d, by increasing the existing surface water abstraction from the River Barrow at Srowland by 22 Ml/d during Winter Months conjunctive use with Ballymore Eustace WTP when there are periods of low flow within the River Barrow.	22
SA9-23c	This option proposes to increase the deployable output by 37 Ml/d, by increasing the existing surface water abstraction from the River Barrow at Srowland by 37 Ml/d during Winter Months conjunctive use with Ballymore Eustace WTP when there are periods of low flow within the River Barrow.	37
SA9-23d	This option proposes to increase the deployable output by 12 Ml/d, by increasing the existing surface water abstraction from the River Barrow at Srowland by 12 Ml/d during Winter Months conjunctive use with Ballymore Eustace WTP when there are periods of low flow within the River Barrow. This option also allows for bankside storage.	12
SA9-23e	This option proposes to increase the deployable output by 37 Ml/d, by increasing the existing surface water abstraction from the River Barrow at Srowland by 22 Ml/d during Winter Months conjunctive use with Ballymore Eustace WTP when there are periods of low flow within the River Barrow. This option also allows for bankside storage.	37
SA9-23f	This option proposes to increase the deployable output by 62 Ml/d, by increasing the existing surface water abstraction from the River Barrow at Srowland by 62 Ml/d during Winter Months conjunctive use with Ballymore Eustace WTP when there are periods of low flow within the River Barrow. This option also allows for bankside storage.	62
SA9-28	This option proposed to increase supply to the WRZ by an upgrade to Leixlip WTP and optimisation of operating regime of Poulaphouca Reservoir in agreement with ESB. The option includes approximately 24.5km of new/upgraded network to allow for the additional supply. note	70

Option Code	Feasible Options SA9 Greater Dublin Area Option Description	Approx. Additional Supply Ml/d
	this option in only feasible in the winter critical period and during a normal year event and will not provide additional supply in a DYCP event.	
SA9-29	New Wellfield at Ballyadams - Milford (7 BHs; 3 Ml/d)	3
SA9-30	New Wellfield at Tullamore (6 BHs; 3 Ml/d)	3
SA9-32	New Wellfield at Monasterevin (7 BHs; 5 Ml/d)	5
SA9-33	New Wellfield at Portalington (7 BHs; 5 Ml/d)	5
SA9-40	New Wellfield at Monasterevin (7 BHs; 5 Ml/d) & Portalington (7 BHs; 5 Ml/d)	10
SA9-41	New Wellfield at Monasterevin (7 BHs; 5 Ml/d), Tullamore (6 BHs; 3 Ml/d) & Portalington (7 BHs; 5 Ml/d)	13
SA9-42	This option proposed to increase supply to the WRZ by a new abstraction from the Irish Sea near Balbriggan. The option includes a new desalination WTP, new balancing storage reservoir, new/upgraded pumps, brine return outfall and approximately 35km of new/upgraded network to allow for the transfer of the new supply for blending at Ballycoolen Reservoir.	50
SA9-43a	This option proposed to increase supply to the WRZ by a new abstraction from the Irish Sea near Balbriggan. The option includes a new desalination WTP, new balancing storage reservoir, new/upgraded pumps, brine return outfall and approximately 35km of new/upgraded network to allow for the transfer of the new supply for blending at Ballycoolen Reservoir.	100
SA9-43b	This is the same as option 43a, however, the trunk mains take a different route.	100
SA9-44a	This option proposed to increase supply to the WRZ by a new abstraction from the Irish Sea near Balbriggan. The option includes a new desalination WTP, new balancing storage reservoir, new/upgraded pumps, brine return outfall and approximately 35km of new/upgraded network to allow for the transfer of the new supply for blending at Ballycoolen Reservoir.	150
SA9-44b	This is the same as option 44a, however, the trunk mains take a different route.	150
SA9-45	Leixlip WTP Upgrade - +30 Ml/d – note this option in only feasible in the winter critical period and during a normal year event and will not provide additional supply in a DYCP event.	30
SA9-46	Leixlip WTP Upgrade - +50 Ml/d – note this option in only feasible in the winter critical period and during a normal year event and will not provide additional supply in a DYCP event.	50
SA9-47	Leixlip WTP Upgrade - +75 Ml/d – note this option in only feasible in the winter critical period and during a normal year event and will not provide additional supply in a DYCP event.	75
SA9-48	2No. Wellfields in Mid-Kildare (8 Ml/d): Curragh Camp (4 Ml/d) & Clownings (4 Ml/d)	8
SA9-51	Impoundment in Fingal for local supply (3 Ml/d)	3
SA9-52	Vartry Tunnel Infiltration.The options includes the provision of a WTP to treat the ground water obtained from the tunnel.	3
SA9-56a	This option proposed to increase supply to the WRZ by effluent re-use form Swords WWTP for Non Domestic Industrial use offsetting 10 Ml/d of water to be supplied to the GDA.	10
SA9-74a	This option proposed to increase supply to the WRZ by a new abstraction from the Irish Sea near Dalkey. The option includes a new desalination WTP, new balancing storage reservoir, new BPT, new/upgraded pumps, brine return outfall and approximately 27km of new/upgraded network to allow for the transfer of the new supply to Saggart & Stillorgan Reservoirs.	50
SA9-74b	This option proposed to increase supply to the WRZ by a new abstraction from the Irish Sea near Dalkey. The option includes a new desalination WTP, new balancing storage reservoir, new BPT, new/upgraded pumps, brine return outfall and approximately 27km of new/upgraded network to allow for the transfer of the new supply to Saggart & Stillorgan Reservoirs.	100
SA9-74c	This option proposed to increase supply to the WRZ by a new abstraction from the Irish Sea near Dalkey. The option includes a new desalination WTP, new balancing storage reservoir, new BPT, new/upgraded pumps, brine return outfall and approximately 27km of new/upgraded network to allow for the transfer of the new supply to Saggart & Stillorgan Reservoirs.	150

Option Code	Feasible Options SA9 Greater Dublin Area Option Description	Approx. Additional Supply Ml/d
SA9-78	New Wellfield at Johnstown (7 BHs; 4 Ml/d)	4
SA9-82	This option proposed to increase supply to the WRZ by a new Surface Water abstraction of 157.5 Ml/d from The Parteen Basin. The option also includes a new WTP at Birdhill with an output capacity of 150 Ml/d. Twin rising mains from abstraction to WTP (2km), A new Break pressure tank, 2 clear water tanks, new pumping station, new termination point reservoir in Peamount. The supply will be transferred approximately 41km from the WTP to the break pressure tank via a new 1600mm pumped pipeline, from the break pressure tank the supply will flow by gravity 130km into the termination point reservoir via a new 1600mm pipeline.	150
SA9-83	This option proposed to increase supply to the WRZ by a new Surface Water abstraction of 178.5 Ml/d from The Parteen Basin. The option also includes a new WTP at Birdhill with an output capacity of 170 Ml/d. Twin rising mains from abstraction to WTP (2km), A new Break pressure tank, 2 clear water tanks, new pumping station, new termination point reservoir in Peamount. The supply will be transferred approximately 41km from the WTP to the break pressure tank via a new 1600mm pumped pipeline, from the break pressure tank the supply will flow by gravity 130km into the termination point reservoir via a new 1600mm pipeline.	170
SA9-84	This option proposed to increase supply to the WRZ by a new Surface Water abstraction of 194 Ml/d from The Parteen Basin. The option also includes a new WTP at Birdhill with an output capacity of 185 Ml/d. Twin rising mains from abstraction to WTP (2km), A new break pressure tank and 2 clear water tanks, new pumping station & booster pumping station, new termination point reservoir in Peamount. The supply will be transferred approximately 41km from the WTP to the break pressure tank via a new 1600mm pumped pipeline, From the break pressure tank the supply will flow by gravity for the first 170Ml/d and pumped when demand goes above 170Ml/d. The pipeline from the Break pressure tank to the termination point reservoir will be 1600mm diameter with an approximate length of 130km.	185
SA9-85	This option includes a 35 Ml/d upgrade of option SA9 -82	35
SA9-86	This option includes a 35 Ml/d upgrade of option SA9 -83	35
SA9-87	Common to all Requirements.	

Option SA9-87 is a group of interventions required to improved resilience and quality, regardless of the Preferred Approach selected to address the SDB deficit* and includes;

- An upgrade to all WTPs in the WRZ to meet the requirements of the Drinking Water Safely Plan.
- Rationalisation of Glenealy and Roundwood Well WTPs
- New Storage and network in North Wicklow, Bray & Environs and Howth;
- New Storage at Saggart (Works have commenced);
- Trunkmain upgrades in Swords, Malahide, Donabate, Balbriggan, South City coast (Merrion Gates), North City coast and Wicklow;
- Pumps upgrade at Leixlip WTP to delivery an increased supply and network improvements in North Kildare and,
- Delivery of new bulk transmission main between Ballymore Eustace WTP and Saggart Reservoir facility to address critical reliability and maintenance issues and remove the network capacity constraint between Ballymore Eustace and Dublin
- A new main from one of our strategic reservoirs to provide 30-40Ml/d to the city centre

*Note this group of interventions do not provide additional supply to the GDA.

5.2.2 Stage 2 - Creation of the Study Area Combinations

For this WRZ the Second Stage of our Approach Development Process involves identifying combinations of options that can address the need within the Study Area. These are called SA Combinations. SA Combinations will consist of a number of different projects or option.

Therefore in this Study Area stage 2 is to determine SA combinations of options to resolve the deficit.

The scale and complexity of the GDA WRZ means that there are a large number of combinations of options to be considered. Due to the scale of the deficit that must be resolved (194 Ml/d by 2044) the only Feasible Options that could resolve the SDB deficit as a single project would be a transfer of treated water from the River Shannon at Parteen Basin. An option to provide desalinated water abstracted from the Irish Sea can make a substantial contribution to resolving the deficit but is limited by the requirement to blend this water with local sources.

Note - Desalinated water is low in minerals and can be aggressive to cementitious and metallic materials used in storage, distribution and plumbing and there are also taste issues associated with desalinated water. Therefore, desalinated water is required to be blended with water from local sources prior to entering the distribution network. We have adopted a 2:1 (treated water: desalinated water) blending ratio to ensure protection our existing network. Given the requirement to blend desalinated water with treated water the maximum achievable output from a desalination plant for the Greater Dublin area is 150Ml/d. Therefore, the option of desalination must be considered in combination with other options.

Apart from transfer of treated water from the River Shannon at Parteen Basin and SA combinations containing desalination options with other smaller options, combinations of smaller options to resolve the overall deficit have been considered.

Table 5.3 below provides an overview of combinations considered. Note some options in Table 5.2 are mutually exclusive of other options. For example if a combination contains option SA9-20a where it is proposed to develop a new raw water source and treatment plant at Islandbridge, this combination cannot also include Option SA9-20d, where it is also proposed to develop an abstraction at Islandbridge as the supply will not be available for both options. Similarly option SA9-28 new wellfield at Monasterevin, Tullamore and Portalington is a combination of options SA9-30 new wellfield at Portalington, SA9-32 new wellfield at Monasterevin and SA9-33 new wellfield at Tullamore, therefore no combination could contain option SA9-28 and option SA9-30, option SA9-32 or SA9-33.

Table 2.3 provides an overview of the SDB which shows an estimated dry year critical period deficit rises over the 25-year period. As we are considering combination of options we will consider the profiling of these options to resolve the deficit over time. Profiling the options over a period can reduce costs estimated NPV costs as the operational costs are only assigned over the period that the solution is operational. The SDB for the GDA shows DYCP deficit of 150Ml/d in 2030 and 2035. Therefore, in all combinations we look to resolve the initial 150Ml/d as quickly as possible prior to 2030 and look to resolve the additional 33 Ml/d by 2044.

To inform the Combination development all options were ranked by according to according to NPV per Ml/d additional supply provided. Combination 1 was developed by picking the options with the lowest NPV per Ml/d additional supply provide in succession excluding any options that were mutually exclusive of the options already considered. This combination provides an additional 149Ml/d therefore the option does not provide the complete deficit of 183 Ml/d.

In Combination 2 and 3 the majority of supply is proposed to be provided initially by the provision of 100Ml/d Desal at Ballbriggan (SA9-43a) and combining this with 1 larger option; an additional 50Ml/d supply at Leixlip (SA9- 20e) in Combination 2 and 62 Ml/d at Srowland/BME (SA9- 23f) in Combination 3. The remaining 33Ml/d and 21 Ml/d for combination 2 and 3 respectively is proposed to be resolved with options that provide the lowest NPV per Ml/d additional supply excluding any options that were mutually exclusive to the options already considered.

In Combination 4 and 5 the majority of supply is proposed to be provided initially by the provision of 100Ml/d Desal in South Dublin (SA9-74b) and combining this with 1 larger option; an additional 50Ml/d supply at Leixlip (SA9- 20e) in Combination 4 and 62 Ml/d at Srowland/BME (SA9- 23f) in Combination 5. The remaining 33Ml/d and 21 Ml/d for combination 4 and 5 respectively is proposed to be resolved with options that provide the lowest NPV per Ml/d additional supply excluding any options that were mutually exclusive to the options already considered.

In Combination 6 the majority of supply is proposed to be provided prior initially by the provision of 150Ml/d Desal in Ballbriggan (SA9-44a). The remaining 33Ml/d is to be provided with options that provide the lowest NPV per Ml/d additional supply excluding any options that were mutually exclusive to the options already considered.

Combination 7 is similar to Combination 6 with the only difference that the Desal WTP is located in South Dublin (SA9-74c).

Combination 8 and 9 are variations of Combination 6 and 7 with the majority of the supply 150Ml/d proposed to be provided using desal in Ballbriggan (SA9-44a) in Combination 8 and desal in South Dublin (SA9-74c) in Combination 9. The remaining 33Ml/d is proposed to be provided by one other option; by increasing output at Leixlip (SA9- 20e).

Combination 10,11 and 12 are combination of options which consider a transfer of treated water from the River Shannon at Parteen Basin. Combination 10 looks to resolve the initial 150Ml/d by the provision of the required pipeline and WTP (SA9-82) with the WTP to be upgraded to provide an additional 35 Ml/d output (SA9-85).

Combination 11 looks to resolve the initial 170Ml/d by the provision of the required pipeline and WTP (SA9-83). This option was considered as 170Ml/d is the maximum pipeline capacity that can be provided by gravity over 130km from the break pressure tank to the reservoir at Peaumount. The WTP is to be upgraded to provide an additional 15 Ml/d output (SA9-86).

Combination 12 looks to resolve the total deficit by the provision of the required pipeline and WTP (SA9-84).

Once the SA combinations were completed a review of the options in the combinations was carried out to determine if any additional works were required to ensure the combinations worked and ensure the combinations are comparable to each other.

For SA Combinations 10, 11 and 12 it was determined that a main allowing connectivity from the strategic reservoirs to the city centre was required, Network Upgrade 1 in Figure 5.2.

For SA Combination 1, 2 and 4 , 17 Ml/d additional supply is provided in the area South of the Vartry WTP. As there are a limited number of customers in this area these combinations require 15km trunk main between Callow Hill and Bray to ensure we can utilise the supply, Network Upgrade 2 in Figure 5.2.

Also for SA Combination 1, 2 and 4 11 Ml/d additional supply is provided in the South Kildare area near Srowland WTP. As there are a limited number of customers in this area these combinations require network upgrades to deliver this supply from Srowland WTP via BME to Saggart Reservoir. These upgrades include a pumping station and reservoir upgrade, Network Upgrade 3 in Figure 5.2.

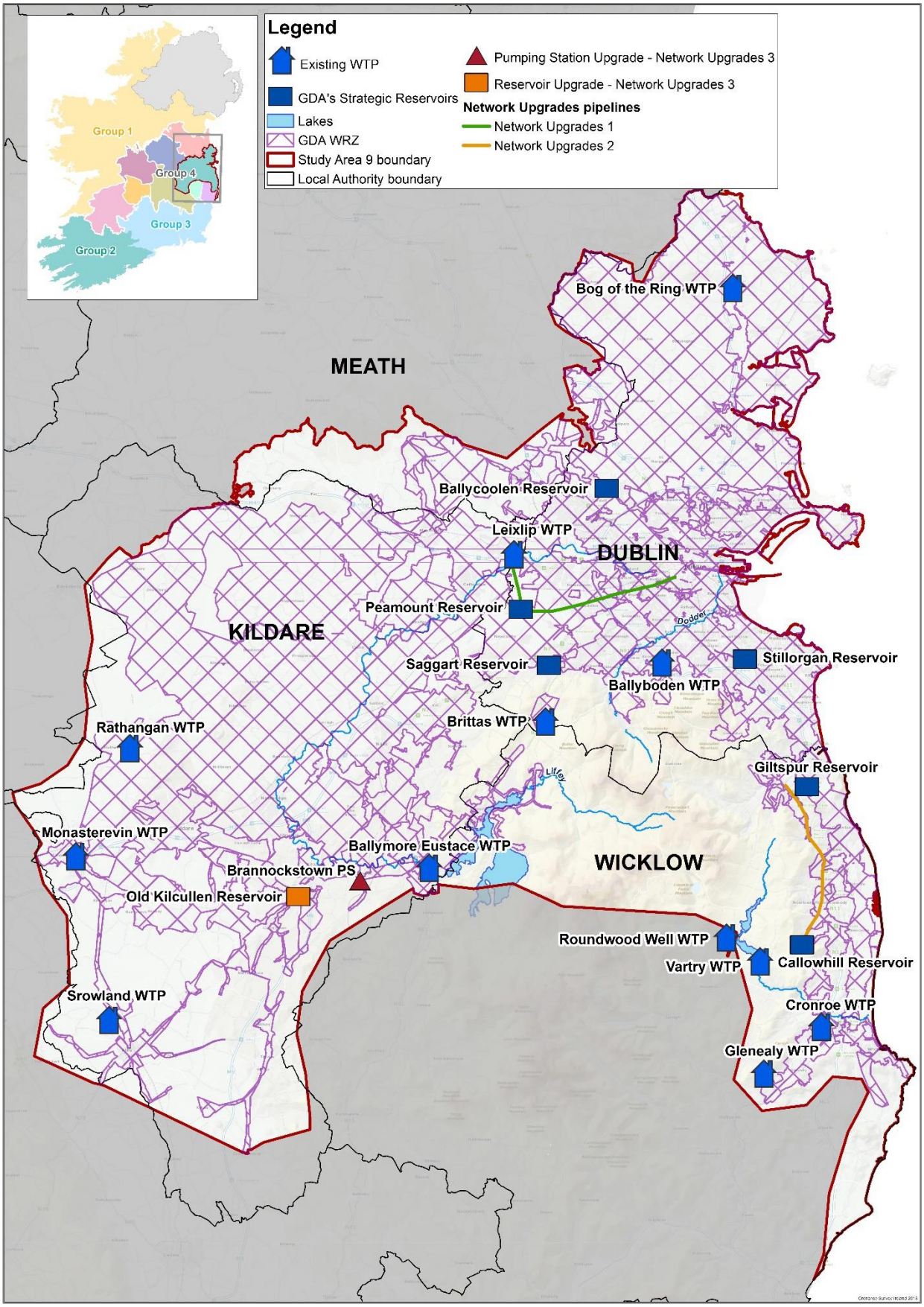


Figure 5.2 Network Upgrades

Combination	Option Code	Water Resource Zone Code	Combination Overview
Combination 1 (Figure 5.3)	SA9-52	Vartry Tunnel Infiltration. The options includes the provision of a WTP to treat the groundwater obtained from the tunnel.	This combination comprises all options which do not include a new source from the River Shannon or the Irish Sea The feasible options were ranked based on the lowest NPV cost per Ml/d additional supply provided. This combination provides an additional 149Ml/d therefore the option does not provide the complete deficit of 183 Ml/d. The combination involves the development of 15 separate projects and requires 9 new ground water abstractions and 5 new surface water abstractions. One of the options, SA9-56a, includes the provision of 10Ml/d treated wastewater effluent for non-domestic use. Non – domestic customers will need to identified for this supply prior to the development of that project.
	SA9-22a	This option proposed to increase supply to the WRZ by an increase of 20 Ml/d in the existing surface water abstraction from the River Liffey at Leixlip. The new abstraction will be offset by re-circulation of treated effluent from Leixlip WWTP to an outfall d/s of the abstraction which will require approximately 1.2km of new/upgraded network.	
	SA9-48	2 new Wellfields in Mid-Kildare (8 Ml/d): Curragh Camp (4 Ml/d) & Clownings (4 Ml/d)	
	SA9-13	New SW abstraction from the River Owendoher and raw water transfer to Ballyboden WTP	
	SA9-12	New SW abstraction from the River Dargle and new WTP	
	SA9-51	Impoundment in Fingal for local supply (3 Ml/d)	
	SA9-11	New SW abstraction from the River Tolka and new WTP	
	SA9-14	New SW abstraction from the River Avonmore and new WTP	
	SA9-17	Rehabilitation of existing Ballyboden WTP	
	SA9-78	New Wellfield at Johnstown (7 BHs; 4 Ml/d)	
	SA9-23f	This option proposes to increases the deployable output by 62 Ml/d, by increasing the existing surface water abstraction from the River Barrow at	

Combination	Option Code	Water Resource Zone Code	Combination Overview
		Srowland by 62 Ml/d during Winter Months conjunctive use with Ballymore Eustace WTP when there are periods of low flow within the River Barrow. This option also allows for bankside storage.	
	TG4-SA9-29	New Wellfield at Ballyadams - Milford (7 BHs; 3 Ml/d)	
	SA9-41	New Wellfield at Monasterevin (7 BHs; 5 Ml/d), Tullamore (6 BHs; 3 Ml/d) & Portalington (7 BHs; 5 Ml/d)	
	TG4-SA9-56a	This option proposed to increase supply to the WRZ by effluent re-use form Swords WWTP for Non Domestic Industrial use offsetting 10 Ml/d of water to be supplied to the GDA.	

