Draft Water Resources Management Plan 2024

Appendix G – Our preferred plan & adaptive pathways

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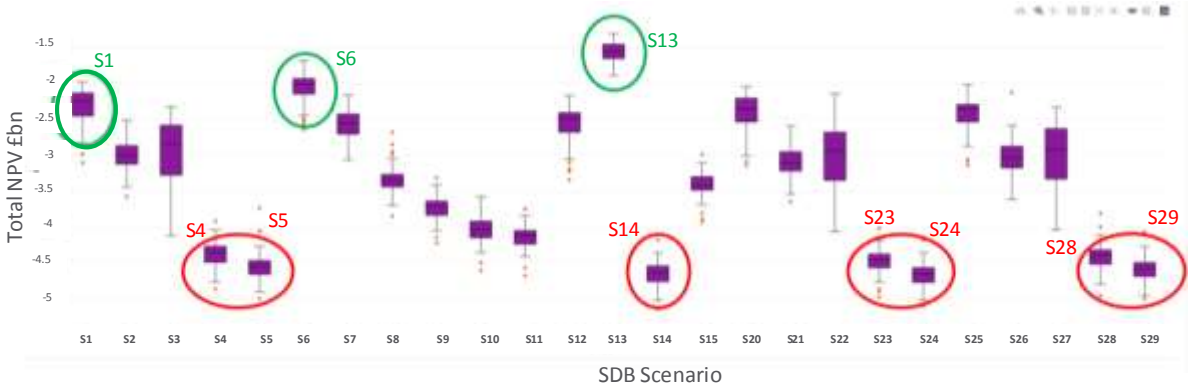
Appendix G: Our Preferred Plan and Adaptive Pathways

In this section we describe our preferred plan to accommodate the most likely future changes in supply and demand for water, while also maintaining flexibility to adapt to future uncertainties. In the preceding appendices we have described the approaches we have used to assess the scale of potential future supply and demand needs and the information we have used to inform our choices.

Our long-term water resources strategy is built around our commitments to halve water leakage by 2045 and to make our contribution towards achieving the government's household consumption target of 110 litres per head per day. All of the potential future investment scenarios we have explored have these commitments at their heart. Our investment scenario modelling has then assessed what additional investment might be needed in new or replacement water supply capacity in order to meet future demand for water.

Figure G1.1 illustrates an example of the broad range of water supply investment programmes associated with the future scenarios we have modelled. We can see the magnitude of difference between the most benign and the most challenging scenarios and we can explore the cost impacts of planning for a wide range of different possible futures.

Figure G1.1: Illustration of a range of different possible programme costs



Using the decision-making framework already described in Appendix F, we have derived a preferred plan that represents our most likely future investment needs. We have also explored a wide range of future scenarios and identified alternative possible future pathways that best represent a plausible range of likely futures.

The following sections describe our preferred plan along with the alternative plans that we have assessed along the way.

G1 The preferred best value plan

Our preferred plan is based around our commitments to halve leakage by 2045 and to roll out a universal household metering programme by 2035, accompanied by enhanced water efficiency activities that will help customers reduce their consumption.

The preferred plan also includes the no / low-regret new water supply options that we believe will be necessary over the next five to ten years to accommodate the vast majority of future potential long-term supply / demand scenarios.

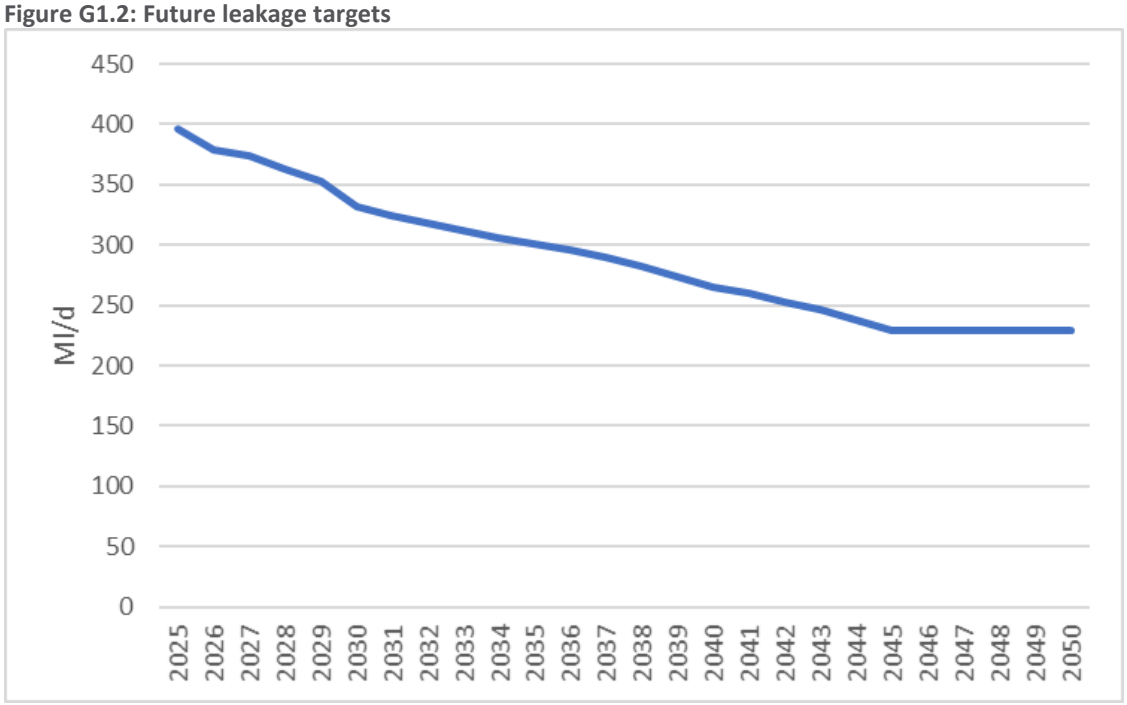
Our preferred plan also indicates some large and challenging supply options that are likely to be required by the 2050s to meet the challenges presented by the Environment Agency's environmental destination scenarios as well as the impacts of climate change.