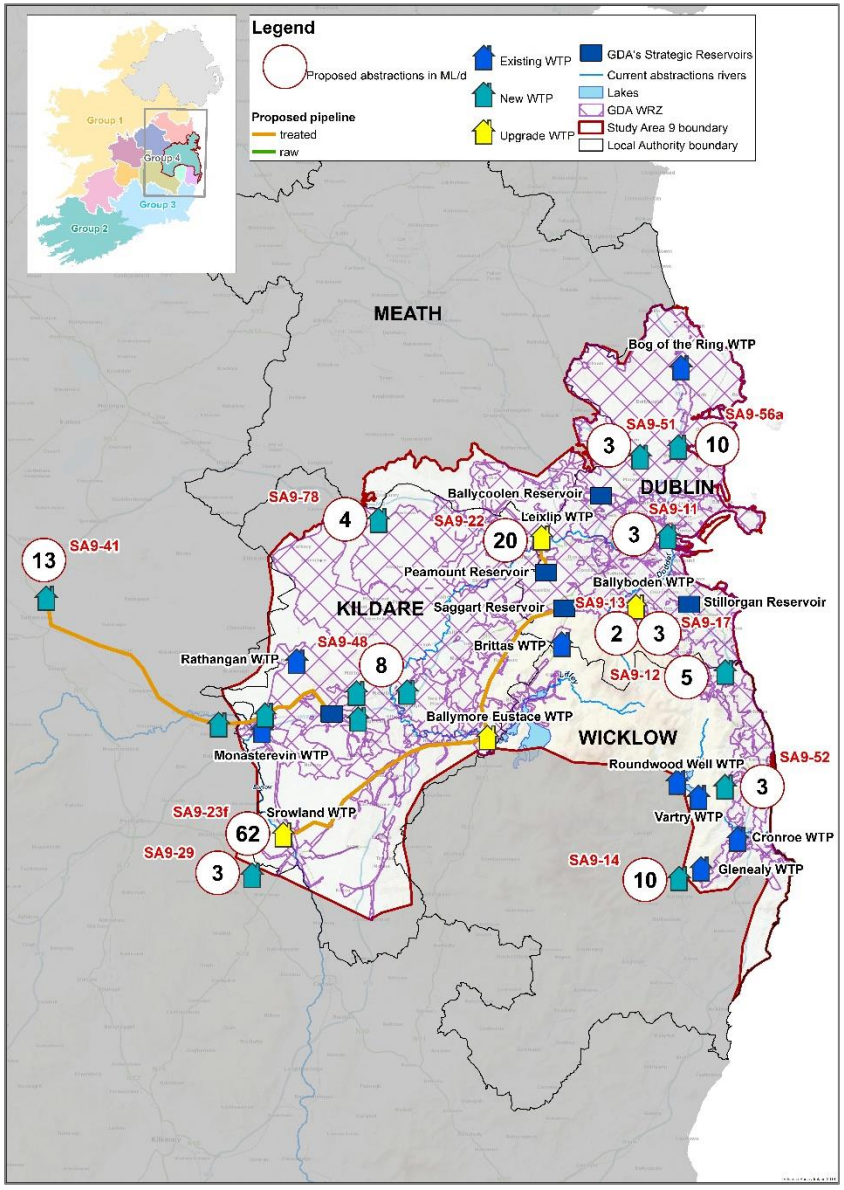


Figure 5.3 Combination 1

Combination 2 (Figure 5.4)	SA9-20e	New 50 Ml/d abstraction from R.Liffey at Islandbridge upstream of the weir. The 50 Ml/d raw water is proposed to be piped for treatment at Leixlip WTP. As the abstraction is greater than the environmental allowable abstraction at this location it is proposed to discharge treated wastewater from Ringsend WwTP directly downstream of the abstraction. Therefore a pipeline from Ringsend WwTP is also required as part of this option.	This combination comprises an option to abstract 50 Ml/d from the River Liffey at Islandbridge and an option to obtain 100 Ml/d from an abstraction from the Irish Sea at a location north of the city. These two options provide an additional 150Ml/d supply. The remaining 33 Ml/d is provided by smaller options. These smaller options were chosen based on cost i.e. options which provide the lowest NPV per Ml required were selected first. The combination involves the development of 9 separate projects and requires 3 new ground water abstractions and 6 new surface water abstractions and 1 abstraction from the Irish Sea.
	SA9-43a	This option proposed to increase supply to the WRZ by a new abstraction from the Irish Sea near Balbriggan. The option includes a new desalination WTP, new balancing storage reservoir, new/upgraded pumps, brine return outfall and approximately 35km of new/upgraded network to allow for the transfer of the new supply for blending at Ballycoolen Reservoir.	
	SA9-52	Vartry Tunnel Infiltration. The options includes the provision of a WTP to treat the groundwater obtained from the tunnel.	
	SA9-48	2 new Wellfields in Mid-Kildare (8 Ml/d): Curragh Camp (4 Ml/d) & Clownings (4 Ml/d)	
	SA9-13	New SW abstraction from the River Owendoher and raw water transfer to Ballyboden WTP	
	SA9-12	New SW abstraction from the River Dargle and new WTP	
	SA9-51	Impoundment in Fingal for local supply (3 Ml/d)	
	SA9-11	New SW abstraction from the River Tolka and new WTP	
	SA9-14	New SW abstraction from the River Avonmore and new WTP	

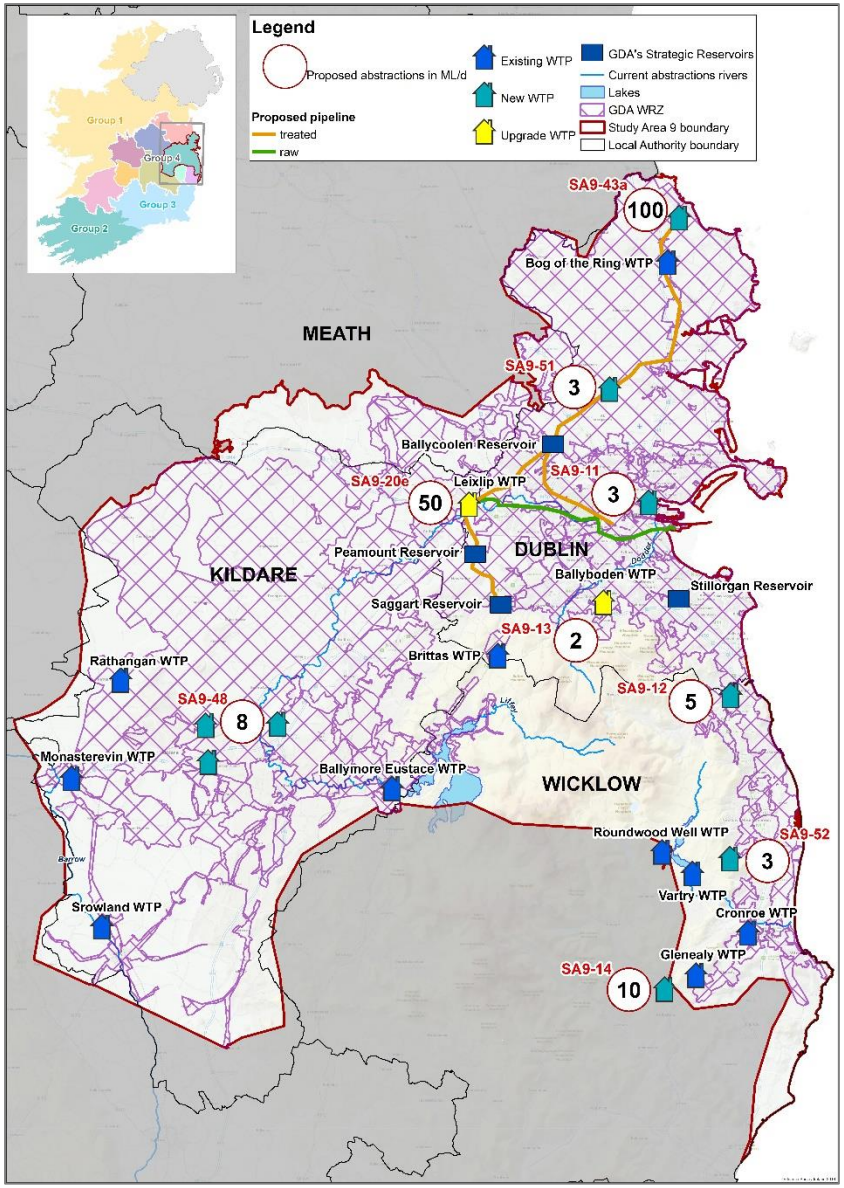


Figure 5.4 Combination 2

Combination 3 (Figure 5.5)	SA9-23f	This option proposes to increases the deployable output by 62 Ml/d, by increasing the existing surface water abstraction from the River Barrow at Srowland by 62 Ml/d during Winter Months conjunctive use with Ballymore Eustace WTP when there are periods of low flow within the River Barrow. This option also allows for bankside storage.	This combination comprises an option which increases the deployable output during dry year critical periods by 62 Ml/d, by conjuctive use between Srowland and the Ballymore Eustace WTP with additional storage at Srowland and an option to obtain 100Ml/d from an abstraction from the Irish Sea at a location North of the City. These two options provide an additional 162Ml/d supply. The remaining 21 Ml/d is provided by smaller options. These smaller options were chosen based on cost i.e. options which provide the lowest NPV per Ml required were selected first. The combination involves the development of 4 separate options and requires 1 new ground water abstractions and 1 abstraction from the Irish Sea.
	SA9-43a	This option proposed to increase supply to the WRZ by a new abstraction from the Irish Sea near Balbriggan. The option includes a new desalination WTP, new balancing storage reservoir, new/upgraded pumps, brine return outfall and approximately 35km of new/upgraded network to allow for the transfer of the new supply for blending at Ballycoolen Reservoir.	
	SA9-52	Vartry Tunnel Infiltration. The options includes the provision of a WTP to treat the groundwater obtained from the tunnel.	
	SA9-22	This option proposed to increase supply to the WRZ by an increase of 20 Ml/d in the existing surface water abstraction from the River Liffey at Leixlip. he new abstraction will be offset by re-circulation of treated effluent from Leixlip WWTP to an outfall d/s of the abstraction which will require approximately 1.2km of new/upgraded network.	

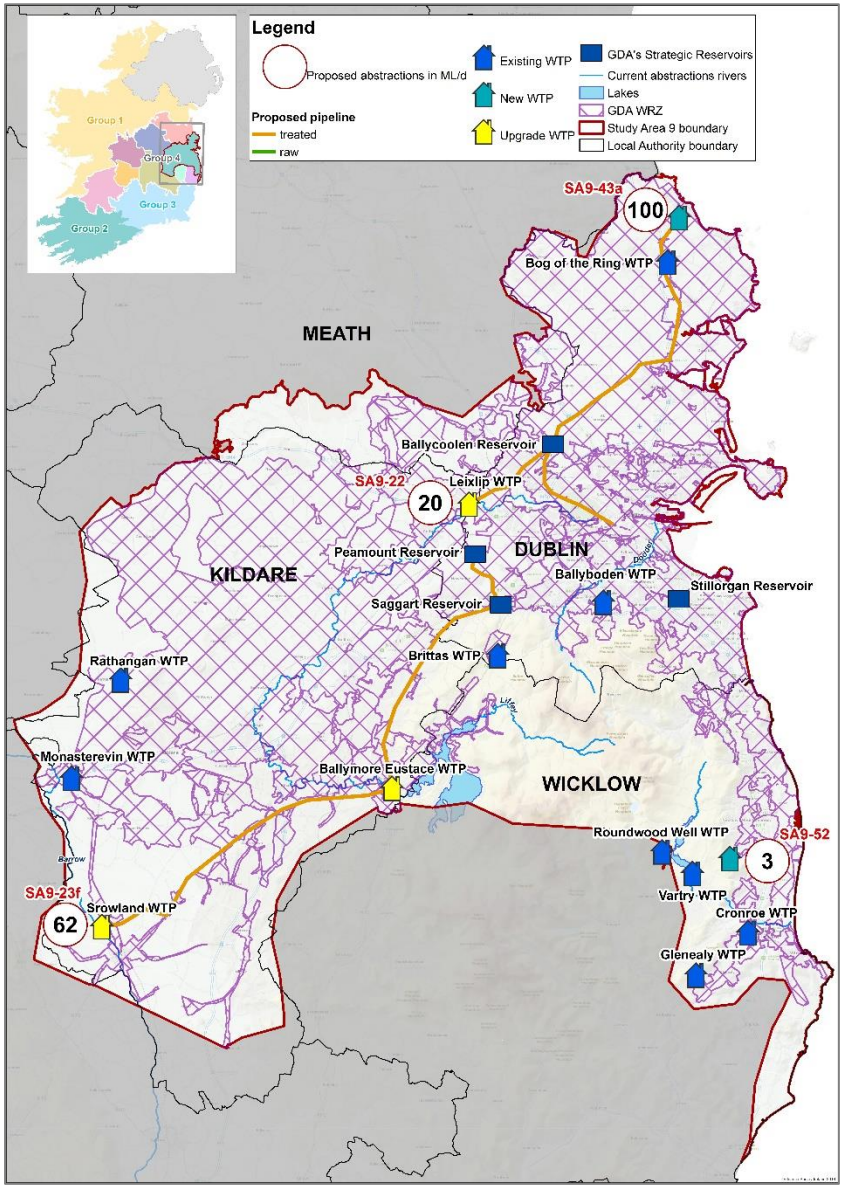


Figure 5.5 Combination 3

Combination 4 (Figure 5.6)	SA9-20e	New 50 Ml/d abstraction from R.Liffey at Islandbridge upstream of the weir. The 50 Ml/d raw water is proposed to be piped for treatment at Leixlip WTP. As the abstraction is greater than the environmental allowable abstraction at this location it is proposed to discharge treated wastewater from Ringsend WwTP directly downstream of the abstraction. Therefore a pipeline from Ringsend WwTP is also required as part of this option.	This combination is similar to combination 2 it comprises an option to abstract 50 Ml/d from the River Liffey at Islandbridge and an option to obtain 100Ml/d from an abstraction from the Irish Sea, however this combination the abstraction from the Irish Sea is at a location South of the city. These two options provide an additional 150Ml/d supply. The remaining 33Ml/d is provided by smaller options. These smaller options were chosen based on cost i.e. options which provide the lowest NPV per Ml required were selected first. The combination involves the development of 9 separate options and requires 3 new ground water abstractions and 6 new surface water abstractions and 1 abstraction from the Irish Sea.
	SA9-74b	This option proposed to increase supply to the WRZ by a new abstraction from the Irish Sea near Dalkey. The option includes a new desalination WTP, new balancing storage reservoir, new BPT, new/upgraded pumps, brine return outfall and approximately 27km of new/upgraded network to allow for the transfer of the new supply to Saggart & Stillorgan Reservoirs.	
	SA9-52	Vartry Tunnel Infiltration. The options includes the provision of a WTP to treat the ground water obtained from the tunnel.	
	SA9-48	2 new Wellfields in Mid-Kildare (8 Ml/d): Curragh Camp (4 Ml/d) & Clownings (4 Ml/d)	
	SA9-13	New SW abstraction from the River Owendoher and raw water transfer to Ballyboden WTP	
	SA9-12	New SW abstraction from the River Dargle and new WTP	
	SA9-51	Impoundment in Fingal for local supply (3 Ml/d)	
	SA9-11	New SW abstraction from the River Tolka and new WTP	
	SA9-14	New SW abstraction from the River Avonmore and new WTP	

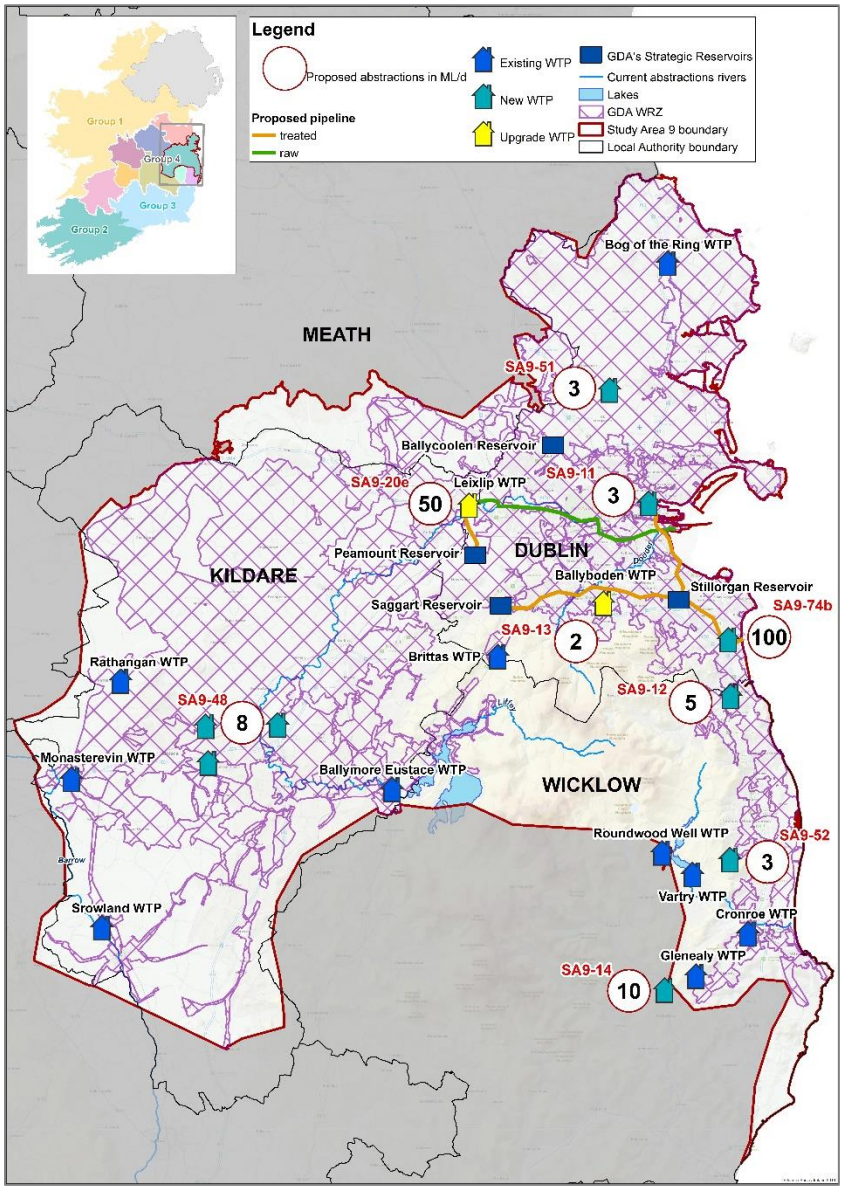


Figure 5.6 Combination 4

Combination 5 (Figure 5.7)	SA9-23f	This option proposes to increases the deployable output by 62 Ml/d, by increasing the existing surface water abstraction from the River Barrow at Srowland by 62 Ml/d during Winter Months conjunctive use with Ballymore Eustace WTP when there are periods of low flow within the River Barrow. This option also allows for bankside storage.	This combination is similar to combination 3. It comprises an option which increases the deployable output during dry year critical periods by 62 Ml/d, by conjuctive use between Srowland and the Ballymore Eustace WTP with additional storage at Srowland and an option to obtain 100Ml/d from an abstraction from the Irish Sea at a location South of the City. These two options provide an additional 162Ml/d supply. The remaining 21 Ml/d is provided by smaller options. These smaller options were chosen based on cost i.e. options which provide the lowest NPV per Ml required were selected first. The combination involves the development of 4 separate projects and requires 1 new ground water abstractions and 1 abstraction from the Irish Sea.
	SA9-74b	This option proposed to increase supply to the WRZ by a new abstraction from the Irish Sea near Dalkey. The option includes a new desalination WTP, new balancing storage reservoir, new BPT, new/upgraded pumps, brine return outfall and approximately 27km of new/upgraded network to allow for the transfer of the new supply to Saggart & Stillorgan Reservoirs.	
	SA9-52	Vartry Tunnel Infiltration. The options includes the provision of a WTP to treat the ground water obtained from the tunnel.	
	SA9-22	This option proposed to increase supply to the WRZ by an increase of 20 Ml/d in the existing surface water abstraction from the River Liffey at Leixlip. he new abstraction will be offset by re-circulation of treated effluent from Leixlip WWTP to an outfall d/s of the abstraction which will require approximately 1.2km of new/upgraded network.	

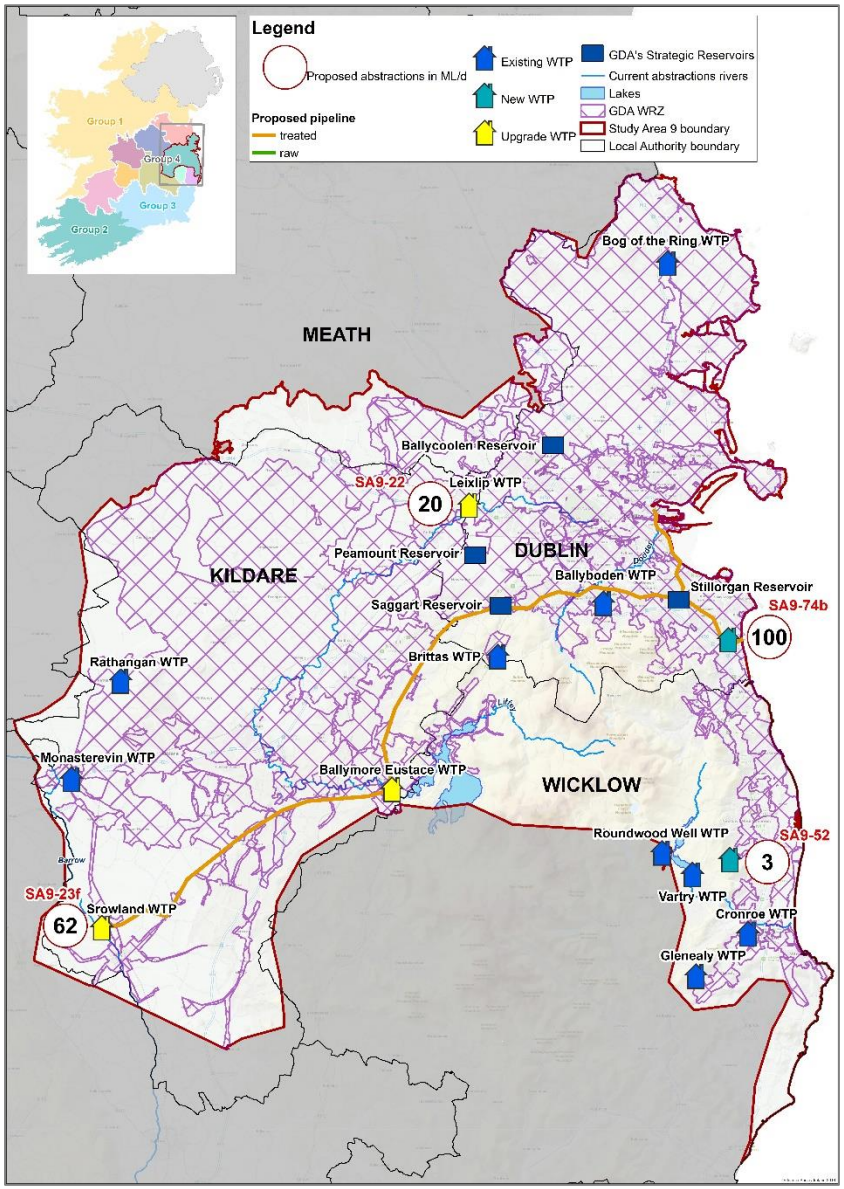


Figure 5.7 Combination 5

Combination 6 (Figure 5.8)	TG4-SA9-44a	This option proposed to increase supply to the WRZ by a new abstraction from the Irish Sea near Balbriggan. The option includes a new desalination WTP, new balancing storage reservoir, new/upgraded pumps, brine return outfall and approximately 35km of new/upgraded network to allow for the transfer of the new supply for blending at Ballycoolen Reservoir.	This combination looks at a larger abstraction from the Irish Sea at a location north of the city to provide an additional 150Ml/d supply. The remaining 33Ml/d is provided by smaller options. These smaller options were chosen based on cost i.e. options which provide the lowest NPV per Ml required were selected first. The combination involves the development of 6 separate projects and requires 2 new ground water abstractions and 3 new surface water abstractions and 1 abstraction from the Irish Sea.
	SA9-52	Vartry Tunnel Infiltration. The options includes the provision of a WTP to treat the ground water obtained from the tunnel.	
	SA9-22a	This option proposed to increase supply to the WRZ by an increase of 20 Ml/d in the existing surface water abstraction from the River Liffey at Leixlip. he new abstraction will be offset by re-circulation of treated effluent from Leixlip WWTP to an outfall d/s of the abstraction which will require approximately 1.2km of new/upgraded network.	
	SA9-48	2 new Wellfields in Mid-Kildare (8 Ml/d): Curragh Camp (4 Ml/d) & Clownings (4 Ml/d)	
	SA9-13	New SW abstraction from the River Owendoher and raw water transfer to Ballyboden WTP	
	SA9-12	New SW abstraction from the River Dargle and new WTP	

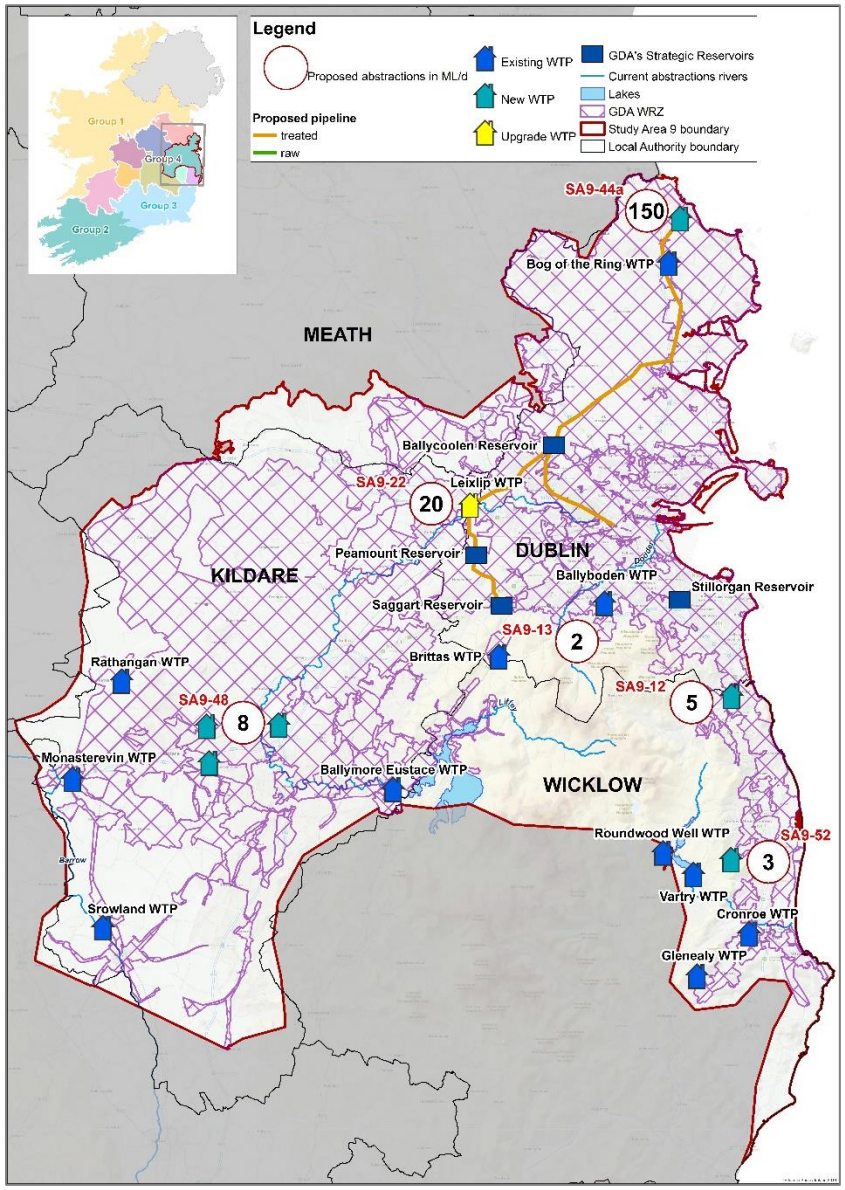


Figure 5.8 Combination 6

Combination 7 (Figure 5.9)	SA9-74c	This option proposed to increase supply to the WRZ by a new abstraction from the Irish Sea near Dalkey. The option includes a new desalination WTP, new balancing storage reservoir, new BPT, new/upgraded pumps, brine return outfall and approximately 27km of new/upgraded network to allow for the transfer of the new supply to Saggart & Stillorgan Reservoirs.	This combination looks at a larger abstraction from the Irish Sea at a location south of the city to provide an additional 150Ml/d supply. The remaining 33Ml/d is provided by smaller options. These smaller options were chosen based on cost i.e. options which provide the lowest NPV per Ml required were selected first. The combination involves the development of 6 separate projects and requires 2 new ground water abstractions and 2 new surface water abstractions and 1 abstraction from the Irish Sea.
	SA9-52	Vartry Tunnel Infiltration. The options includes the provision of a WTP to treat the ground water obtained from the tunnel.	
	SA9-22a	This option proposed to increase supply to the WRZ by an increase of 20 Ml/d in the existing surface water abstraction from the River Liffey at Leixlip. he new abstraction will be offset by re-circulation of treated effluent from Leixlip WWTP to an outfall d/s of the abstraction which will require approximately 1.2km of new/upgraded network.	
	SA9-48	2 new Wellfields in Mid-Kildare (8 Ml/d): Curragh Camp (4 Ml/d) & Clownings (4 Ml/d)	
	SA9-13	New SW abstraction from the River Owendoher and raw water transfer to Ballyboden WTP	
	SA9-12	New SW abstraction from the River Dargle and new WTP	

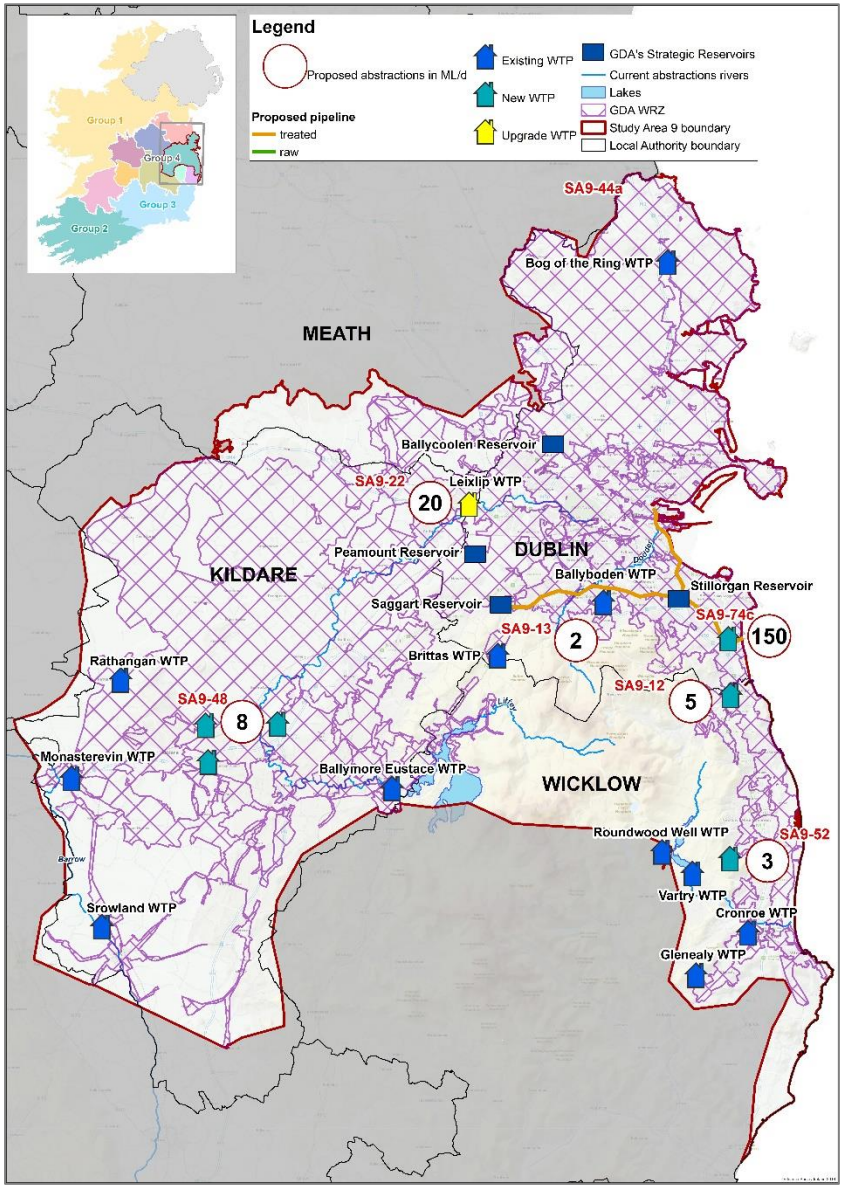


Figure 5.9 Combination 7

Combination 8 (Figure 5.10)	SA9-44a	This option proposed to increase supply to the WRZ by a new abstraction from the Irish Sea near Balbriggan. The option includes a new desalination WTP, new balancing storage reservoir, new/upgraded pumps, brine return outfall and approximately 35km of new/upgraded network to allow for the transfer of the new supply for blending at Ballycoolen Reservoir.	This combination looks to provide the supply required with a combination of a new source from the Irish Sea (100Ml/d) north of the city and a new abstraction from the River Liffey at Islandbridge (50Ml/d). The combination involves the development of 2 separate projects and requires 1 new surface water abstraction and 1 abstraction from the Irish Sea.
	SA9-20e	New 50 Ml/d abstraction from R.Liffey at Islandbridge upstream of the weir. The 50 Ml/d raw water is proposed to be piped for treatment at Leixlip WTP. As the abstraction is greater than the environmental allowable abstraction at this location it is proposed to discharge treated wastewater from Ringsend WwTP directly downstream of the abstraction. Therefore a pipeline from Ringsend WwTP is also required as part of this option.	