G1.1 Leakage reduction

In WRMP19 we set out our long-term commitment to halve water leakage by 2045 and that commitment continues in this latest dWRMP24. We have reviewed the planned leakage reduction profile and have amended it to reflect AMP7 performance and the likely future supply and demand pressures faced in different water resource zones.

Our planned leakage reduction profile to meet our 2045 commitment is shown in Figure G1.2.

Figure G1.2: Future leakage targets



Our leakage reduction ambition is extremely stretching and will require more investment in a range of interventions to help drive down leakage from our network and from customers' pipes. Those activities include:

- Active leakage control: this is the activity to find and fix leaks as they occur on our distribution network. This becomes progressively more expensive as leakage reduces and smaller leaks become more difficult to find.

- Mains renewal: we need to increase the rate at which we renew mains in order that we can offset the effects of an ageing network and proactively prevent future leaks from occurring. Active leakage control alone will not be sufficient to reduce total leakage by 50% and an increase in mains renewal rates is needed to prevent the overall deterioration of our network over time and reduce the likelihood of future mains bursts and leakage occurring.

- Pressure management: reducing pressure in our supply system helps reduce leakage outbreak although it does not improve the condition of the network assets.

- Reducing trunk mains leakage: we will increase the number of meters on our trunk mains and improve our ability to find and fix trunk mains leaks.

- Household water metering: we plan to achieve near universal household meter coverage by 2035 using smart meter technology. This will deliver additional leakage benefits by helping us to identify leaks on customers' supply pipes and proactively repair them. As we drive down leakage on our water distribution network, an increasing proportion of total leakage will come from customers' supply pipes unless we intervene.

The combined benefits from increased investment in these activities will be required if we are to achieve our 50% leakage reduction target. The costs of these activities are included in our PR24 business plan.

G1.2 Water metering

In WRMP19 we described our strategy to achieve near universal water metering coverage across our household customer base by 2035. At that time our preferred approach was to proactively install water meters and encourage our customers to switch to measured charging over time. Since WRMP19 the Environment Agency has updated its water scarcity status assessment and has officially designated Severn Trent as being in a seriously water stressed area.

Our AMP7 metering strategy is based on three components:

- Free option (Customer Requested or 'FROPT'),
- Proactive meter install followed by customer persuaded option,
- A maintenance strategy to replace old or broken meters reactively,

Our FROPT policy alone would only achieve 71% penetration by 2035 and so we have assessed the best options to accelerate metered charging uptake.

Most Water Companies have started or plan to start a smart metering strategy this coming AMP and we have used their experiences to help inform our choices. Furthermore, as part of Ofwat's Green Recovery investment plan, we were awarded funding to trial a Smart Meter Network to understand the benefits of a Smart Network in the SvE region.

To inform our preferred metering approach we have assessed the costs and benefits of a number of scenarios which considered differing combinations of the options below:

- Stay with our AMP7 FROPT/Persuaded strategy
- Switch to a compulsory metering policy
- Stay with AMR (semi-smart) meter technology
- Adopt AMI (smart) meter technology
- Maintain our fix/replace on fail maintenance strategy
- Switch to a proactive maintenance strategy

As a result of the change in water scarcity status and having considered the different options, we are recommending a move to compulsory metering using AMI technology. Based on an assessment of supply pipe repairs, leak run times and industry studies we estimate the benefits as:

- Consumption: a 15% reduction = 21.3 litres per day/0.021m^3 for every new AMI Meter installed
- Leakage: 0.024m^3/day customer side leak reduction
- Total benefit: 0.045m^3 day per meter installed

We continue with our Green Recovery smart metering technology trial to improve our understanding of the costs and benefits of the different meter technology and roll out options.

Overall, we expect to install 1.1m new smart meters and proactively upgrade 1.4m existing meters by 2035. As part of our overall smart metering strategy, we are also considering the phasing options and associated costs of replacing our existing meter asset base to AMI.

G1.3 Water efficiency

Our universal water metering programme is complemented by our proactive water efficiency activities which will help customers reduce their water consumption and save money on their bills. We are committed to doing our part to help achieve the government's consumption target of 110 litres per head per day by 2050.

Our water efficiency activities include:

- Provision of free and subsidised products to household customers. We intend to increase promotion of these to drive an increase in uptake.
- Extending our home water efficiency audits (HWEC) to housing association tenants and our highest water using customers, where we will:
    - Give advice on reducing the volume of water they use,
    - install water efficient devices where appropriate
    - repair leaks on internal fittings where it is simple to do so.
- As we roll out our universal metering programme and make increasing use of smart meter technology, we will proactively use leak alarms to identify opportunities to repair supply pipe leaks.
- Incentives to housebuilders to build new properties to higher water efficiency standards than those required by Building Regulations. We will also target new build homes to help identify and repair leaking toilets which from previous work we understand may be a significant cause of demand in new build properties.
- Continuing to provide advice to our customers on how to reduce their water use which includes continuing our work with schools which includes site visits and online interactive sessions.

Overall, we expect our proactive metering and water efficiency activities to reduce average per capita consumption to around 118 litres per head per day by 2050. We know that the government also intends to introduce legislation that will require mandatory water efficiency labelling of white goods. Once this legislation is enacted we expect this to help drive per capita consumption down even further. These product technology changes will be essential if we are to achieve the government's overall target of 110 litres per head per day by 2050.

As well as working with household customers we will also extend our proactive water efficiency activities to work with non-household customers to help them reduce water consumption. We will use the learning from

our AMP7 Green Recovery delivery and other trials of working with schools and local authorities to extend these services in future. Will also continue to explore opportunities to help non-household customers with rainwater harvesting options.