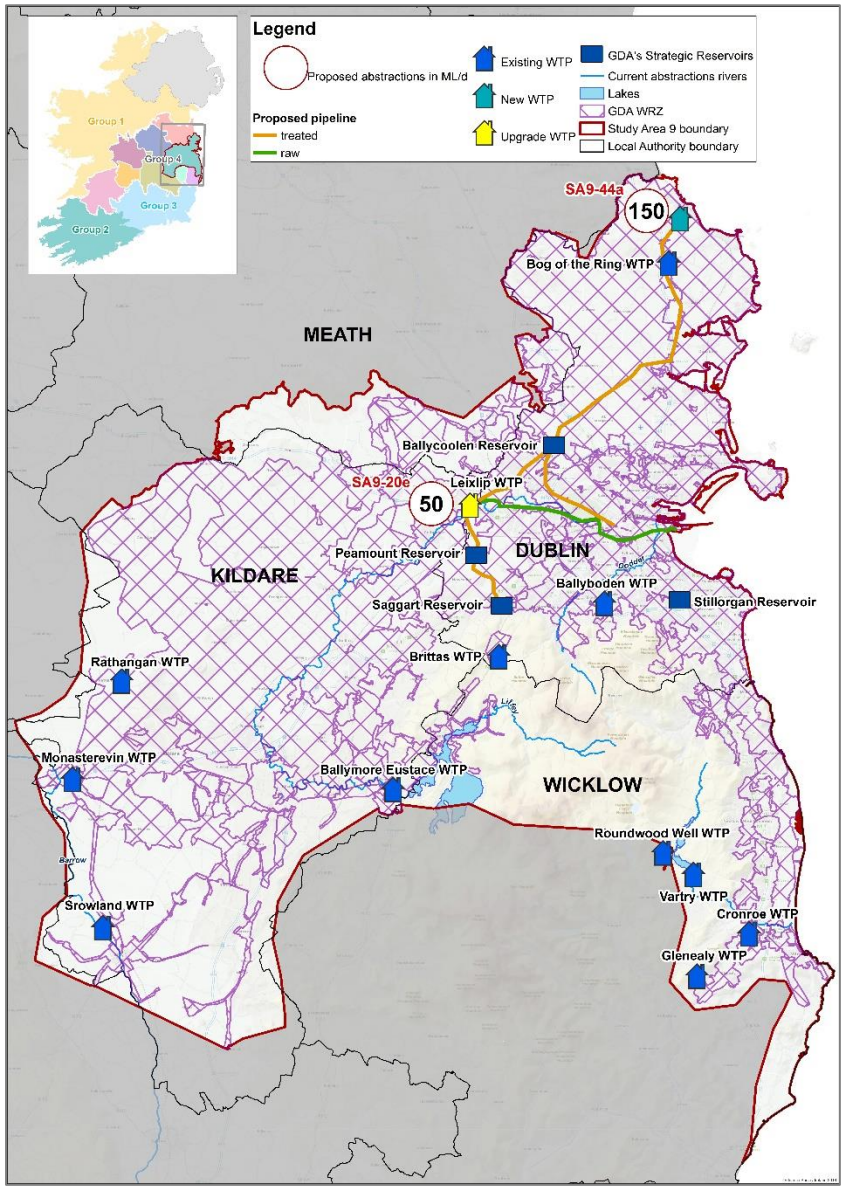


Figure 5.10 Combination 8

Combination 9 (Figure 5.11)	SA9-74c	This option proposed to increase supply to the WRZ by a new abstraction from the Irish Sea near Dalkey. The option includes a new desalination WTP, new balancing storage reservoir, new BPT, new/upgraded pumps, brine return outfall and approximately 27km of new/upgraded network to allow for the transfer of the new supply to Saggart & Stillorgan Reservoirs.	This combination is similar to combination 8 it looks to provide the entire supply required with a combination of a new source from the Irish Sea south of the city (150 Ml/d) and a new abstraction from the River Liffey at Islandbridge (50 Ml/d). The combination involves the development of 2 separate projects and requires 1 new surface water abstraction and 1 abstraction from the Irish Sea.
	SA9-20e	New 50 Ml/d abstraction from R.Liffey at Islandbridge upstream of the weir. The 50 Ml/d raw water is proposed to be piped for treatment at Leixlip WTP. As the abstraction is greater than the environmental allowable abstraction at this location it is proposed to discharge treated wastewater from Ringsend WwTP directly downstream of the abstraction. Therefore a pipeline from Ringsend WwTP is also required as part of this option.	

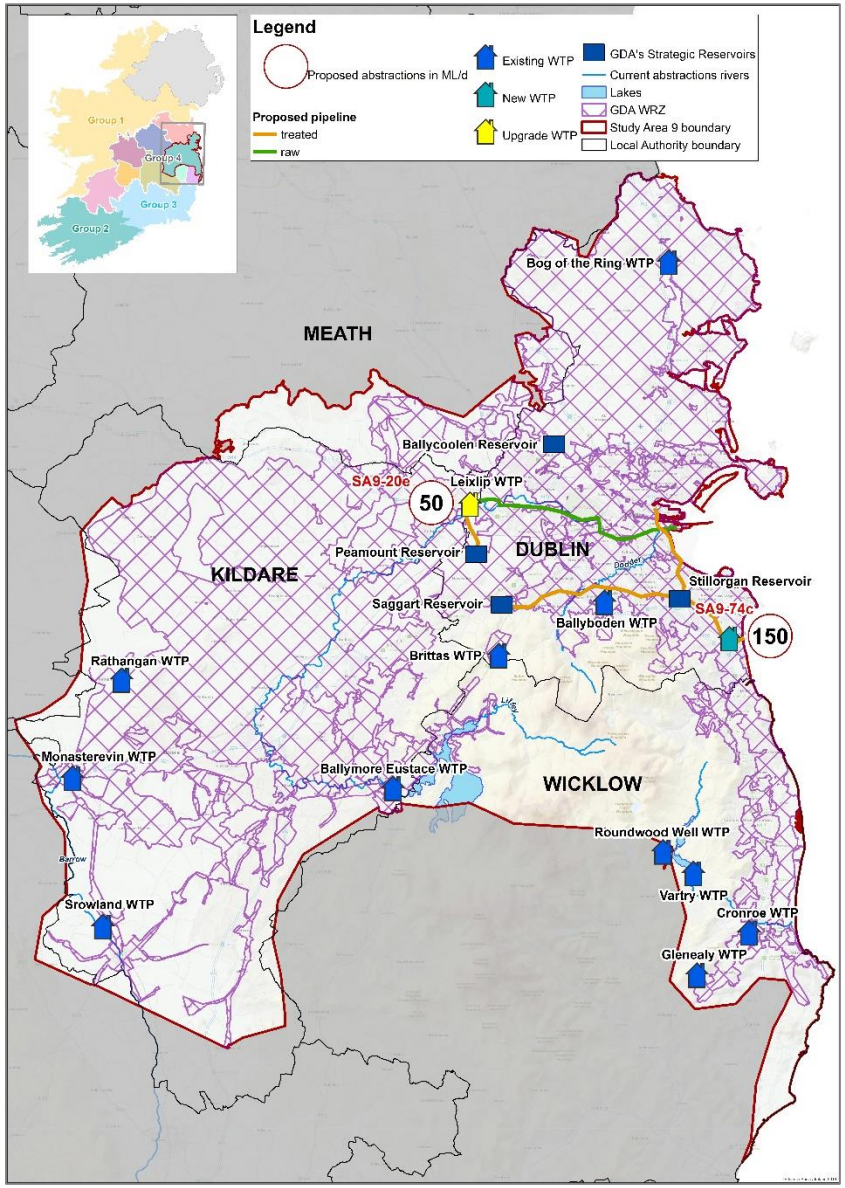


Figure 5.11 Combination 9

Combination 10 (Figure 5.12)	SA9-82	This option proposed to increase supply to the WRZ by a new Surface Water abstraction of 178.5 Ml/d from The Parteen Basin. The option also includes a new WTP at Birdhiil with an output capacity of 150 Ml/d. Twin rising mains from abstraction to WTP (2km), A new BPT, 2x CWT, new pumping station, new termination point reservoir in Peamount. The supply will be transferred approximately 41km from the WTP to the BPT via a new 1600mm pumped pipeline, from the BPT the supply will flow by gravity 130km into the TPR via a new 1600mm pipeline.	This combination looks to provide the supply required from a new source from the Parteen basis. This combination looks to phase the project over a number of years. The first section of the project is to develop the mains and water treatment plant with a 150 Ml/d capacity and to upgrade this later with an increase in treatment capacity at the source and the provision of a pump on the main to increase the capacity to the full 185 Ml/d. The combination involves the development of 2 projects and requires 1 new surface water abstraction.
	SA9-85	This option includes a 35 Ml/d upgrade of option SA9 -82	

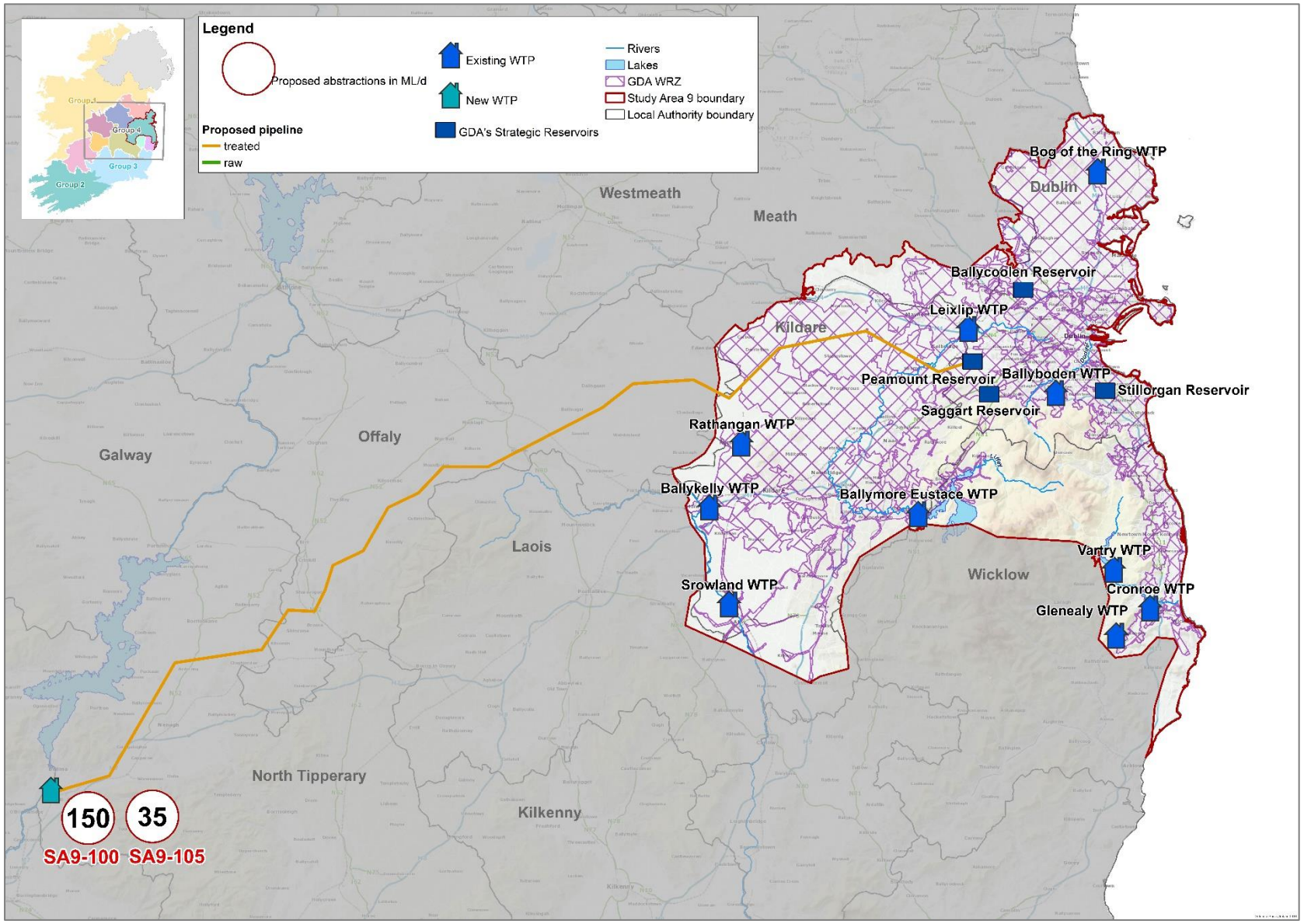


Figure 5.12 Combination 10

Combination 11 (Figure 5.13)	SA9-83	This option proposed to increase supply to the WRZ by a new Surface Water abstraction of 178.5 Ml/d from The Parteen Basin. The option also includes a new WTP at Birdhiil with an output capacity of 170 Ml/d. Twin rising mains from abstraction to WTP (2km), A new BPT, 2x CWT, new pumping station, new termination point reservoir in Peamount. The supply will be transferred approximately 41km from the WTP to the BPT via a new 1600mm pumped pipeline, from the BPT the supply will flow by gravity 130km into the TPR via a new 1600mm pipeline.	Similar to Combination 10, this combination looks to provide the supply required from a new source from the Parteen basis. This combination looks to phase the project over a number of years. The first section of the project is to develop the mains and water treatment plant with a 170 Ml/d capacity and to upgrade this later with an increase in treatment capacity at the source and the provision of a pump on the main to increase the capacity to the full 185 Ml/d. The combination involves the development of 2 projects and requires 1 new surface water abstraction.
	SA9-86	This option includes a 15 Ml/d upgrade of option SA9 -83	

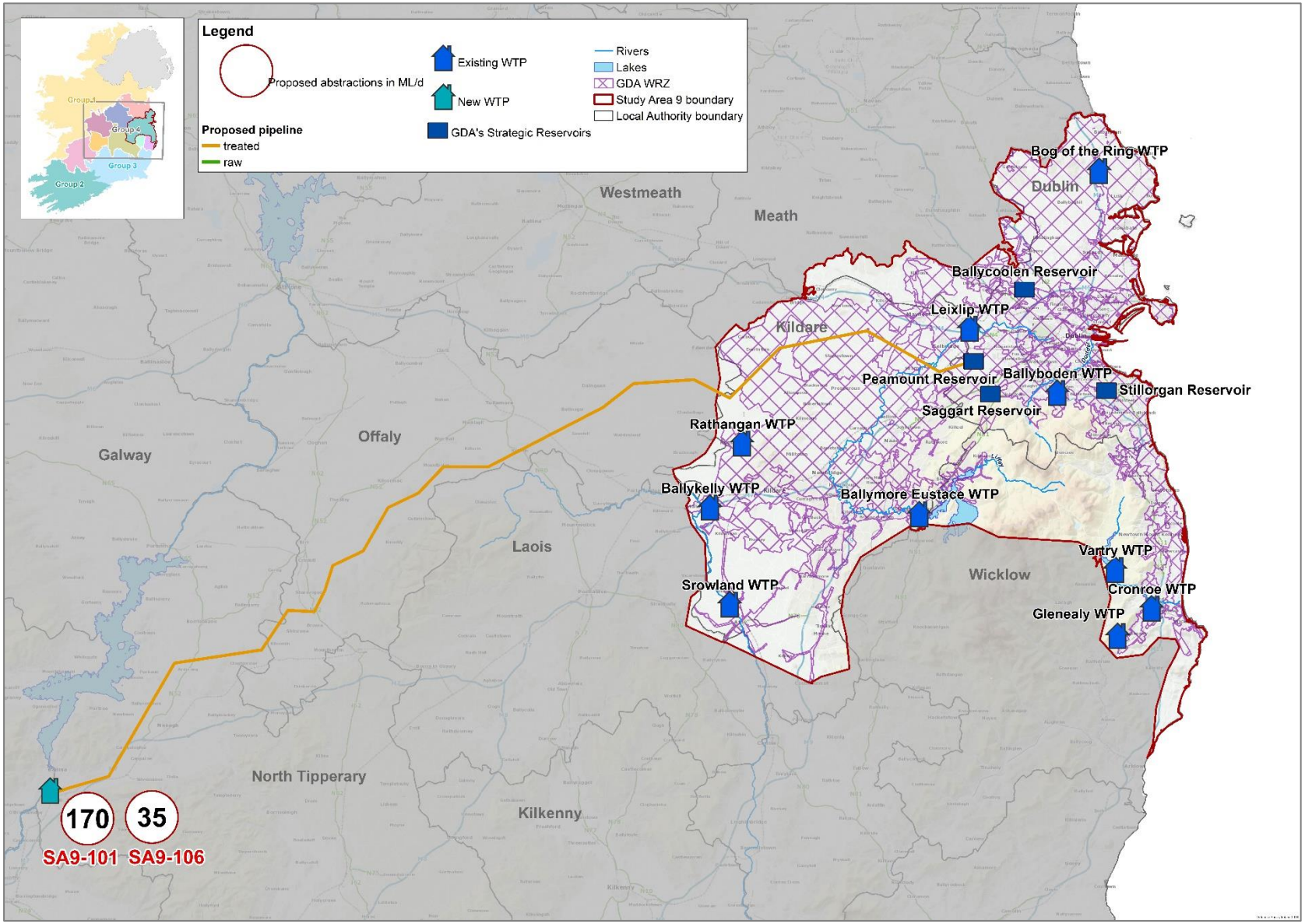


Figure 5.13 Combination 11

Combination 12 (Figure 5.14)	SA9-84	This option proposed to increase supply to the WRZ by a new Surface Water abstraction of 194 Ml/d from The Parteen Basin. The option also includes a new WTP at Birdhill with an output capacity of 185 Ml/d. Twin rising mains from abstraction to WTP (2km), A new break pressure tank, 2 clear water tanks, new pumping station & booster pumping station, new termination point reservoir in Peamount. The supply will be transferred approximately 41km from the WTP to the break pressure tank via a new 1600mm pumped pipeline, From the break pressure tank the supply will flow by gravity for the first 170Ml/d and pumped when demand goes above 170Ml/d. The pipeline from the Break pressure tank to the termination point reservoir will be 1600mm diameter with an approximate length of 130km.	This combination looks to provide the supply required from a new source from the Parteen basis, however, this differs from combination 10 and 11 as the entire treatment plant and infrastructure is provided in the one project. The combination involves the development of 1 project and 1 new surface water abstraction.

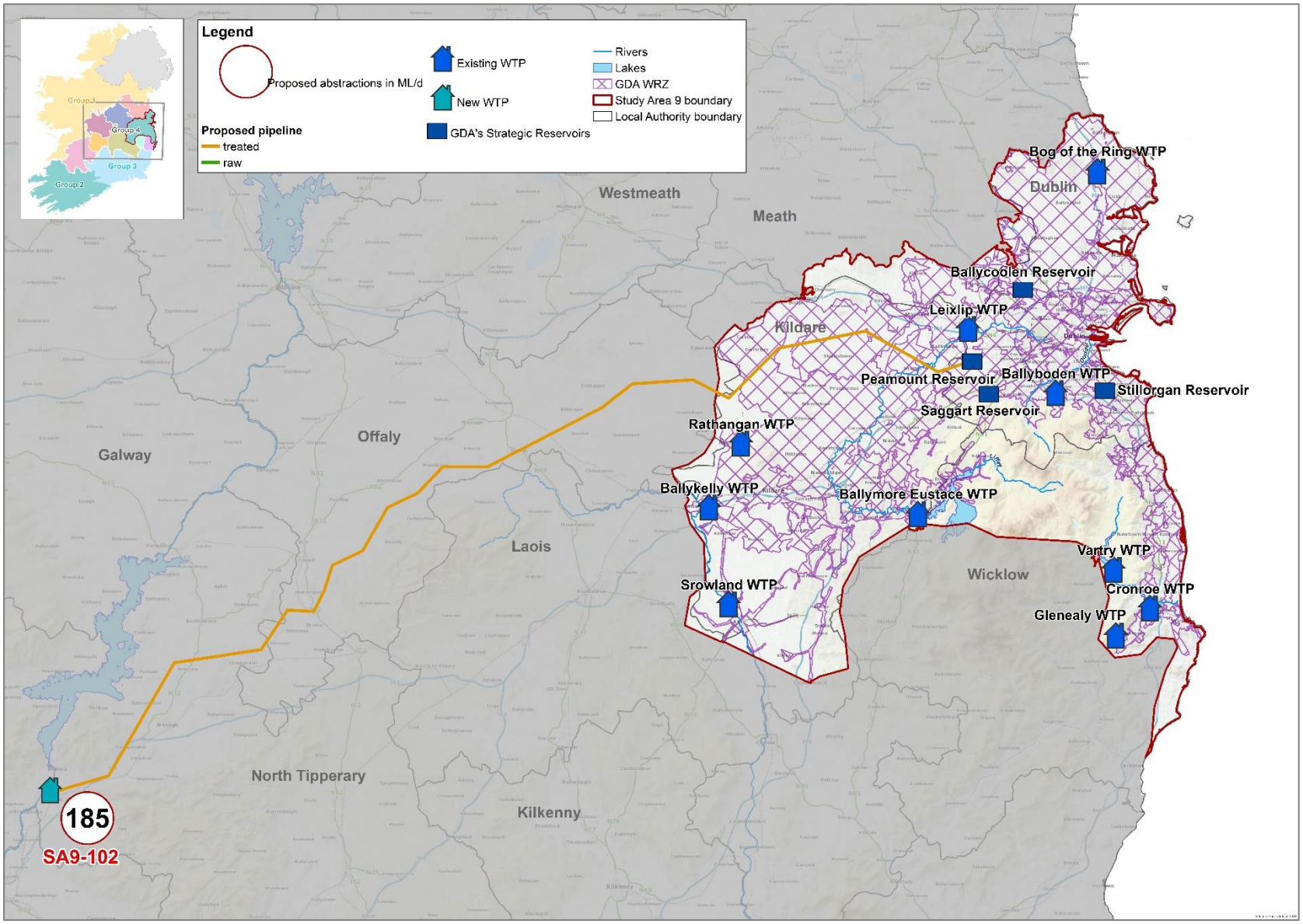


Figure 5.14 Combination 12

5.2.3 Stage 3 – Preferred Approach at Study Area Level

As part of stage three, we compare the SA Combinations to determine the Preferred Approach that provides the best outcome for the Study Area.

We use the EBSD tool to rank the SA combinations against the assessment criteria and we then compare the best performing SA Combinations under each of the six approach types, using the 7 step process set out in Fig 5.1, to establish the Preferred Approach at Study Area level. The results of this process are provided in Table 5.6.

Note Combination 1 does not meet full demand therefore it not considered in any the approaches. In accordance with Section 7.2.2 of the RWRP EM, where options or combinations of options achieve similar, although not exactly identical scores under the six approach types, IW takes a wider look at the comparable combinations /options to consider which to categorise as the "Best" approach within each category. In particular, IW takes into account whether the option or combination of options meets the SEA and Habitats objectives outlined in the Framework Plan. This is an example of the professional judgement from the multi-disciplinary teams, identified in section 8.3.7.4 of the Framework Plan.

For SA9, Combination 4, 5, 10, 11 and 12 had a very similar ranking under the Least Cost category. The Least Cost Approach is determined using an Irish Water Net Present Value assessment tool. The NPV tool uses a strict set of requirements and is limited in what flexibility it offers. Therefore, as set out in further detail in Section 7.2.1 of the RWRP EM, where an Option or Combination of Options provide similar NPV costs, and in some circumstances so as to ensure that no option is discounted at this early stage by reference to "Least Cost" only, Irish Water has considered that all options within a 5% NPV cost margin are in principle eligible to be identified as the "Least Cost" option. This approach recognises the desktop nature of the NPV assessment and the fact that the figures will almost certainly change at project stage.

When we compare these five combinations against each other to identify which should go forward as the Least Cost approach, Combination 12 scored significantly better against the Quickest Delivery, Best AA, Most Resilient and Environmental criteria than Combination 4 and 5. Combination 12 also scored significantly better than Combination 5 for the Lowest Carbon category and better than Combination 4 within the Lowest Carbon category.

Combinations 10, 11 and 12 achieved the same MCA ranking under the Best Environmental, Best AA, and Most Resilient Categories. Combinations 10, 11 and 12 are very similar options and comprise the same infrastructural components and the same raw water source. They all involve an abstraction from the Parteen Basin to the GDA, the only difference being that Combinations 10 and 11 will be delivered in phases, compared to Combination 12 which will be delivered as one project. Of the three options, Combination 12 performed better under the Least Cost and categories than Combinations 10 and 11. Combination 10 which scored slightly better in terms of Carbon. As the difference in carbon is within 7%, it was not considered significantly better. On the basis that each of Combinations 10, 11 and 12 achieved the same MCA ranking under the Best Environmental, Best AA, and Most Resilient Categories, but Combination 12 performed better under the Least Cost, Combination 12 was identified as the best performing option of the three combinations and brought through to the Approach Development Stage.

Table 5.6 SA9 Summary of SA Combination of Performance against Approach Type

Ranked order (best to worst)	Best														Worst

	Combination 1*	Combination 2	Combination 3	Combination 4	Combination 5	Combination 6	Combination 7	Combination 8	Combination 9	Combination 10	Combination 11	Combination 12 Preferred Approach
Least Cost								Worst				Best
Quickest Delivery							Best	Worst				
Best AA *no. of -3 scores against biodiversity	5 No. -3 AA scores	4 No. -3 AA scores	2 No. -3 AA scores	4 No. -3 AA scores.	2 No. -3 AA scores	2 No. -3 AA scores	2 No. -3 AA scores	2 No. -3 AA scores	2 No. -3 AA scores	1 No. -3 AA scores	1 No. -3 AA scores	1 No. -3 AA scores
Lowest Carbon			Worst							Best		
Most Resilient						Worst						Best
Best Environmental				Worst								Best

The SA combinations outlined in Section 5.2.2 are assessed in Table 5.6 to determine the approach categories as summarised in Table 5.7.

Table 5.7 Best Combinations

Approach Categories	Best Performing Combination
Least Cost (LCo)	Combination 12
Best Environmental (BE)	Combination 12
Quickest Delivery (QD)	Combination 7
Most Resilient (MR)	Combination 12
Lowest Carbon (LC)	Combination 10
Best AA (BA)	Combination 12

The MCA assessment included the following assessment criteria:

- Resilience;
- Deliverability and Flexibility;
- Progressibility; and
- Sustainability (Environmental and Social Impacts).

The NPV Costs are based on four criteria:

- Capital Costs – the cost to construct the option, including all overheads, consent and land acquisition costs;
- Operational Costs – the whole life cost to operate the option, including operators, chemical requirements and energy requirements including pumping;
- Carbon Costs – the whole life embodied and operational Carbon costs of the option; and
- Environmental and Social – the whole life Environmental and Social cost of the option covering climate regulation, traffic disruption and food production (carbon emissions are covered separately in the bullet point above).

The wider range of costs used in the estimation of the NPV aligns our Plan with any future Project Level Cost Benefit Analysis, in accordance with the Public Spending Code. In terms of NPV Cost, the SA Combination 12, transfer of treated drinking water from the River Shannon has the lowest NPV Cost, as shown in Figure 5.15, with the lowest total costs (CAPEX and OPEX) over the solutions lifetime.

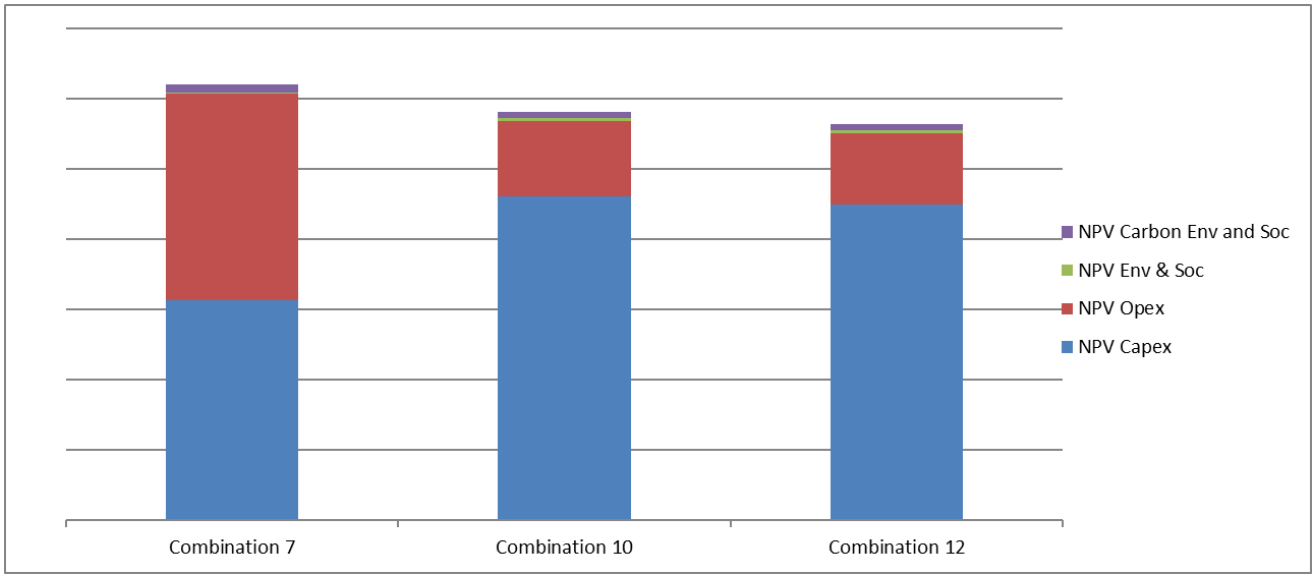


Figure 5.15 SA9 NPV Costs for SA approaches

In accordance with the Options Methodology, these approaches are then compared against each other using the 7-Step process in Figure 5.3 to generate the best value combination of options at the Study Area level. The best value combination of options at the Study Area level is the SA Preferred Approach. The outputs from the assessment were as follows:

- Step 1 – We compared the Least Cost Approach against the Best AA approach. The least cost approach is the Best AA approach therefore the least Cost Approach was retained at this stage.
- Step 2 – We compared the Quickest Delivery Approach against the Least Cost Approach. The Quickest Delivery Approach is faster to deliver as it comprises 6 smaller options, however, it would require significant resources to these projects and the Quickest Delivery Approach performed poorly against the resilience and environmental criteria when compared to the Least Cost Approach and comprises 2 options with a -3 biodiversity score. The Least Cost approach was therefore retained at this stage.
- Step 3 - We compared the Least Cost against the Best Environmental Approach. The Least Cost approach is the Best Environmental approach therefore the Least Cost Approach was retained at this stage.
- Step 4 – We compared the Least Cost against the Most Resilient Approach. The Least Cost approach is the Most Resilient Approach therefore the Least Cost Approach was retained at this stage.
- Step 5 - We compared the Least Cost Approach against the Least Carbon Approach. The carbon costs are within 7% and relatively close in terms of overall cost. The Least Cost also has the best overall environmental score, therefore the Least Cost Approach was retained at this stage.
- Step 6 – A final assessment of the Least Cost was completed against the Least Carbon, Best AA, Best Environmental, Quickest Delivery and Most Resilient Approaches. The Least Cost Approach is the Best AA, Best Environmental and Most Resilient Approach. The Quickest Delivery Approach performed poorly against the resilience and environmental criteria and

comprises 4 options with a -3 biodiversity score. The Lowest Carbon has carbon costs that are within 7% and are relatively close in terms of overall cost, and has a worse environmental score overall. The Least Cost approach was therefore retained at this stage.

- Step 7 – The Least Cost Approach was therefore selected as the Preferred Approach for the Water Resource and Study Area Levels.

5.3 Study Area Preferred Approach Summary

On the basis of this initial assessment at Plan level, combination 12 represents the Preferred Approach for Study Area 9 . Figure 5.16, 5.17 and Table 5.4 below provides an overview of the combination. Note the preferred approach also includes option 87 the common to all option and the requirement of a main allowing connectivity from the strategic reservoirs to the city centre.

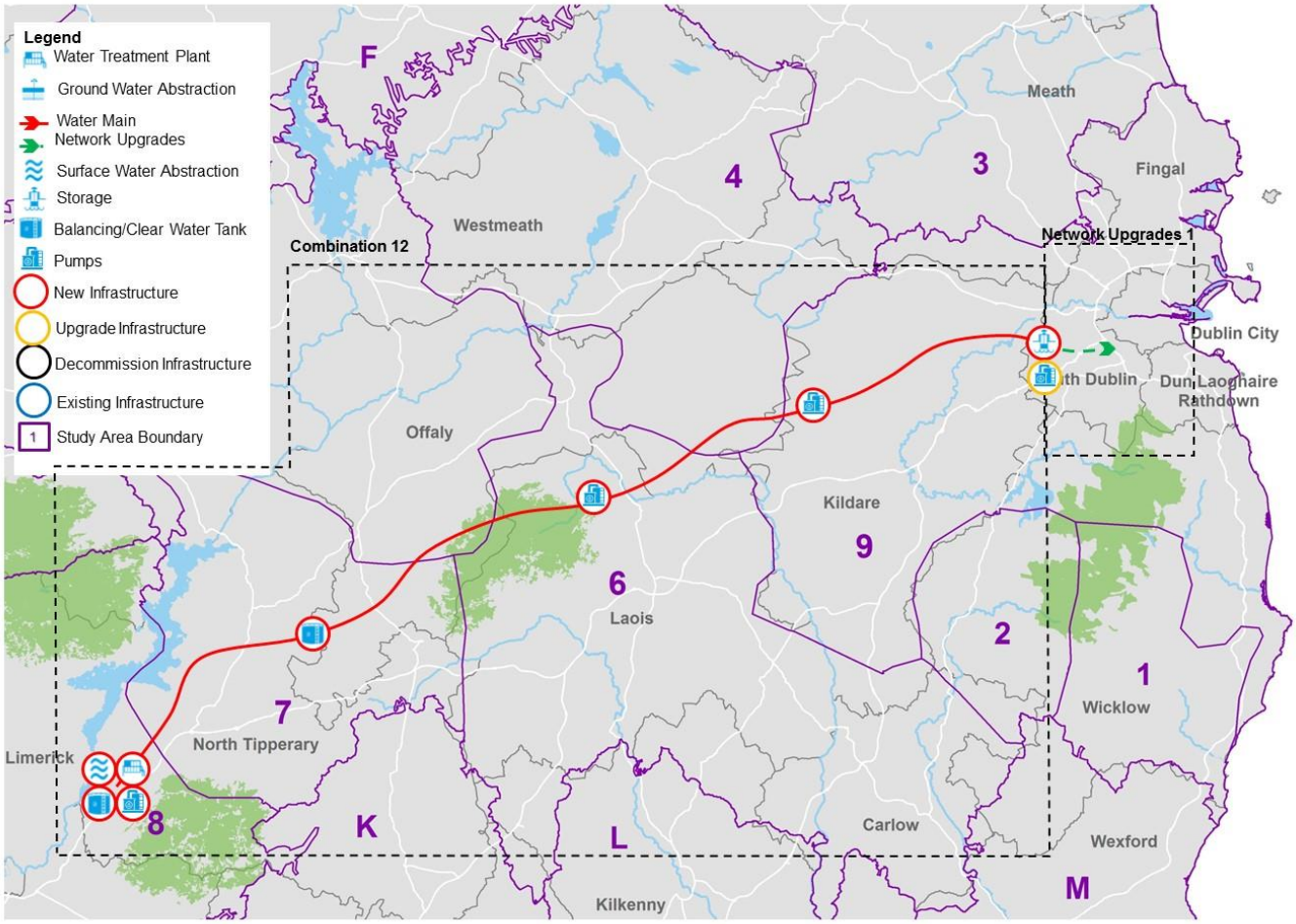


Figure 5.16 Greater Dublin Water Resource Zone – Preferred Approach

Figure 5.17 Common to all requirements

Table 5.4 - Preferred Approach Summary

Approach Option Codes	Option Description
SA9-84	This option proposed to increase supply to the WRZ by a new Surface Water abstraction of 194 Ml/d from The Parteen Basin. The option also includes a new WTP at Birdhill with an output capacity of 185 Ml/d. Twin rising mains from abstraction to WTP (2km), A new break pressure tank, 2 clear water tanks, new pumping station & booster pumping station, new termination point reservoir in Peamount. The supply will be transferred approximately 41km from the WTP to the break pressure tank via a new 1600mm pumped pipeline, From the break pressure tank the supply will flow by gravity for the first 170Ml/d and pumped when demand goes above 170Ml/d. The pipeline from the Break pressure tank to the termination point reservoir will be 1600mm diameter with an approximate length of 130km.
Network Upgrade 1	Main from Strategic Reservoir to the City Centre. This main is required to deliver 30-40Ml/d of supply from our strategic reservoirs to the city centre. The exact route and location of this main and required strategic reservoir connectivity will be determined at project assessment stage.
SA9-87	Common to all Requirements.

The preferred approach at the Study Area level is similar in concept but smaller in capacity than the proposal for Water Supply Project Eastern and Midlands Region. However, at the Regional Level, it provides an opportunity to facilitate water transfers to meet the need in Water Resource Zones in other study areas. When the SA9 preferred approach is considered in the context of the Regional Plan, along with all of the other SA preferred approaches, the ultimate Preferred Approach at the Regional level will be selected on the basis of the needs of all SAs.

As noted, there are marginal differences in terms of costs and MCA scores for Combinations 10,11 and 12. Combinations 10, 11 and 12 are very similar options and comprise the same infrastructural components and the same raw water source. They all involve an abstraction from the Parteen Basin and the provision of a pipeline from the proposed new WTP in Birdhill to the GDA, the only difference being that in Combinations 10 and 11 the WTP and pumping stations will be delivered in modular phases, compared to Combination 12 were all infrastructure will be delivered as one project.

As there is minimal difference between Combinations 10,11 and 12 at plan level it is recommended that further assessment of the phasing of the delivery of the project should be considered at project level.

Before we adopt this approach at Plan level for Study Area 9 – Greater Dublin Area, we must give consideration to the following:

- **Interim Solutions:** Based on scale of investment required across the entire country it is likely that it may take 5-10 investment cycles before we address all issues with the existing water supplies. No options were identified in this process that could significantly and sufficiently reduce the deficit and hence customer risk in a short timeframe. Whilst we progress with the Preferred Approach we have examined whether there are any Interim Solutions that can allow us to maintain existing LoS to our customers until the Preferred Approach can be delivered. These may not satisfy all the requirements of permanent options but may reduce the supply risk significantly to outweigh the disadvantages for a limited period. This is detailed in section 6 of this Technical Report.
- **Sensitivity Analysis**: When planning for water supplies over a medium to long term horizon, we must give consideration to adaptability of our plan to change across a range of future scenarios (for example, what if population growth rates are lower than expected or what if we are unable to secure a licence in the medium term to abstract the quantity water currently allowed for at a given location).

6

Preferred Plan Constraints – Interim Solutions

6 Preferred Plan Constraints – Interim Solutions

As outlined in more detail in Section 8.3.7.6 of the Framework Plan, the NWRP provides for an "interim solution" approach, which allows shorter term interventions to be identified and prioritised, when needed. The Preferred Approach for each WRZ, Study Area and Region will be delivered on a phased basis subject to budget and regulatory constraints. It will take many investment cycles to deliver the Preferred Approach across all WRZs, therefore, Irish Water must have a means to continue delivering safe, secure and reliable water supplies (on a short to medium term basis) while we deliver our Preferred Approach.

On this basis, interim, short term capital maintenance solutions have been identified for all WTPs and will be utilised when needed. These solutions will allow IW time to deliver the Preferred Approach, while at the same time, maintaining a sustainable water supply. These interim solutions are generally smaller in scale and rely on making best use of already existing infrastructure.