Our preferred plan includes the demand saving benefits that will accrue from our proactive metering and enhanced water efficiency activities. In the longer term, we have also included the demand saving benefits that we expect to arise as the government implements the measures described in its July 2021 Written Ministerial Statement on reducing demand. The government has set out its intentions to :

- make regulations to introduce a mandatory water efficiency label to inform consumers and encourage the purchase of more water efficient products for both domestic and business use.
- develop a roadmap towards greater water efficiency in new developments and retrofits, including the exploration of revised building regulations and how the development of new technologies can contribute to meeting these standards. The government will ensure that the underlying legislation can, where appropriate, accommodate any potential future expansion of rainwater harvesting, water re-use and storage options.

These government led initiatives have the potential to make a material reduction in our future water demand projections and in our preferred plan we have included these benefits from 2050 onwards.

G1.4 Our preferred water supply options

Our preferred plan promotes options that make best use of existing sustainable sources of supply. We have described in Appendix D how the challenges around long term sustainable abstraction predominantly affect our groundwater sources of supply. As a result, we have very few feasible options to increase groundwater abstraction. Instead, our feasible options generally feature increased use of our existing reservoirs and river water treatment works along with new infrastructure to distribute that water to areas of need.

Table G1.1 summarises the preferred new supply options that feature in our dWRMP24 to maintain supply and demand for water between now and 2050. The options prioritised for AMP8 and AMP9 are considered to be no / low-regret options that would be needed in multiple potential future scenarios. The need for these options is driven by the impacts of the Environment Agency abstraction licensing policy to prevent deterioration of Water Framework Directive status and to ensure we can achieve the required 1 in 500 year drought resilience standard.

Table G1.1: Our preferred water resources programme

AMP 8		AMP 9		AMP 10		AMP 11		AMP 12 and beyond	
Trimpley DO recovery	4Ml/d	Import to Mardy	1Ml/d	UU import to Shelton WTW	25Ml/d	West Midlands Quarry	-	West Midlands Quarry	33Ml/d
Whitacre DO recovery	4Ml/d	Terminate DV export to YKS	35Ml/d	Raise Tittesworth	-	Raise Tittesworth	-	Raise Tittesworth	14Ml/d
Expand Shelton	12Ml/d	Derwent Valley Storage Increase	-	Derwent Valley Storage Increase	-	Derwent Valley Storage Increase	-	Derwent Valley Storage Increase	60Ml/d
Carsington to Tittesworth	30Ml/d*	New WTW near Stafford	-	New WTW near Stafford	-	New WTW near Stafford	23Ml/d	Milton groundwater source	5Ml/d
Transfers from Grid to Notts (Heathy Lea)	37Ml/d*					Third Party Reservoir and new WTW's	-	Third Party Reservoir and new WTW's	18Ml/d
Homesford expansion	5Ml/d					River Weaver new WTW	-	River Weaver new WTW	20Ml/d
Expand Strensham WTW	15Ml/d					New River Trent WTW at Notts	-	New River Trent WTW at Notts	30Ml/d
Little Eaton DO recovery	5Ml/d					East Midlands Quarry	-	East Midlands Quarry	24Ml/d
Draycote Reservoir expansion	9Ml/d					New groundwater near Soar	-	New groundwater near Soar	5Ml/d
UU Vyrnwy release to River Severn	23Ml/d					Ogston expansion	15Ml/d	Hampton Loade to Nurton	12Ml/d*
								Imports from UU to North Staffs	8Ml/d
								Draycote DO recovery	4Ml/d
								Elmhurst new borehole	2Ml/d
								Transfers from Grid to Notts (Ambergate)	30Ml/d
								Bham to Wolves link	32Ml/d*
								Dam extensions at Whitacre, Stanford, Shustoke	9Ml/d
								Ruyton support link main	1Ml/d
								Oldbury to Meriden	15Ml/d
								UU import to Kinsall	1Ml/d
								Blackbrook Reservoir	8Ml/d
								Campion Hills DO recovery	2Ml/d

										East Midlands Quarry	45Ml/d
										Carsington expansion	110Ml/d
										Carsington to Tittesworth phase 2	16Ml/d*
Total	144Ml/d	Total	36Ml/d	Total	25Ml/d	Total	38Ml/d			Total	504Ml/d

(These are internal transfers and the Ml/d shows the maximum expected utilisation in the planning period)*

A summary of these recommended schemes is set out below. Those schemes proposed for AMP8 and AMP9 form part of our low / no-regret investment plan and are consistent with the 'core' pathway we have included in our PR24 business plan submission to Ofwat.

In the longer term, some of the recommended scheme options are more complex to deliver and their costs and benefits more uncertain. Our PR24 business plan includes the costs of continuing to develop the feasibility of these longer-term options in order to make sure that they are deliverable in the time required.

A summary of the water resource schemes included in our preferred plan is given in tables G1.2 – G1.5 below.

Table G1.2: Summary of the recommended AMP8 schemes

AMP 8		
Trimpley DO recovery	4Ml/d	This scheme is to enhance the water treatment capacity of our existing Trimpley water treatment works to enable the site to sustainably operate at 60Ml/d output for longer periods of time. The scheme requires: - Rapid Gravity Filters (RGFs) - Replacement of current interstage pumps - Granular Activated Carbon (GAC) adsorbers - Washwater tank
Whitacre DO recovery	4Ml/d	This scheme is to enhance the water treatment capacity of our existing Whitacre water treatment works to enable the site to sustainably operate at 49Ml/d output for longer periods of time. The scheme requires: - Granular activated carbon adsorbers - Low lift pumps at Whitacre reservoir - Replacement of existing interstage pumps - Additional 2 x new pumps at River Blythe pumping station - Additional capacity of Eel screen
Expand Shelton	12Ml/d	This scheme is to enhance the water treatment capacity of our Shelton water treatment works with a new 10Ml/d process stream that will enable more optimal use of the full existing River Severn abstraction licence at the Shelton water treatment works site.
Carsington to Tittesworth	30Ml/d	This scheme is to enable the transfer of raw water from the River Derwent and Carsington Reservoir to Tittesworth water treatment works through the provision of a new pumped raw water pipeline. The additional raw water will enable water in Tittesworth Reservoir to be conserved for dry periods thus enabling Tittesworth water treatment works to operate longer into dry seasons and deploy additional potable water into the North Staffs WRZ. The scheme is sized for a maximum raw water transfer of 30Ml/d plus distribution system network enhancements to allow the treated water to be deployed into the wider water resource zone. The scheme requires:

		- 42.6km of new 800mm dia pipeline between Carsington Reservoir and Tittesworth water treatment works with an associated new 30Ml/d pumping station. - New settlement lagoon near to Tittesworth Reservoir to receive raw water from Carsington Reservoir. - Connection to the inlet of Tittesworth water treatment works. - New pumping station and 14.8km of new 700mm distribution pipeline.
Transfers from Grid to Notts (Heathy Lea)	37Ml/d	This scheme is to transfer water from the Strategic Grid water resource zone to Nottinghamshire water resource zone. The transfer will be enabled by making a new connection from the Derwent Valley Aqueduct (DVA) in the Strategic Grid to the distribution system in Nottinghamshire water resource zone. The scheme requires the following: - 36.9km of new 700mm dia pipeline. - A new 633kW pumping station.
Homesford expansion	15Ml/d	This scheme is to increase the capacity of Homesford water treatment works to 54Ml/d to enable treatment of the high flows during spring/summer. Treated water is then to be deployed into the Derwent Valley Aqueduct via a new booster station. The scheme requires the following: - Chlorine and Phosphate dosing - Storage reservoir of 800m3 - 325kW pumping station to lift water to DVA - Ultrafiltration system
Expand Strensham WTW	5Ml/d	This scheme is to expand the capacity of Strensham water treatment works by 30Ml/d and construct a new intake at Upton-upon-Severn. This additional water will be transferred to the expanded Strensham treatment works predominantly in winter when there is greater water availability in the River Severn. This scheme also complements the investment required, and that is detailed in our PR24 business case, on resilience and water quality. The following activities are required for the scheme: - New 30Ml/d river intake and pumping station on the River Severn near Upton-upon-Severn. - 5km of 800mm diameter pipeline from the River Severn Intake to Strensham water treatment works. - 30Ml/d expansion of Strensham water treatment works to treat additional water. - Pumping Station at Strensham water treatment works.
Little Eaton DO recovery	5Ml/d	This scheme is to expand the capacity of Little Eaton water treatment works to enable the site to sustainably operate at 88Ml/d output for longer periods of time. The scheme requires: - Two new GAC adsorbers - One Lamella clarifier - WRc thickeners sufficiently sized for increased flow
Draycote Reservoir expansion	9Ml/d	The scheme is to increase the storage capacity of Draycote Reservoir by 6% by raising the top water level by 0.6m. This increase in water level will add 1,400 Ml of capacity to the current reservoir capacity of 22,730Ml. The additional raw water will be treated at Draycote water treatment works and deployed to the Strategic Grid zone. The scheme requires the following activities: - Raise the overflow weir sill by 0.6m - Raise a bridge by 0.6m to retain its existing clearance from the water.

Vyrnwy Reservoir releases to River Severn	25Ml/d	This scheme is to enable managed release of an additional 25Ml/d of raw water from Lake Vyrnwy into the River Vyrnwy that subsequently augments flow in the River Severn to support Severn Trent abstractions on the River Severn.
Total	**151Ml/d**	

Table G1.3: Summary of the recommended AMP9 schemes

AMP 9		
UU import to Mardy	1Ml/d	This scheme involves a new treated water import from our Shelton WRZ to Mardy WRZ.
Terminate DV export to YKS	35Ml/d	This scheme involves terminating the Derwent Valley Reservoirs export agreement with Yorkshire Water Service Limited. This will provide Severn Trent with an anticipated additional 21,550Ml/yr (59Ml/d) raw water in the Derwent Reservoirs. This additional water will be stored and utilised during dry periods and will enable Severn Trent to keep operating Bamford water treatment works at higher capacity during dry seasons. No capital works are required by STWL for this scheme, although there will be a loss of annual revenue from the bulk supply agreement and an operational change associated with abstracting and treating additional raw water. This scheme is associated with the Upper Derwent Valley Reservoir Expansion strategic resource option project.

Table G1.4: Summary of the recommended AMP10-12 schemes

AMP 10 to AMP12		
UU import to Shelton WTW	<25Ml/d	This scheme involves an import of up to 25Ml/d from United Utilities' Llanforda water treatment works using the existing booster pumping station to serve customers in and around Oswestry and further extending the benefit eastwards towards Shelton water treatment works. The import will fully replace the existing transfer in the Shelton Link Main enabling this supply to be utilised elsewhere in the zone. The scale of the import will also enable the imported supply to be transferred eastwards, reversing flow in the Shelton Link Main to further increase the number of customers supplied from the import. The scheme requires the following: - New agreement to be established with UU for this import. - Pumping station upgrade at the Llanforda booster pumping station to deliver 25Ml/d towards Oswestry, Pant and Shelton water treatment works. - Upgrades to the connections between the Llanforda booster pumping station and Severn Trent network.
Raise Tittesworth	14Ml/d	This scheme is to increase the storage capacity of Tittesworth Reservoir by 25%. The capacity increase will enable additional water in Tittesworth Reservoir to be conserved for dry periods thus enabling Tittesworth water treatment works to operate at higher capacity longer into dry seasons. The additional raw water will be treated at Tittesworth treatment works and deployed to the North Staffs water resource zone. This scheme will raise the top water level by 2.3m from 196.90m AOD to 199.2m AOD. This increase in water level will add 1,610 Ml of storage to the current reservoir (6,400Ml). The scheme requires the following: - Demolishing the existing wave wall and constructing a new wall. - Raise existing embankment by 2.3m. - Increase bellmouth weir crest level. - Modify the draw-off tower with extension of pipework, reconstruction of control house and provision of additional valves.

		- Install an internal lining to strengthen the draw-off culvert. - Provide a longer access bridge from the raised crest levels. - Placement of rip rap along the toe of the road embankment near to the expanded reservoir.
Derwent Valley Storage Increase	60Ml/d	The concept of this scheme is to increase the storage in the Derwent Valley Reservoirs complex by increasing the height of an existing dam. This will enable storage of more raw water in the Derwent Reservoirs, and enable a higher output from Bamford WTW to be maintained for longer into dry seasons. For the purpose of the WRMP scheme a 10m raising has been selected. The proposed construction methodology assumed for the raising is the use of post tensioned anchors to add a structure onto the crest of the existing dam. The scheme concept used in the dWRMP24 has been superseded by the more detailed engineering and environmental appraisal done for the UDVRE strategic resource option. See the UDVRE SRO reports for more up to date information.
West Midlands Quarry	-	This scheme is to convert an existing third-party owned quarry site to a pumped raw water storage reservoir. To achieve a water resource benefit, the scheme will enable raw water abstraction of 100 Ml/d at times of high flow in the River Severn that can be stored until such times as there are low flows when a return release of up to 50Ml/d can be made to the River Severn. In turn this will be used to support existing abstractions downstream at Trimpley or Lickhill, where water can be transferred for treatment into the Strategic Grid. This option includes the construction of a dam around part of the quarry structure. Initial estimates of working volume provided by this option will be approximately 4,900Ml subject to the ground levels once mineral extraction ceases. The scheme comprises the following functional components: - A new abstraction site on the River Severn with associated structure. - New bi-directional pipeline and associated pumping station. - Discharge mechanism into the quarry. - Quarry conversion and dam, with emergency drawdown provision as required. - Abstraction from the quarry and connection into the bidirectional pipeline - Discharge into the River Severn - Abstraction from the River Severn for treatment and subsequent distribution of potable supply to customers.
New River Trent WTW at Notts	30Ml/d	This scheme provides additional resource to Nottinghamshire WRZ by establishing a new abstraction point on the River Trent with associated raw water storage reservoir near to Stoke Bardolph to supply raw water to a new water treatment works (near to the abstraction site. Potable water will be deployed to the distribution system north of Nottingham. The assumption is that the abstraction may require trading of abstraction rights with other existing abstractors. The scheme requires: - New intake on the River Trent and associated intake pumping station - Two new bank side storage reservoirs to total 8000Ml capacity offering 160 days of storage - Low lift pumps and pipelines to transfer raw water from the storage to the new WTW. - A new 50Ml/d water treatment works - A new 1,805kW high lift pumping station for potable water - 9km of new 900mm diameter pipeline from the new WTW to the receiving distribution system
New WTW near Stafford	23Ml/d	This scheme will provide benefit to Stafford water resource zone which is currently supplied exclusively by groundwater sources. The notional scheme is to construct a new abstraction point on the River Sow near Little Haywood with an adjacent water treatment works and transfer of treated water.

		The scheme requires the following: - 25Ml/d raw water intake and pumping station on the River Sow - 25Ml/d new water treatment works - 14.9km (total) of new 700mm diameter pipelines - A new 515kW pumping station to transfer the potable water
River Weaver new WTW	20Ml/d	This scheme is to provide an additional source of supply into North Staffordshire water resource zone. This zone is currently supplied principally from groundwater sources with support from Tittesworth reservoir. The scheme involves constructing a new abstraction point and water treatment works at the River Weaver near Nantwich. The treated water will be deployed into the existing network. The scheme requires the following: - A new 20Ml/d river intake and pumping station (626kW) on the River Weaver, south of Nantwich. - A new settlement tank to accept the raw water prior to the WTW - 20 Ml/d new water treatment works close to the settlement tank and abstraction point. - A new 626kW pumping station and 460m of pipeline - Connecting pipework between the river abstraction point, settlement tank and the WTW.
Raise Tittesworth	14Ml/d	This scheme is to increase the storage capacity of Tittesworth Reservoir by 25%. The capacity increase will enable additional water in Tittesworth Reservoir to be conserved for dry periods thus enabling the water treatment works to operate at higher capacity longer into dry seasons. This scheme will raise the top water level by 2.3m from 196.90m AOD to 199.2m AOD. This increase in water level will add 1,610 Ml of storage to the current reservoir (6,400Ml). The scheme requires the following: - Demolishing the existing wave wall and constructing a new wall. - Raise existing embankment by 2.3m. - Increase bellmouth weir crest level. - Modify the draw-off tower with extension of pipework, reconstruction of control house and provision of additional valves. - Install an internal lining to strengthen the draw-off culvert. - Provide a longer access bridge from the raised crest levels. - Placement of rip rap along the toe of the road embankment near to the expanded reservoir.
Third party reservoir purchase + WTW	18Ml/d	This scheme is to agree purchase of a third party reservoir and construction of a new water treatment works. The reservoir, previously used for industrial purposes, would provide raw water to a new 18Ml/d water treatment works constructed close to the reservoir. Treated water will be deployed to the existing trunk main system via two new pipelines. The scheme requires: - Engagement with existing owners and subsequent purchase of reservoir - A new intake structure at the reservoir and new 226kW raw water pumping station. - A new 18Ml/d water treatment works with pipeline connection to the new intake. - 7km of new 600mm dia pipeline from the new water treatment works - A new 570kW pumping station - 13.4km of new 450mm dia pipeline - A new 137kW pumping station to transfer water from the new water treatment works to customers in Beanfield and Market Harborough - Reline 3km of existing pipeline - Clean 4km of existing pipeline between in Market Harborough.