The Preferred Approach, which includes a transfer of treated drinking water from the River Shannon, is a significant project. It will be a significant challenge to progress a project of this scale and complexity through the necessary consent, procurement and construction phases to make it fully operational before the end of the decade.

At present the GDA has a critical supply demand balance issue, with planning deficits in normal conditions in the order of 48 Ml/d in 2019. Even when accounting for heavy investment in leakage reduction, this deficit will increase further based on expected growth and economic development (aligned with the National Planning Framework).

As outlined in Section 2.2 we have a number of ongoing supply intervention projects including the new WTP at Vartry and the Srowland network extension project which alongside leakage and water conservation measures will allow us maintain the existing Level of Service (LoS) to our customers while facilitating growth to 2025. Therefore we will need further supply interventions, beyond the ongoing supply interventions, prior to the delivery of the preferred approach.

Without such interventions Irish Water will potentially need to implement measures to protect the LoS provided to existing water users, which may include potential restrictions on new connections to the network. Such measures, if required to be implemented, would severely impact growth and economic development in the region.

There is also a risk of an increase in the number of water quality incidents in the region associated with such a significant supply demand balance deficit. While we operate with this scale of deficit it is not possible to take parts of our treatment plants out of service for required maintenance. Therefore if we do not provide further supply improvements between now and delivery of Preferred Approach impacts such as the precautionary Boil Water Notices imposed on Leixlip WTP in 2019, which affected 600,000 water users, may occur again.

Either of these impacts are unacceptable, so an interim solution must be established which will address the most critical need in the medium term.

A review of all feasible options was carried out to determine options or combinations of options which could provide some additional supply to the GDA region in the short term.

The smaller scale options which involve new abstractions or long lengths of water main network will have long lead in times. Combinations of these options are unlikely to yield enough supply to maintain the existing LoS and therefore do not address the interim supply demand balance issues. Also, due to the fact that they do not add resilience to the overall network, and they would have high operational costs it is likely that such options would be decommissioned once the preferred approach has been delivered. Therefore, combinations of small supplies represent poor value for money and not considered appropriate as an interim solution.

Consideration was also given to smaller desalination options; however, such options could take longer to deliver than the preferred approach therefore would not be appropriate as an interim solution

As these feasible options cannot be delivered within the timeframe, and acceleration of leakage reduction activities to reduce demand have already been taken into account, the only viable interim options to address supplies involve optimising our existing sources and asset base therefore consideration was given to the feasible options which considered optimising outputs from existing sources such as;

- Option 46 - Leixlip WTP Upgrade - +50Ml/d – Winter Critical Period and Normal Year Annual Average only
- Option 28 - Increase abstraction at BME by optimising storage at Poulaphouca Reservoir and provision of 24km main from BME to the Saggart Area.

No new WTPs works or abstractions are required for these options and they have the potential to be delivered prior to the Preferred Approach.

In Section 2.1 of this report, an upgrade at Leixlip WTP was noted under “quality need” and in Section 2.3 “Security of supply from Ballymore Eustace to Saggart” was noted under “reliability need”. These options resolve both these needs, therefore while the requirement for additional supply provided by these options is temporary, the infrastructure required will increase long term security and reliability of the entire supply.

It is noted that our existing abstractions from the River Liffey are significant, and these may have sustainability issues in relation to the WFD in addition to reliability issues in drought periods. On that basis, any increases in abstraction from this water body would need to be carefully planned, be temporary in nature, and may need to be facilitated via exemption processes allowed for in legislation (with associated environmental assessments, as required). Storage from Poulaphouca can be optimised by works to reduce the level of the abstraction inlet and/or by modifications to the storage curve. Consideration would need to be given to dam safety and a potential increase in flood risk along the Liffey if a proposal to change the storage curve was considered. The feasibility of these interim options will be further investigated at a project level.

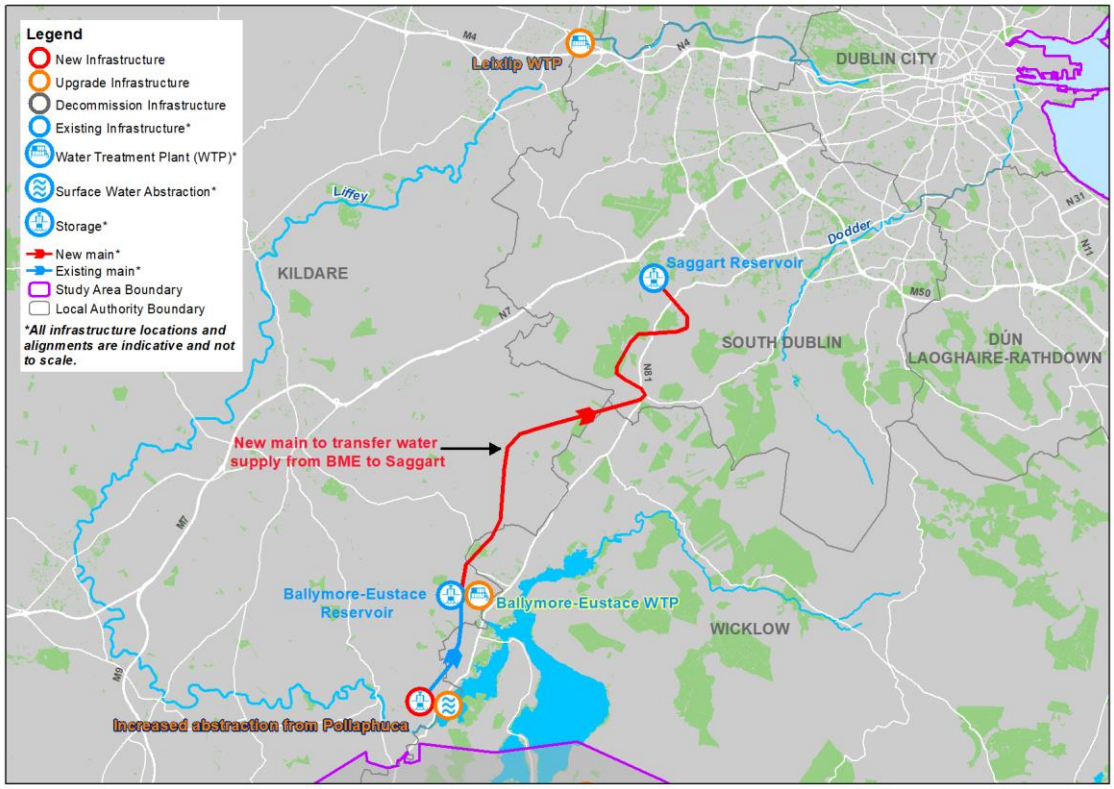


Figure 6.1 SA9 Interim Options

The potential interim solutions for the SA9 supplies are summarised in Figure 6.1 and Table 6.1 . These solutions alongside leakage and water conservation measures will allow us maintain the existing Level of Service (LoS) to our customers while facilitating growth prior to the delivery of the Preferred Approach and in long term these solutions will improve resilience in the network and improve the security and reliability of the supply to the GDA.

Table 6.1 SA9 Interim Options

Option Code	Option Description	Option Capacity (Ml/d)
SA9-46	Leixlip WTP Upgrade - +50Ml/d – Winter Critical Period and Normal Year Annual Average only	50
SA9 - 28	Increase abstraction at BME by optimising storage at Poulaphouca Reservoir and provision of 24km main from BME to the Saggart Area	62

The recommended interim option for the GDA involves a temporary increase in abstraction from the River Liffey and increase in production at Leixlip and Ballymore Eustace WTPs, subject to the appropriate statutory consents. The proposed interim solution also aligns with recommendations in the Department of Housing Planning and Local Government's Water and Waste Water Quality Sectoral Adaptation Plan[4].

The NWRP does not confer funding availability and any interim measures will be subject to budget availability, AA screening and other relevant consents in the normal way. Irish Water will work with the EPA, ESB and OPW to further investigate this interim option, and acknowledge that this proposal is not sustainable in the long term. However, with optimisation of the existing inlet and storage in the system any potential impacts could be mitigated and the proposal would be temporary in nature until the Preferred Approach is delivered.

[4] Water Quality and Water Services Infrastructure - Climate Change Sectoral Adaptation Plan, Department of Housing, Planning and Local Government. http://www.housing.old.gov.ie/water/water-quality/water-quality-and-water-services-infrastructure-climate-change-sectoral.

7

Preferred Approach – Sensitivity Analysis

7 Preferred Approach – Sensitivity Analysis

Our supply demand forecast and water quality barrier deficit assessments have been developed using the application of best practice methods within the data available. We have identified areas where we will focus improvements in data to improve the certainty of our forecasts. However, all long-term forecasts are subject to uncertainty. We have explored the sensitivity of our supply and demand forecasts to some of the key factors which influence them through a range of scenarios. This enables us to test the sensitivity of the Preferred Approach to changes in need, in order to ensure that our decision making is robust and that the approach is adaptable. We describe the factors which have been considered in Chapter 8 of the Framework Plan. In summary we test our Preferred Approach against the following questions:

1) What if the deployable output across our supplies is reduced based on sustainability limits within the new legislation on abstraction resulting in a larger supply demand balance deficit?
2) What if climate change impacts on our existing supplies are greater than anticipated?
3) What if our forecasts are too great and expected demand growth does not materialise resulting in a smaller supply demand balance deficit?
4) What if we are able to reduce leakage below SELL within the timeframe of the plan resulting in lower Needs?
5) What if we fail to achieve our leakage targets?

A summary of the adaptability criteria and analysis we have undertaken for SA9 is shown in Table 7.1.

Table 7.1 Sensitivity Analysis for SA9

Uncertainty	Likelihood	Increase/ Decrease in Deficit	Impact on Preferred Approach
Sustainability	Moderate/High (as our current abstractions are large compared to the water bodies from which they abstract)	+90 Ml/d	**The impact of sustainability reductions would reduce the volumes that can be abstracted from our existing sources therefore increasing the supply demand balance deficit.** Although the likelihood of this scenario is high based on a desktop assessment of our existing abstractions, potential impacts may be mitigated against by optimizing our operations on a more environmentally sustainable basis across the range of supplies as the Preferred Approach will allow us to benefit from major sources, in areas of the country with differing climatic conditions. Also as the estimated sustainable abstraction available from the Lough Derg source is in excess of that required for the GDA therefore the Preferred Approach can be scaled up if required.

Uncertainty	Likelihood	Increase/ Decrease in Deficit	Impact on Preferred Approach
			Based on this scenario, the SA Preferred Approach remains the optimal solution.
Climate Change	High (international climate change targets have not been met)	+10 Ml/d	**The impact of increased climate change scenarios would impact our existing supplies and result in decreased water availability at certain times of year**. Although the likelihood of this scenario is high based on climate change adaptation to date, potential impacts may be mitigated against by optimizing our operations on a more environmentally sustainable basis across the range of supplies. as the Preferred Approach will allow us to benefit from major sources, in areas of the country with differing climatic conditions. Also the estimated sustainable abstraction available from the Lough Derg source is in excess of that required for the GDA therefore the Preferred Approach can be scaled up if required..
			Based on this scenario, the Preferred Approach remains the optimal solution.
Demand Growth	Low/Moderate (growth has been based on policy)	-40 Ml/d	**The impact of lower than expected growth would reduce the supply demand balance deficit and the overall need requirement.** The supply demand balance deficit is driven in equal parts by limitations in existing supplies, the reliability of the overall supply and demand. Therefore, even if there were no demand growth in the region, there is still a need for a new source of water. The estimated sustainable abstraction available from the Lough Derg source is in excess of that required for the GDA therefore the Preferred Approach can be scaled up if required.
			Based on this scenario, the Preferred Approach remains the optimal solution.

Uncertainty	Likelihood	Increase/ Decrease in Deficit	Impact on Preferred Approach
Leakage Targets	Moderate (the distribution network in the region is extensive at nearly 10,000 kilometers)	92.4 Ml/d	**The impact of lower than expected leakage savings would increase the supply demand balance deficit and the overall need requirement**. As Irish Water is committed to achieving leakage reductions, the likely scenario would be an extension in the period of time taken to achieve leakage targets as opposed to accepting lower targets.
			Based on this scenario, the Preferred Approach remains the optimal solution.
Leakage Targets	Low (The distribution network in the region is extensive at nearly 10,000 kilometers and Existing Targets for the GDA are aggressive)	- 62 Ml/d	**The impact of reducing leakage to 10% of total Demand would reduce the supply demand balance deficit and the overall need requirement.** The supply demand balance deficit is driven in equal parts by limitations in existing supplies, the reliability of the overall supply and demand. Therefore, there is still a need for a new source of water.
			Based on this scenario, the Preferred Approach remains the optimal solution.

In reality, a combination of these scenarios may occur together. For example, growth in demand might be lower if we achieve greater leakage reductions. However, if this coincided with a reduction in permitted abstraction volume under the abstraction licensing regime, the reduction in demand may offset some or all of the loss in supply availability due to abstraction sustainability reductions. Effectively this means our supply side preferred approach should not be altered on the basis of choosing a single scenario form the sensitivity analyses. They most be reviewed in totality

Based on the adaptability criteria and analysis, the Interim and Preferred Approaches perform as follows:

- Interim Approach – As the purpose of the Interim Approach is to maintain the existing LoS before the Preferred Approach can be delivered, the solutions will have a limited design life (usually less than 10 years) however this capitalises on the infrastructure already

identified as required for quality and resilience needs in the WRZ. They allow time to assess the Preferred Approach and improve adaptability within our Plan; and

- Preferred Approach – This performs well across the range of uncertainty scenarios as the estimated sustainable abstraction available from the Lough Derg source is in excess of that required for the GDA therefore the option can be scalable if required.

In summary, based on a sensitivity assessment, the Interim and Preferred Approaches are both highly adaptable to a broad range of future scenarios, and therefore represent ‘no regrets’ infrastructure.

8

Summary of Study Area 9

8 Summary of Study Area 9

The Preferred Approach for after planned leakage reduction and other water conservation objectives have been delivered consists of a transfer of 185 Ml/d of treated drinking water via pipeline from a new Shannon source.

Delivery of the Preferred Approach will secure all of the supplies in the area to 2044 in terms of Quality, Quantity, Sustainability and Resilience. The Preferred Approach for SA9 also includes for demand side (**Lose Less** and **Use Less**) measures, including:

- Ongoing leakage management including active leakage control, pressure management and find and fix activities to offset NRR;
- Net leakage reduction of 92 Ml/d to move towards achieving the National SELL Target by 2034;
- Ongoing Water Conservation Messaging; and
- The option to implement legally enforceable Water Conservation Orders in drought periods in order to protect the environment and our public water supplies.

Given the lead time of the New Shannon Source (NSS) project interim solutions (summarised in Figure 5.16, 5.17 and Table 5.4) have been identified. These interim solutions alongside leakage and water conservation measures will allow us maintain the existing Level of Service (LoS) to our customers while facilitating growth prior to the delivery of the Preferred Approach and in long term these solutions will improve resilience in the network and improve the security and reliability of the supply to the GDA.

Annex A Study Area 9 Water Treatment Plants

WTP Name	Local Plant Names
Ballymore Eustace WTP	Ballymore Eustace WTP
Vartry WTP	Vartry WTP
Ballyboden WTP	Ballyboden WTP
Leixlip WTP	Leixlip WTP
Bog of the Ring Water WTP	Bog of the Ring WTP
Srowland WTP	Srowland WTP
Rathangan Wellfields WTP	Rathangan WTP
Monasterevin WTP	Ballykelly WTP
Brittas WTP	Brittas WTP
Cronroe WTP	Cronroe Ashford WTP
Roundwood Well WTP	Roundwood Well WTP
Glenealy WTP	Glenealy WTP

Annex B Study Area 9 Rejection Register Summary

Study Area 9 - CS Rejection

Option Reference	Option Description	Rejection Reasoning	Resilience	Deliverability & Flexibility	Sustainability (Environmental and Social Impacts)
TG4-SA9-01	Water Transfer from the River Shannon. Water to be abstracted and treated on the eastern shore of Lough Ree before it is transferred to the GDA. Option proposed to provide Full Need of 330 Ml/d	Option A from the Water Supply Options Working Paper which was required to meet full need of 330Ml/d considered in this report* On the review of the water available for abstraction it was noted that the ESB minimum normal operation levels for the Shannon at Lough Ree were not maintained during the 1995 drought without an abstraction, therefore any abstraction at this location would not be resilient as the yield is not available and would likely have a negative environmental impact. Therefore, this option did not meet the requirements of the Environmental, Resilience or Deliverability criteria and was not progressed to the fine screening stage.	●	●	●
TG4-SA9-04	Water Transfer from the River Shannon. Water to be abstracted and treated on the eastern shore of both Lough Derg and Lough Ree before it is transferred to the GDA. Option proposed to provide Full Need of 330 Ml/d	Option D from the Water Supply Options Working Paper which was required to meet full need of 330Ml/d considered in this report.* On the review of the water available for abstraction it was noted that the ESB minimum normal operation levels for the Shannon at Lough Ree were not maintained during the 1995 drought without an abstraction, therefore any abstraction at this location would not be resilient as the yield is not available and would likely have a negative environmental impact. Therefore this option did not meet the requirements of the Environmental, Resilience or Deliverability criteria and was not progressed to the fine screening stage. .	●	●	●
TG4-SA9-05	Water Transfer from the River Shannon. Water to be abstracted and treated on the eastern shore of Lough Ree before it is transferred to the GDA. Full Need of 330 Ml/d	Option E from the Water Supply Options Working Paper which was required to meet full need of 330Ml/d considered in this report* On the review of the water available for abstraction it was noted that the ESB minimum normal operation levels for the Shannon at Lough Ree were not maintained during the 1995 drought without an abstraction, therefore any abstraction at this location would not be resilient as the yield is not available and would likely have a negative environmental impact. Therefore, this option did not meet the requirements of the			●

Option Reference	Option Description	Rejection Reasoning	Resilience	Deliverability & Flexibility	Sustainability (Environmental and Social Impacts)
		Environmental, Resilience or Deliverability criteria and was not progressed to the fine screening stage. .			
TG4-SA9-06a	Water Transfer from the River Shannon. Water to be abstracted from Lough Derg with raw water storage provided in a bog at Rochfortbridge. Option proposed to provide Full Need of 330 Ml/d	Option F1 from the Water Supply Options Working Paper which was required to meet full need of 330Ml/d considered in this report* Raw water transfer across catchments is not feasible due to the risk of transfer of invasive species. Therefore, this option was not considered environmental viable and was rejected at coarse screening stage			•
TG4-SA9-06b	Water Transfer from the River Shannon. Water to be abstracted from Lough Derg with raw water storage provided in a bog at Garryhinch. Option proposed to provide Full Need of 330 Ml/d	Option F2 from the Water Supply Options Working Paper which was required to meet full need of 330Ml/d considered in this report* Raw water transfer across catchments is not feasible due to the risk of transfer of invasive species. Therefore this option was not considered environmental viable and was rejected at coarse screening stage.			•
TG4-SA9-07	Water Transfer from the River Shannon. Raw water to be transferred and stored in an impoundment in the Wicklow Mountains where it will be treated before it is transferred to the GDA. Option proposed to provide Full Need of 330 Ml/d	Option G from the Water Supply Options Working Paper which was required to meet full need of 330Ml/d considered in this report* On the review of the water available for abstraction it was noted that the ESB minimum normal operation levels for the Shannon at Lough Ree were not maintained during the 1995 drought without an abstraction, therefore any abstraction at this location would not be resilient as the yield is not available and would likely have a negative environmental impact. Therefore this option did not meet the requirements of the Environmental, Resilience or Deliverability criteria and was rejected at coarse screening stage.	•	•	•