Ogston expansion	15Ml/d	This scheme is to expand Ogston water treatment works and make better use of raw water in the River Derwent sources. Ogston water treatment works is supplied with raw water from Ogston Reservoir that in turn receives both natural inflow and a pumped supply from the River Derwent (or transfer from Carsington Reservoir). The additional output from Ogston treatment works can be used to support customers in the Strategic Grid water resource zone and support operational flexibility with the large number of groundwater sources to the east of Mansfield in the Nottinghamshire water resource zone. To enable the additional transfer, treatment and deployment of water from Ogston water treatment works, it is anticipated that the following will be required: - Modify raw water pumps at the Ambergate River Derwent intake to achieve 130Ml/d peak winter transfer to Ogston Reservoir and 110Ml/d from Carsington Reservoir direct to Ogston in the summer periods (Carsington licence may need to be modified). - Upgrade the existing New Ogston water treatment works to achieve 55Ml/d - Build a third 40 Ml/d treatment process stream giving a total Ogston output of 120Ml/d. - clean mains to enable flows to be reversed in winter. - Install any pipelines/boosters required to transfer an additional 40 Ml/d summer output from Ogston WTW to the Derwent Valley Aqueduct (DVA).
Milton groundwater source	5Ml/d	The scheme concept is to recommission the Milton groundwater source and use the raw water to support Melbourne Water Treatment Works and supply the Strategic Grid water resource zone. The scheme requires: - rehabilitation of Milton source (re-drill boreholes if necessary) and abandon the Stanton by Bridge groundwater source. - A new pipeline (2.1 km length) will be required to connect the Milton site to existing pipeline infrastructure that connects with Melbourne water treatment works. - A new pumping station will be required to lift raw water from Milton through the new pipeline and into the existing mains to Melbourne water treatment works.
New groundwater near Soar	5Ml/d	This scheme is to establish two new production boreholes in the Soar - PT sandstone groundwater body located to north of Coalville. Approximately 5Ml/d raw water will be abstracted from these new boreholes and will be transferred to Melbourne water treatment works using new pumps and pipeline. The scheme requires the following: - Establish suitable site and drill two new boreholes - Two new 85kW borehole pump sets and headworks - 2.2km of new 350mm dia pipeline from the boreholes to Melbourne water treatment works - A new 24.4kW pumping station to lift water from the boreholes to Melbourne
Hampton Loade to Nurton	12Ml/d	This scheme is to redirect some of the potable supply received from Hampton Loade water treatment works towards the Shelton water resource zone instead of it being delivered the Wolverhampton zone. The intention is to deliver up to 10Ml/d to Shelton zone, essentially achieving a transfer of water from the Wolverhampton zone. The resulting reduction of supply to Wolverhampton zone may need to be substituted by another scheme. The scheme requires the following: - 11.7km of new 500mm dia pipeline will be connected to existing distribution system and transfer water to the Shelton WRZ.

UU Peckforton import	5Ml/d	This scheme is to import treated water from United Utilities' Vyrnwy aqueduct close to the existing Severn Trent site at Peckforton. The existing mains will be used to transfer up to 5Ml/d of imported additional water to the North Staffs zone. This will reduce reliance on the borehole sites of Peckforton, Tower Wood and Tattenhall. The scheme requires the following: - Reinstate and reuse the existing (disused) connection and link main between Peckforton and the Vyrnwy aqueduct in the reverse direction. - Install/upgrade network chlorination at two existing sites along the Peckforton main to maintain chlorine residual. - Decommission existing booster chlorination stations. - Upscale the existing chloramination plant. - Install a new 282kW pumping station. Ongoing discussion with Unitied Utilities suggest that up to 20Ml/d could be available. We continue to explore this option between draft and final WRMP.
UU Mow Cop import	2Ml/d	This scheme is to import potable water from United Utilities' Mow Cop borehole to the North Staffordshire water resource zone.
UU Bearstone import	1Ml/d	This scheme is to import potable water from United Utilities Bearstone borehole to the North Staffordshire water resource zone.
Draycote DO recovery	4Ml/d	This scheme will increase the treatment capacity at Draycote water treatment works and enable the site to sustainably operate at 35Ml/d output. The current maximum sustainable capacity is estimated at 26.9Ml/d. The scheme requires: - Dissolved air flotation plant - 3 x Granular Activated Carbon (GAC) adsorbers - Phosphate Dosing - Flash Mixer (Replacement of flocculator paddle) - Intake pumping station (6Ml/d to increase existing pump capacity) - Emergency storage capacity increase (450m3)
Elmhurst new borehole	2Ml/d	This scheme will recommission the disused Elmhurst borehole and associated water treatment works to deploy ~2 Ml/d for local distribution. The scheme includes the following activities: - Recommission the disused Elmhurst GWS borehole. Involving borehole testing, rehabilitation/ redrilling (if appropriate) and installation of a new borehole pump. - A new nitrate removal plant and UV disinfection plant. Also the upgrade of peripheral assets such as dosing rigs, power and telemetry to return the abandoned site to supply. These other upgrades are a raw water balancing tank; UV disinfection; a chlorination system; a phosphate dosing system; final water pH adjustment and a final balance tank. - Disposal of nitrate treatment plant waste stream to Leek Sewage Treatment Works through construction of 10.3 km of 150mm dia pumped transfer main with associated 5 kW pumping station at Elmhurst BH. - A new 2.2km pumped main from Elmhurst BH / water treatment works with an associated 90kW pumping station.
Transfers from Grid to Notts (Ambergate)	30Ml/d	This scheme is to transfer water from the Strategic Grid water resource zone to Nottinghamshire zone. The transfer will be enabled by making a new connection from the Derwent Valley Aqueduct at Ambergate to the Nottinghamshire zone (sized at a maximum transfer of 30Ml/d). The scheme requires the following:

		- 15km of new 750mm dia pipeline from Ambergate. - 6km of new 750mm dia pipeline in Nottinghamshire zone. - A new 112kW pumping station
River Weaver new water treatment works	20Ml/d	This scheme is to provide an additional source of supply into North Staffordshire WRZ. The scheme involves constructing a new abstraction point and WTW at the River Weaver near Nantwich. The treated water will be deployed into the existing network and serve to reduce demand on the existing system. The scheme requires the following: - A new 20Ml/d river intake and pumping station (626kW) on the River Weaver, south of Nantwich. - A new settlement tank to accept the raw water prior to the WTW - 20 Ml/d new water treatment works close to the settlement tank and abstraction point. - A new 626kW pumping station and 460m of pipeline. - Connecting pipework between the river abstraction point, settlement tank and the WTW.
Oldbury to Meriden	15Ml/d	This scheme is to increase the capacity of part of the Strategic Grid network. The scheme will increase the capacity by 65Ml/d to provide a maximum transfer capacity of 120Ml/d. This will enable surplus sources of water in the eastern grid to be transferred to the southern parts of the Strategic Grid and vice versa as need arises. The scheme requires the following: - 14.4km of new 1000mm dia pipeline - A new 666kW pumping station
Bham to Wolves link	32Ml/d	This scheme is to connect Frankley water treatment works in the Strategic Grid zone to Tettenhall Pumping Station in the Wolverhampton zone. To enable this transfer, both existing and new assets will be utilised and some modification and recommissioning will be carried out of existing assets. The scheme will require: - Internal cleaning of existing 600mm mains - 18.9km of new 750mm pipeline - Recommission Cell 1 at an existing distribution service reservoir - 7.7km of new 750mm pipeline - Pipework and pump control modifications to allow bi-directional flow at Tettenhall Pumping Station
Minor Dam Extensions (Stanford)	3Ml/d	This scheme is to increase storage capacity of Stanford Reservoir by 11%. This is achieved by increasing the Top Water Level at the reservoir by 0.22m from 110.76m AOD to 110.98m AOD. The increased water level would add 147.4 Ml of capacity to Stanford Reservoir. To enable this increase in volume of the reservoir, the following works are required: - Raise the overflow weir sill by 0.22m
Minor Dam Extensions (Lower Shustoke)	3Ml/d	This scheme is to increase the storage capacity of Lower Shustoke reservoir by 10%. This is achieved by increasing the Top Water Level of the reservoir by 0.52m from 79.90m AOD to 80.42m AOD. The increased water level would add 192 Ml of capacity to Shustoke Reservoir. To enable this increase in volume of the reservoir, the following works are required: - Construction of a 400mm high reinforced concrete wave wall along the embankment crest. - Modification to the pipework between the upper and lower reservoirs.

Minor Dam Extensions (Whitacre)	3Ml/d	The increase in storage capacity of Whitacre reservoir by 5% is to be achieved by increasing the Top Water Level at the reservoir by 0.17m from 70.00m AOD to 70.17m AOD. The increased water level would add 7.8 Ml of capacity to Whitacre Reservoir. To enable this increase in volume of the reservoir, the following works are required: - Raise the spillway crest level by 170mm - 500mm high reinforced concrete wave wall along the embankment crest

Table G1.5: Summary of the recommended schemes beyond AMP12

Beyond AMP12		
Expand Carsington Reservoir	110Ml/d	This scheme is to enlarge Carsington Reservoir to provide an additional storage volume of 25,000 Ml. This will require raising the reservoir full level by approximately 7.9m. It is expected that the main items required by this scheme are: - Raising of the main embankment dam by 6.4 m - Raising of the spill weir and modifications to the upper part of the spillway system - Raising of the inlet/outlet tower by 6.4 m, including new superstructure and associated works - Modifications to the tailbay control structures - Construction of a new earthfill embankment between Sheepwash and Hall Wood (Hopton Embankment) (approx. 24 m high and 1.4 km long) - Construction of new pumping station to lift run-off water captured by the new Hopton embankment into Carsington Reservoir, including civil/mech & elec works - Re-location of the amenity buildings (visitor centre, wildlife centre, sailing club etc.) and associated civil infrastructure - Re-alignment of the public highway crossing the main dam and associated traffic management works - Reservoir perimeter works, including re-alignment of footpaths, vegetation clearance etc.
Carsington to Tittesworth phase 2	16Ml/d	This scheme is a second phase of the AMP8 scheme to transfer raw water from the River Derwent and Carsington Reservoir to Tittesworth water treatment works through the provision of a new pumped raw water pipeline. The additional raw water will enable water in Tittesworth Reservoir to be conserved for dry periods thus enabling Tittesworth water treatment works to operate longer into dry seasons and deploy additional potable water into the North Staffs WRZ. The scheme is sized for a maximum raw water transfer of 16Ml/d plus distribution system network enhancements to allow the treated water to be deployed into the wider water resource zone.
East Midlands quarry storage	45Ml/d	This scheme will provide provision of additional raw water storage in the Strategic Grid water resource zone by converting an existing quarry into a raw water storage reservoir. This new reservoir will be supplied with raw water abstracted from the River Trent near Weston-on-Trent. Raw water in the reservoir will be abstracted and treated at a new water treatment works adjacent to the site and deployed to the Strategic Grid zone. The scheme requires the following: - Conversion of existing quarry to enable storage of raw water - 50Ml/d raw water intake and pumping station on the River Trent