Option Reference	Option Description	Rejection Reasoning	Resilience	Deliverability & Flexibility	Sustainability (Environmental and Social Impacts)
TG4-SA9-08	Desalination plant in North Fingal. Water to be treated in North Fingal and treated water to be transferred to the GDA network. Brine discharge near location of abstraction. Option proposed to provide Full Need of 330 Ml/d	Option H from the Water Supply Options Working Paper which was required to meet full need of 330Ml/d considered in this report* Desalination of full 330MLD not feasible as a 2:1 blending ratio would be required there this option was not considered feasible or deliverable and was rejected at coarse screening stage. Options considering smaller desalination plants, to meet NWRP required demand, at Balbriggan and South Dublin are considered in other options.		●	
TG4-SA9-09	Groundwater abstraction. Various groundwater abstractions within 80km radius of Dublin. Option proposed to provide Full Need of 330 Ml/d	Option I from the Water Supply Options Working Paper which was required to meet full need of 330Ml/d considered in this report* Groundwater supply for the full 330 MLD is not achievable as the full yield is not available. Therefore, this option did not meet the requirements of the Environmental, Resilience or Deliverability criteria and was rejected at coarse screening stage. Options considering smaller groundwater sources , to meet NWRP required demand, are considered.	●	●	●
TG4-SA9-10	Increased abstraction at the River Barrow. Increase of existing abstraction when more water is available in the Winter/ Spring and combine and transfer for treatment at Ballymore Eustace to increase output. Option proposed to provide Full Need of 330 Ml/d	Option J from the Water Supply Options Working Paper which was required to meet full need of 330Ml/d considered in this report* Option does not provide full 330 MLD as the full additional yield is not available. Therefore, this option did not meet the requirements of the Environmental, Resilience or Deliverability criteria and was rejected at coarse screening stage. Other version of the option , to meet NWRP required demand, providing some supply are considered.	●	●	●
TG4-SA9-16	New Surface Water abstraction from the River Dan. Abstract and treat water from the River Dan in Wicklow before transferring to the GDA. Option proposed to provide 5 MLD in WCP	Option required the construction of a dam at Lough Dan for the provision on an additional supply of 5MLD. The proposed operational regime required the pumping of flow from the lake to maintain Q95 flow in the channel downstream. The option is considered likely to result in the waterbody not achieving good WFD status. Therefore this option did not meet the requirements of the Environmental, Resilience or Deliverability criteria and was rejected at coarse screening stage.	●	●	●

Option Reference	Option Description	Rejection Reasoning	Resilience	Deliverability & Flexibility	Sustainability (Environmental and Social Impacts)
TG4-SA9-19	Surface Water abstraction from the Grand Canal Docks. Abstract and treat water from the Grand Canal Docks. Option proposed to provide 8 MLD in the WCP	Option considered not feasible as the available supply is limited to 8MLD in winter only and there are water quality issues with the raw water. Therefore this option did not meet the requirements of the Resilience or Deliverability criteria and was rejected at coarse screening stage.	●	●	
TG4-SA9-22b	Increase abstraction and production at Leixlip WTP. Offset additional abstraction by discharging treated water at Leixlip WwTP upstream of abstraction. Option proposed to provide 20 MLD	It is considered that effluent reuse for domestic customers is unacceptable as it does not provide potable water to our customers, that is fit for drinking. As there are other viable options that can deliver compliant water, this option is not considered to be feasible and was not taken forward to fine screening.	●	●	
TG4-SA9-24a	Increase abstraction and WTP at Ballymore Eustace WTP to 400 MLD. Option proposed to provide 82 MLD in WCP	This is only feasible on review of the operation curve for the Reservoir which is considered in option 28.	**This option is a repeat and is assessed as part of a different feasible option.**		
TG4-SA9-25	Effluent Reuse from Shanganagh WwTP. Options includes treatment of discharge from Shanganagh WwTP to the required standard for drinking water. Option proposed to provide 30 MLD	It is considered that effluent reuse for domestic customers is unacceptable as it does not provide potable water to our customers, that is fit for drinking. As there are other viable options that can deliver compliant water, this option is not considered to be feasible and was not taken forward to fine screening.	●	●	
TG4-SA9-26	Effluent Reuse from Swords WwTP. Options includes treatment of discharge from Swords WwTP to the required standard for	It is considered that effluent reuse for domestic customers is unacceptable unless there are no other feasible options, however, this option is considered for non-domestic customers.	●	●	

Option Reference	Option Description	Rejection Reasoning	Resilience	Deliverability & Flexibility	Sustainability (Environmental and Social Impacts)
	drinking water. Option proposed to provide 10 MLD				
TG4-SA9-27	Optimisation of Poulaphouca Reservoir operating regime to manage water levels to increase water available for abstraction. Option proposed to provide additional 100 MLD	Repeat of option 28	**This option is a repeat and is assessed as part of a different feasible option.**		
TG4-SA9-34	New Ground Water abstraction at Loughshinny. Option includes abstraction and associated WTP and connection to the GDA network. Option proposed to provide additional 4 MLD	Option considered not feasible as uncertainty associated with the actual yield available. Given the status of the aquifer a significant number of boreholes would be required to achieve a limited supply of 4MLD if available. Therefore this option did not meet the requirements of the Resilience or Deliverability criteria and was rejected at coarse screening stage	•	•	
TG4-SA9-36	New Ground Water abstraction at Lucan. Option includes abstraction and associated WTP and connection to the GDA network. Option proposed to provide additional 4 MLD	Option considered not feasible as uncertainty associated with the actual yield available. Given the status of the aquifer a significant number of boreholes would be required to achieve a limited supply of 4MLD if available. Therefore this option did not meet the requirements of the Resilience or Deliverability criteria and was rejected at coarse screening stage.	•	•	
TG4-SA9-37	New Ground Water abstraction at Ballinahinch. Option includes abstraction and associated WTP and connection to the GDA network. Option proposed to provide additional 2.2 MLD	Option considered not feasible as desktop assessment showed no supply available in this location. Therefore this option did not meet the requirements of the Resilience or Deliverability criteria and was rejected at coarse screening stage.	•	•	

Option Reference	Option Description	Rejection Reasoning	Resilience	Deliverability & Flexibility	Sustainability (Environmental and Social Impacts)
TG4-SA9-38	New Ground Water abstraction at Ballinahinch. Option includes abstraction and associated WTP and connection to the GDA network. Option proposed to provide additional 1 MLD	Option considered not feasible as desktop assessment showed no supply available in this location. Therefore this option did not meet the requirements of the Resilience or Deliverability criteria and was rejected at coarse screening stage.	●	●	
TG4-SA9-39	New Ground Water abstraction at Miltown. Option includes abstraction and associated WTP and connection to the GDA network. Option proposed to provide additional 0.4 MLD	Option considered not feasible as desktop assessment showed no supply available in this location. Therefore this option did not meet the requirements of the Resilience or Deliverability criteria and was rejected at coarse screening stage.	●	●	
TG4-SA9-49	New Surface Water abstraction from impoundment in Fingal. Option includes water treatment and transfer to GDA network. Option proposed to provide additional 0.1 MLD	Option considered not feasible as significant works required to achieve a limited supply of 0.1 MLD. Therefore this option did not meet the requirements of the Resilience or Deliverability criteria and was rejected at coarse screening stage.	●	●	
TG4-SA9-50	New Surface Water abstraction from impoundment in Fingal. Option includes water treatment and transfer to GDA network. Option proposed to provide additional 0.1 MLD	Option considered not feasible as significant works required to achieve a limited supply of 0.1 MLD. Therefore this option did not meet the requirements of the Resilience or Deliverability criteria and was rejected at coarse screening stage.	●	●	
TG4-SA9-54	Reuse of treated effluent from Oberstown WwTP for Non Domestic Customers. Treat discharge from Oberstown WwTP to the standard required for industry and transfer to non-domestic customers.	Option considered not feasible as effluent discharge currently returns to the River Liffey and is abstracted as part of existing supplies. Therefore this option did not meet the requirements of the Resilience or Deliverability criteria and was rejected at coarse screening stage.	●	●	

Option Reference	Option Description	Rejection Reasoning	Resilience	Deliverability & Flexibility	Sustainability (Environmental and Social Impacts)
	Option proposed to provide 20 MLD				
TG4-SA9-55	Reuse of treated effluent from Ballymore Eustace WwTP. Treat discharge from Ballymore Eustace WwTP to the standard required for drinking water. Option proposed to provide 0.5 MLD	Option considered not feasible as effluent discharge currently returns to the River Liffey and is abstracted as part of existing supplies. Therefore this option did not meet the requirements of the Resilience or Deliverability criteria and was rejected at coarse screening stage.	•	•	
TG4-SA9-57	Ringsend WWTP effluent reuse for potable use	It is considered that effluent reuse for domestic customers is unacceptable as it does not provide potable water to our customers, that is fit for drinking. As there are other viable options that can deliver compliant water, this option is not considered to be feasible and was not taken forward to fine screening.	•	•	
TG4-SA9-58	De-silting of Vartry reservoir to gain additional yield.	This option will allow additional resilience in summer months, however, it will not increase volume of water available for supply. Therefore this option did not meet the requirements of the Resilience or Deliverability criteria and was rejected at coarse screening stage.		•	
TG4-SA9-59	Ringsend WWTP effluent reuse for potable use	This option is a repeat of options 21 and 22.	**This option is a repeat and is assessed as part of a different feasible option.**		
TG4-SA9-60	Reuse heated water from ESB (Poolbeg) Options proposed to provide 4 MLD	Water usage at ESB stations difficult to predict as it is very dependent on external factors (environmental and market conditions). Therefore this option did not meet the requirements of the Resilience or Deliverability criteria and was rejected at coarse screening stage.	•	•	

Option Reference	Option Description	Rejection Reasoning	Resilience	Deliverability & Flexibility	Sustainability (Environmental and Social Impacts)
TG4-SA9-61	Reuse of Leixlip wash water. Treat wash water to required standard. Options proposed to provide 15 MLD	Volume from wash water is discharged in the River Liffey therefore already considered in the water balance. Therefore this option did not meet the requirements of the Resilience or Deliverability criteria and was rejected at coarse screening stage.	●	●	
TG4-SA9-62	Raising of Poulaphouca reservoir dam in order to increase storage to gain yield available.	Yield from the dam would still be limited by the operation curve. Optimisation of operational regime to increase yield is considered in option 28.	**This option is a repeat and is assessed as part of a different feasible option.**		
TG4-SA9-63	New Surface Water abstraction from the River Poddle. Abstract raw water from the River Poddle and treat locally prior to transfer to the network. Option proposed to provide 0.4 MLD	Option considered not feasible as significant works required to achieve a limited supply of 0.4 MLD and as a urban watercourse there are likely issues with water quality. Therefore this option did not meet the requirements of the Resilience or Deliverability criteria and was rejected at coarse screening stage.	●	●	
TG4-SA9-64	New Surface Water abstraction from the River Bradogue at Cabra. Abstract raw water from the River Poddle and treat locally prior to transfer to the network. Option proposed to provide 0.1 MLD	Option considered not feasible as significant works required to achieve a limited supply of 0.1 MLD and as a urban watercourse there are likely issues with water quality. Therefore this option did not meet the requirements of the Resilience or Deliverability criteria and was rejected at coarse screening stage.	●	●	
TG4-SA9-65	New Surface Water abstraction from the River Swan. Abstract raw water from the River Poddle and treat locally prior to transfer to the network. Option proposed to provide 0.1 MLD	Option considered not feasible as significant works required to achieve a limited supply of 0.1 MLD and as a urban watercourse there are likely issues with water quality. Therefore this option did not meet the requirements of the Resilience or Deliverability criteria and was rejected at coarse screening stage.	●	●	

Option Reference	Option Description	Rejection Reasoning	Resilience	Deliverability & Flexibility	Sustainability (Environmental and Social Impacts)
TG4-SA9-66	New Surface Water abstraction from the River Naniken. Abstract raw water from the River Poddle and treat locally prior to transfer to the network. Option proposed to provide 0.1 MLD	Option considered not feasible as significant works required to achieve a limited supply of 0.1 MLD and as a urban watercourse there are likely issues with water quality. Therefore this option did not meet the requirements of the Resilience or Deliverability criteria and was rejected at coarse screening stage.	•	•	
TG4-SA9-67	Surface Water abstraction from the Royal Canal.	Option considered not feasible as significant works required to achieve a limited supply and as a urban watercourse there are likely issues with water quality. Therefore this option did not meet the requirements of the Resilience or Deliverability criteria and was rejected at coarse screening stage.	•	•	
TG4-SA9-69	Maximize potential of assets	Option removed from screening and taken forward as part of ongoing 'Tactical' improvements, for day to day operations	**This option is a tactical option and is unlikely to meet the full deficit. This will likely be implemented along with a new supply option**		
TG4-SA9-70	Demand management of non-domestic users	Option removed from screening and taken forward as part of ongoing 'Tactical' improvements, for day to day operations	**This option is a tactical option and is unlikely to meet the full deficit. This will likely be implemented along with a new supply option**		
TG4-SA9-71	Stop bunkering ships	Option removed from screening and taken forward as part of ongoing 'Tactical' improvements, for day to day operations	**This option is a tactical option and is unlikely to meet the full deficit. This will likely be implemented along with a new supply option**		
TG4-SA9-72	Change operational regime of Leixlip WTP	Option removed from screening and taken forward as part of ongoing 'Tactical' improvements, for day to day operations	**This option is a tactical option and is unlikely to meet the full deficit. This will likely be implemented along with a new supply option**		
TG4-SA9-73	The Curragh GW abstraction	Repeat of option 48.	**This option is a repeat and is assessed as part of a different feasible option.**		

Option Reference	Option Description	Rejection Reasoning	Resilience	Deliverability & Flexibility	Sustainability (Environmental and Social Impacts)
TG4-SA9-75	Increase Surface Water abstraction from the River Boyne and increase treatment at Staleen WTP. Option proposed to provide 10 MLD.	Option considered not feasible as full abstraction required for south Louth east Meath supply. Increase a further 10MLD is considered likely to result in the waterbody not achieving good WFD status. Therefore this option did not meet the requirements of the Environmental, Resilience or Deliverability criteria and was rejected at coarse screening stage.	•	•	•
TG4-SA9-76	Rainwater harvesting	Option removed from screening and taken forward as part of ongoing 'Tactical' improvements	**This option is a tactical option and is unlikely to meet the full deficit. This will likely be implemented along with a new supply option**		
TG4-SA9-77	Enhanced leakage reduction	This option refers to a "Tactical Option" as planned works are underway across all our WRZs as part of the National Leakage Reduction Programme. However it is unlikely to meet the full deficit on its own. IW is committed to Leakage reduction and targets are included in SDB. As leakage reduction targets will progress in conjunction with other supply options, this option was screened out of the Preferred Approach development phase at coarse screening	**This option is a tactical option and is unlikely to meet the full deficit. This will likely be implemented along with a new supply option**		
TG4-SA9-79	New Ground Water abstraction at Roberstown, Kildare . Option includes abstraction and associated WTP and connection to the GDA network. Option proposed to provide additional 4 MLD	Option considered not feasible as the abstraction was likely to have an impact on the SAC and the option is considered likely to result in the ground waterbody not achieving good WFD status. Therefore this option did not meet the requirements of the Environmental, Resilience or Deliverability criteria. Therefore this option did not meet the requirements of the Environmental criteria and was rejected at coarse screening stage.	•	•	•
TG4-SA9-80	Ringsend WWTP effluent reuse for non-domestic use	This option would require significant network infrastructure to transfer water the treated effluent directly to Non domestic customers and keep the supply separate from domestic supply. Therefore this option did not meet the requirements of the Resilience or Deliverability criteria and was rejected at coarse screening stage.	•	•	

* Water Supply Project Eastern and Midlands Region, Water Supply Options Working Paper, June 2015 - http://www.watersupplyproject.ie/wp-content/uploads/2015/05/150525WSP1_Options-Working-Paper_A011.pdf

Study Area 9 - FS Rejection

Option Reference	Option Description	Rejection Reasoning	Reliability	Deliverability & Flexibility	Environment
TG4-SA9-15a	New Surface Water abstraction from the River Ow. Abstract and treat water from the River Ow before transferring to the GDA. Dam is required at the River Ow to facilitate abstraction. Option proposed to provide 7 MLD	Abstracting the volume of water required to make this a feasible option is considered likely to result in the waterbody not achieving WFD objectives. Therefore this option did not meet the requirements of the Environmental, Resilience or Deliverability criteria and was rejected at fine screening stage.	●	●	●
TG4-SA9-15b	New Surface Water abstraction from the River Ow and the River Aughrim. Abstract and treat water from the River Ow before transferring to the GDA. Dam is required at the River Ow to facilitate abstraction. Raw water transfer from the River Aughrim to the dam to increase volume of water available. Option proposed to provide 11 MLD	Abstracting the volume of water required to make this a feasible option is considered likely to result in the waterbody not achieving WFD objectives. Therefore this option did not meet the requirements of the Environmental, Resilience or Deliverability criteria and was rejected at fine screening stage.	●	●	●
TG4-SA9-18b	New abstraction from Lower Bohernabreena Reservoir. De-silting & Ballyboden WTP upgrade Option proposed to provide 25 MLD	On further review of the this option at fine screening stage it was noted that the proposal would require raising the lower reservoir dam height by 25m and the purchase and demolition of houses, land purchase, including area of forestry and site prep to allow for flooding of valley. Therefore this option did not meet the requirements of the deliverability environmental criteria and was rejected at fine screening stage.	●	●	●
TG4-SA9-31	New Ground Water abstraction at Allenwood. Option includes abstraction and associated WTP and connection to the GDA network. Option proposed to provide additional 5 MLD	Option considered not feasible as uncertainty associated with the actual yield available. Given the status of the aquifer a significant number of boreholes would be required to achieve a limited supply if available. Therefore this option did not meet the requirements of the Resilience or Deliverability criteria and was rejected at fine screening stage..	●	●	

Option Reference	Option Description	Rejection Reasoning	Reliability	Deliverability & Flexibility	Environment
TG4-SA9-35	New Ground Water abstraction at Lucan. Option includes abstraction and associated WTP and connection to the GDA network. Option proposed to provide additional 4 MLD	Option considered not feasible as uncertainty associated with the actual yield available. Given the status of the aquifer a significant number of boreholes would be required to achieve a limited supply if available. Therefore this option did not meet the requirements of the Resilience or Deliverability criteria and was rejected at fine screening stage.	●	●	
TG4-SA9-53	New Surface Water abstraction from the River Slaney. Abstract and treat water at the River Slaney at Glen of Imaal. To obtain abstraction of 12 MLD an impoundment is also required. Option proposed to provide 12 MLD.	Abstracting the volume of water required to make this a feasible option is considered likely to result in the waterbody not achieving WFD objectives. Therefore this option did not meet the requirements of the Environmental, Resilience or Deliverability criteria and was rejected at fine screening stage.	●	●	●
TG4-SA9-56b	Reuse of treated effluent from Shanganagh WwTP. Treat effluent from Swords to a required standard for Non Domestic Customers. Options proposed to provide 30 MLD	This option would require significant network infrastructure to transfer water the treated effluent directly to Non domestic customers and keep the supply separate from domestic supply. Therefore this option did not meet the requirements of the Resilience or Deliverability criteria and was rejected at fine screening stage.	●	●	
TG4-SA9-68	Dublin City appraisal of industrial abstractions at TCD and Guinness (assess in a further step Bankside Filtration in Dublin, like at Budapest)	Option considered not feasible as uncertainty associated with the actual yield available. Given the status of the aquifer a significant number of boreholes would be required to achieve a limited supply if available. Therefore this option did not meet the requirements of the Resilience or Deliverability criteria and was rejected at fine screening stage.	●	●	

Option Reference	Option Description	Rejection Reasoning	Reliability	Deliverability & Flexibility	Environment
TG4-SA9-81	GW in North Meath - Combined volume of 20MLD required between Platin and Kiltrough. Existing abstraction 2.7MLD. Option proposed to provide 17.5MLD to the GDA	The overall WFD status of the groundwater body at Kiltrough is considered poor therefore it was not considered viable to increase an abstraction from this source. Therefore this option did not meet the requirements of the Environmental, Resilience or Deliverability criteria and was rejected at fine screening stage.	●	●	●

Annex C WSP EMR Non-Domestic Demand Forecast

Water Supply Project – Eastern and Midlands Region

Non Domestic Demand Forecast for Ervia

7 September 2020

Reliance restricted

SUMMARY REPORT

Building a better working world

Ernst & Young
Business Advisory Services
Harcourt Centre
Harcourt Street
Dublin 2
D02 YA40
Ireland

Tel: + 353 1 475 0555
Fax: + 353 1 475 0599
ey.com

Reliance Restricted

7 September 2020

Economist Services - Water Supply Project – Eastern and Midlands Region

Dear Sir,

In accordance with the terms of the contract dated 3 February 2020 (the "Agreement"), we are assisting you in providing a Cost Benefit Analysis of the proposed options for the Water Supply Project – Eastern and Midlands Region (WSP); this includes development of a Non-Domestic Demand Forecast and of the Do Minimum option (collectively "the Purpose"). This report addresses the Non-Domestic Demand Forecast. As set out in the tender, the Cost Benefit Analysis will be subject to a number of subsequent updates, including following NWRP and CRU consultation, and in the course of the planning process for the WSP.

Limitations of Scope

We have not, except to such extent as you requested and we agreed in writing, sought to verify the accuracy of the data, information and explanations provided by yourselves, and you are solely responsible for this data, information and explanations. We have therefore relied on the information provided by you to be accurate and complete in all material respects. The report has been provided to you for the above Purpose only and should not be used or relied upon for any other purpose, nor should it be disclosed to, or discussed with, any other party without our prior consent in writing.

Use and distribution of this report

This report is prepared for the purpose set out in the Agreement and may only be used and disclosed, quoted or referred to on the basis set out therein. Notwithstanding the foregoing, it is agreed that Ervia's subsidiary, Irish Water, can use and rely on the non-domestic demand figures in the Non-Domestic Demand Forecast for the purposes of Study Area 9 as part of the National Water Resources Plan. Ernst & Young only accepts responsibility to the addressees of this letter and to Irish Water on the basis of the Agreement (both of which are bound by the terms of the Agreement) and assumes no responsibility whatsoever in respect of or arising out of or in connection with the contents of this letter to parties other than yourselves. If other parties choose to rely in any way on the contents of this letter they do so entirely at their own risk.

We appreciate the opportunity to provide EY's services to Ervia. Should you have any queries or comments regarding this report or if we may be of any further assistance, please do not hesitate to contact us.

Yours sincerely

Ernst & Young

Table of contents

1. Introduction

This report discusses the Non-Domestic Demand Analysis stage of the project, in which a long term water demand forecast has been developed to project the water requirement for industrial and commercial users in the Greater Dublin Area out to 2060. The following areas are covered:

- Key data inputs, sources and assumptions underpinning the analysis
- The methodology used to develop the non-domestic demand forecast
- Non-domestic demand scenario results

This report represents an update of an earlier forecast dated 31 March 2020, to reflect finalisation of actual Non-Domestic Demand for 2019 (the previous estimate of demand was based on data to Q3 2019). The earlier report was based on macroeconomic forecasts produced in Q1 2020, and therefore pre-dated the COVID-19 pandemic.

2. Definitions, data sources, assumptions

2.1 Definition of non-domestic demand

Non-domestic demand relates to metered and non-metered water usage by industrial, commercial, institutional and other non-domestic customers of Irish Water in the Greater Dublin Area (GDA) covering the period 2020-2060.

2.2 Data sources and assumptions

Data Source - Ervia/Irish Water

The information provided by Ervia/Irish Water, and utilised in this version of the CBA, is as follows:

- Metered non-domestic consumption for 2019, by NACE code
- Total non-domestic demand actual estimate for 2019, inclusive of metered demand, unmetered demand and an under reading error allowance. At the time of writing unmetered demand was estimated at 700 litres/day/connection and an under reading error allowance of 5% was included.
- Expected start date, volume and profile of new contracted demand in the GDA (assumptions differ by water demand scenario, with conservative projections for the low scenario, likely projections for the medium scenario and best case for the high scenario)

Macroeconomic forecasts

The following macroeconomic forecasts were incorporated into non-domestic demand forecast modelling at the outset:

- Oxford Economics:
  - Gross Value Added (GVA) forecast for the Greater Dublin Area with sectoral breakdown
  - Note that while the Oxford workforce-based employment forecast for the Greater Dublin Area was initially considered, the Oxford GVA forecast was selected as it is more relevant to water demand.
- EY:
  - Base GVA forecast, with the Oxford Economics GVA forecast sectoral breakdown applied to derive the Greater Dublin Area forecast using EY projections. Note that this forecast was produced in Q1 2020, and therefore the potential impacts of the Covid 19 pandemic have not been accounted for
  - Accelerated 1 and Accelerated 2 forecasts, which reflect strong urban growth in sectors considered as areas of policy focus or comparative advantage in Ireland

The compound annual growth rates (CAGR's) for these forecasts are presented in Table 1 overleaf, followed by a discussion of the methodology underlying the forecasts.

Table 1: Macroeconomic forecast CAGR growth rate comparison

Greater Dublin Area Economic forecasts	2018	2019	2020	2021	2022	2023	2024	CAGR (2018 - 2024)	CAGR (2018 - 2050)
Oxford GVA	7.7%	4.4%	2.3%	1.8%	1.4%	1.2%	1.3%	2.9%	1.4%
EY GVA Base	7.6%	5.8%	3.6%	3.0%	2.9%	2.9%	2.8%	4.1%	2.6%
EY GVA Acc. 1	7.6%	5.8%	4.4%	3.7%	3.6%	3.5%	3.4%	4.6%	3.3%
EY GVA Acc. 2	7.6%	5.8%	4.7%	4.0%	3.8%	3.8%	3.7%	4.8%	3.5%

Oxford Economics:

The Oxford Economics' Ireland workforce-based employment and GDA macro forecasts come from their suite of models. These models are in use across the world and are essentially a neo-classical forecast, in which longer term forecasts reflect a cleared market and thus countries' long-term growth trajectory, which is a trend growth estimate based on long term demographic and productivity (or use of capital) projections.

The models are based on econometric forecasts for Gross Domestic Product (GDP) and output by sector which relies heavily on past data and trends. The local forecasts are derived from labour market data which provides the basis for the GVA sectoral projections. A share of national employment by sector approach is used for the basis of long term local projections. The Oxford Economics long term growth projection for Ireland is towards the lower end of published forecasts for the country.

EY Base Case:

EY publishes its economic forecasts in the Economic Eye publication[1] which is released quarterly. This forecast is produced in-house and covers the island of Ireland. In terms of approach, a similar economic structure to most other forecasting entities (including Oxford Economics) is used, although the model does not contain any long term trend assumptions. It has a broadly Keynesian stock flow structure.

Given the inherent challenge of interpreting Irish headline GDP data, a sectoral model sits below the macro model to allow identification of the underlying trends driving aggregate GDP. Sectoral forecasts use labour market data in conjunction with the GDP data to produce the forecasts. The forecast models run out to 2040; beyond that a trend growth assumption is applied for overall Irish growth, and individual sectors have their outlooks constrained to the overall Irish projection.

EY does not currently publish local forecasts and thus the sectoral shares of the national outlook are taken from the Oxford Economics forecasts to arrive at the EY GDA projections. The macro and sectoral outlooks have been published for 10 years and are used by a wide range of EY clients in Ireland and beyond. The EY base forecast sits towards the upper end of the range of published forecasts for Ireland.

EY accelerated growth scenarios 1 and 2:

These scenarios, compiled for this project, look at a plausible growth trajectory for the GDA that would put it amongst the fastest growing developed cities in the world. This would not be inconsistent with its recent performance. However, it is worth noting that this outlook would most likely drive faster population growth for the area in response to the faster sectoral growth.

[1] https://www.ey.com/en_ie/transactions/economic-eye-forecast

A growth factor is applied to each of the sectors with a strong potential for urban growth or that are considered an area of policy focus or comparative advantage in Ireland. While the growth assumptions underpinning both the accelerated 1 and the accelerated 2 forecasts are similar, a slightly faster trajectory in key growth sectors is assumed for the accelerated 2 outlook. For all other sectors the base forecast remains.

Note that a simplified approach to account for multipliers has been adopted to ensure the forecasts are sensible in the longer term.

The long term growth forecast assumed in these scenarios is 3.3% and 3.5% respectively, which are faster in terms of growth than is assumed in the Oxford published base case forecasts for the Greater Dublin Area (1.4%) and the EY base case (2.6%). The long term sectoral growth rates in the two scenarios are shown in the table below. All manufacturing is treated as a single sector in the model.

Table 2: Growth adjustments by sector applied in EY accelerated 1 and 2 forecasts

Economic forecasts CAGR NACE sector category	EY GVA Acc. 1	EY GVA Acc. 2
Accommodation and food service activities	2.8%	3.0%
Activities of extra territorial organisations and bodies	0.0%	0.0%
Administrative and support service activities	1.4%	1.5%
Agriculture, forestry and fishing	-0.8%	-0.4%
Arts, entertainment and recreation	0.8%	0.9%
Construction	2.9%	3.0%
Education	1.3%	1.4%
Electricity, gas, steam and air conditioning supply	1.6%	1.7%
Financial and insurance activities	3.8%	4.1%
Human health and social work activities	1.4%	1.5%
Information and communication	5.0%	5.4%
Manufacturing	2.5%	2.5%
Mining and quarrying	1.1%	1.1%
Other service activities	1.8%	2.0%
Professional, scientific and technical activities	4.6%	4.6%
Public administration and defence; compulsory social security	1.4%	1.4%
Real estate activities	2.1%	2.2%
Transportation and storage	1.8%	1.9%
Water supply; sewerage, waste management and remediation activities	1.6%	1.7%
Wholesale and retail trade; repair of motor vehicles and motorcycles	0.5%	0.6%

Source: EY

The resulting growth rates by sector for each of the macroeconomic forecasts outlined above are shown in the table overleaf, and the associated water intensity forecast for that sector is also shown for comparison.

Other data sources

Water intensity adjustment factors by sector have been sourced from the 2015 Indecon *WSP Economic Needs Report*[2]. These were developed using an econometric analysis of the WIOD international water usage database[3].

[2] Indecon Economic Consultants, 2015, *WSP Economic Needs Report*. http://www.watersupplyproject.ie/wp-content/uploads/2015/03/Vol-3_WSP-Economic-Needs-Report.pdf

[3] http://www.wiod.org/home

The water intensity factors outlined in the 2015 *WSP Economic Needs Report* could be validated for Ireland if historic non-domestic water demand by sector data were available. However, due to data limitations this data has not been provided for use in this analysis, and we cannot assess the applicability for Ireland specifically with currently available data.

Table 3: Macroeconomic growth rates and water intensity factors by sector

Economic forecasts CAGR NACE sector category	Oxford GVA	EY GVA Base	EY GVA Acc. 1	EY GVA Acc. 2	Intensity factor
Accommodation and food service activities	0.4%	1.9%	2.8%	3.0%	-1.0%
Activities of extra territorial organisations and bodies	0.0%	0.0%	0.0%	0.0%	-1.0%
Administrative and support service activities	2.6%	1.2%	1.4%	1.5%	-1.0%
Agriculture, forestry and fishing	-2.1%	-0.8%	-0.8%	-0.4%	-0.5%
Arts, entertainment and recreation	0.8%	0.7%	0.8%	0.9%	-1.0%
Construction	1.4%	2.7%	2.9%	3.0%	-1.0%
Education	0.2%	1.3%	1.3%	1.4%	-1.8%
Electricity, gas, steam and air conditioning supply	-0.4%	1.5%	1.6%	1.7%	-2.0%
Financial and insurance activities	1.0%	3.2%	3.8%	4.1%	-1.0%
Human health and social work activities	1.5%	1.4%	1.4%	1.5%	-1.8%
Information and communication	2.4%	4.2%	5.0%	5.4%	-1.0%
Manufacturing	1.5%	1.6%	2.5%	2.5%	-1.3%
Mining and quarrying	-1.6%	1.1%	1.1%	1.1%	-1.0%
Other service activities	0.4%	1.5%	1.8%	2.0%	-1.0%
Professional, scientific and technical activities	0.6%	2.8%	4.6%	4.6%	-1.0%
Public administration and defence; compulsory social security	0.2%	1.3%	1.4%	1.4%	-1.0%
Real estate activities	0.3%	2.0%	2.1%	2.2%	-1.0%
Transportation and storage	0.4%	1.6%	1.8%	1.9%	-1.0%
Water supply; sewerage, waste management and remediation activities	0.0%	1.5%	1.6%	1.7%	-1.0%
Wholesale and retail trade; repair of motor vehicles and motorcycles	0.3%	0.5%	0.5%	0.6%	-1.0%

Source: EY

We also believe that over the long term there may be a floor to how much output can be generated with each unit of water used as an input. Indecon have accounted for this by assuming that water intensity in Ireland will be half that estimated by econometric analysis of the WIOD international water usage database).

From a modelling perspective, positive economic growth forecasts by sector have a positive effect on water demand, while water intensity factors have a negative effect on demand, as a unit of output requires declining water volumes over time, due to technology improvements and changes in behaviour, for example.

Outstanding data

Metered data by sector for previous years to test the forecasting approach results and the water intensity factors against historic values were not provided; metered data by sector was available for 2019.

Assumptions

- Metered users with no consumption in 2019 are not projected to have consumption in the future

- It is assumed that metered connections with no NACE sectoral description are not in the manufacturing sector, as manufacturing users (i.e. large users) are likely to be metered
- Similarly, it is assumed that unmetered connections are not in the manufacturing sector
- Outliers have been identified as being those over 2 Megalitres per Day (MLD); however as all outliers are classified as manufacturers and are included in a single category in the model, that sector's growth and water intensity rates are applied
- Assumptions around the timing and profile of new contracted demand have been provided by Ervia and are outlined in Table 4 overleaf

3. Methodology

The approach which has been taken to develop this forecast is outlined below:

1. Actual non-domestic water demand in the Greater Dublin Area for the calendar year 2019 has been supplied by Ervia and incorporated into the non-domestic demand model. Both demand at the individual meter level inclusive of NACE sectoral level description where available, and an overall level of total non-domestic demand (inclusive of unmetered and an under-reading error allowance) have been incorporated

2. Underlying water demand for the Greater Dublin Area has then been projected, using economic growth rates from EY real GVA forecasts for the Greater Dublin Area and water intensity adjustment factors by sector (sources outlined in section 3.2.2 above):

   a) Taking 2019 actual metered non-domestic demand by NACE sector, a water usage factor has been calculated for each sector. This factor describes the relationship between water usage and economic growth by sector as observed in 2019

   b) Water intensity adjustment factors are then applied by sector to recognise the expected improvement in the efficiency of water use, with less water required over time per unit of economic output

   c) Outliers are flagged, with the threshold set at 2 MLD/day. Outliers are grown at the rate of, and adjusted by, the water intensity for the manufacturing sector (as all three outliers are in the manufacturing sector)

   d) Users with no sectoral NACE data and unmetered use are forecasted taking economic growth rates for non-industrial sectors and assuming that water intensity adjustments should reflect non-industrial sectoral expectations

3. The following three scenarios have been developed. The Low, Medium and High scenarios are differentiated by the underlying macroeconomic forecast, the assumptions provided by Ervia around the profile and level of demand from new contracted demand, and whether growth and water intensity factors should be applied to the demand from this contracted demand

Table 4: Non-domestic forecast scenario assumptions

Scenario	Macroeconomic forecast input (for GDA)	43 MLD contracted demand	40 MLD contracted demand	Growth and efficiency applied for contracted demand
Low	GVA - EY base	Excluded	Excluded	n/a
Medium	GVA - EY accelerated 1	9 MLD in 2021, growing to 19 MLD in 2022, 38 MLD in 2023 and 43 MLD in 2024 included	7 MLD included from 2023	No
High	GVA - EY accelerated 2	9 MLD in 2021, growing to 19 MLD in 2022, 38 MLD in 2023 and 43 MLD in 2024 included	7 MLD in 2023 rising to 40 MLD by 2030 Included	Yes

4. Non-Domestic demand forecast

The results of the non-domestic forecast modelling are set out in the following table. An EY Low, Medium and High forecast has been generated.

The EY medium forecast sees NDD growing from 139MLD in 2019 to 256MLD in 2060. This scenario is used as input to the Do Minimum option as developed in Chapter 3 in the CBA report. Although it is based on a macroeconomic growth forecast for the GDA which is somewhat faster than EY's published long term macroeconomic forecast, it is more in line with the recent past in the GDA, and is reflective of the policy ambitions at national and regional level. It was concluded that in the current context a prudent approach to forecasting future demand needs should be taken.

Table 5: Non-domestic demand forecasts, and EY Low, Medium, and High scenarios (MLD)

		2019	2021	2026	2031	2041	2046	2050	2060	CAGR 19 - 50	CAGR 19 - 60
Base forecasts											
Inclusive of 5% under reading error allowance, exclusive of any new contracted demand											
GVA - Oxford Economics		139	138	136	134	131	129	128	125	-0.3%	-0.3%
GVA - EY base		139	142	145	148	154	157	158	161	0.4%	0.3%
GVA - EY accelerated 1		139	144	151	159	176	185	191	206	1.0%	1.0%
GVA - EY accelerated 2		139	144	153	162	181	190	197	214	1.1%	1.1%
Scenario driven forecasts											
Inclusive of 5% under reading error allowance, inclusive of contracted demand where applicable											
GVA - EY base	EY Low	139	142	145	148	154	157	158	161	0.4%	0.3%
GVA - EY accelerated 1	EY Medium	**139**	**153**	**201**	**209**	**226**	**235**	**241**	**256**	**1.6%**	**1.5%**
GVA - EY accelerated 2	EY High	139	153	217	248	282	299	313	345	2.5%	2.2%
	Min	139	142	145	148	154	157	158	161	0.4%	0.3%
	Max	139	153	217	248	282	299	313	345	2.5%	2.2%

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