		- 19km of 1050mm raw water pipeline from the new intake to the quarry - New 50Ml/d water treatment works - 726kW pumping solution (potentially floating pontoon pumps) to lift water out of quarry and transfer to the new WTW. - Connecting pipework between the quarry abstraction pumps and water treatment works. - 10.2km of 1050mm pipeline - 686kW pumping station to transfer potable water to distribution system
Blackbrook Reservoir to Cropston water treatment works	8Ml/d	The scheme is the recommissioning of existing intakes at Blackbrook reservoir and conveyance of up to 8Ml/d raw water to Cropston water treatment works inlet via new pipeline. The existing Cropston water treatment capacity will be upsized to make additional capacity for treatment of the additional 8Ml/d during seasons of peak raw water availability. The treated water will be deployed via the existing supply network. The scheme requires the following: - Recommission the raw water intake at Blackbrook Reservoir for 8Ml/d - bring the draw-off works back into operation - A new 13.2km, 500mm diameter pipeline between Blackbrook Reservoir and Cropston WTW and an associated new pumping station. - Upsizing of Cropston water treatment processes.
Campion Hills deployable output increase	2Ml/d	This scheme will enhance the treatment capacity of Campion Hills water treatment works to enable the site to sustainably operate at 23Ml/d output for longer. The scheme requires: - Borehole pumps - Telemetry outstation - New 620m3 backwashing tanks - Granular activated carbon adsorbers - Rapid gravity filters - Replacement of high lift pumps - Lamella clarifier - - 178kW New pumping station for 10Ml/d transfer
United Utilities import to Kinsall WRZ	1Ml/d	This scheme is to import 1Ml/d from United Utilities' Vyrnwy Aqueduct to the Kinsall WRZ. The imported water will be distributed into the STWL network and be used to support existing sources. The scheme requires the following: - New cross connection between Vyrnwy Aqueduct and existing network - Cleaning of existing pipelines - Installation of a new pressure reducing valve (PRV) and flow meter for this supply.

G2 Alternative pathways considered in our adaptive plan

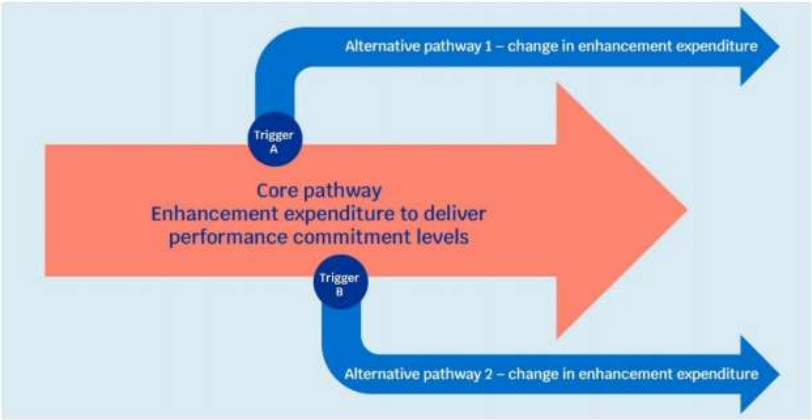
The future is uncertain, and we need to understand how robust our supply and demand choices would be under the different plausible future scenarios that could unfold over time. Different supply and demand scenarios will change the magnitude and timing of the investment required.

For our draft WRMP we have explored different scenarios to expose the 'no / low-regrets' decisions that make up our core pathway investment needs. These core pathway decisions will give us confidence we can meet the imminent AMP8 supply-demand needs whilst setting ourselves up for the longer term. Our approach provides us with the necessary information to make informed choices at key trigger and decision points as the future unfolds and allows us to define our adaptive plan.

An adaptive planning approach is one which is flexible and that will allow us to make better long-term investment decisions on behalf of our customers by tracking and monitoring key decisions and triggers. Adaptive planning is at the heart of our dWRMP24 and our long-term delivery strategy as it allows us to meet our ambitions under a range of future scenarios. As the future is inherently uncertain, it is important that our strategy is flexible enough to cope with changes in circumstance, so it is robust over time.

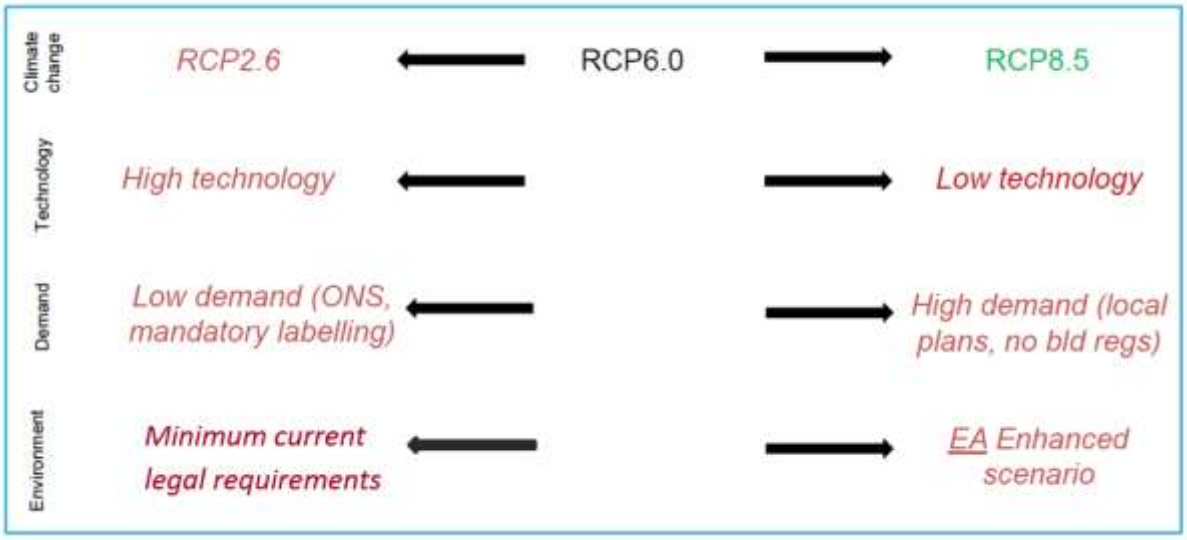
The adaptive planning approach identifies clear decision points and triggers where alternative pathways, deviating from our core pathway, would need to be followed in the event of a change in circumstances or additional information becoming available during the planning period. Figure G2.1 graphically represents this approach (from Ofwat's PR24 and beyond publication). We can balance affordability by using adaptive planning to deal with key future uncertainties.

Figure G2.1: An illustration of adaptive pathways



In Appendix F we describe the wide range of potential supply and demand scenarios that we have investigated using our investment optimisation tools. In addition to these scenarios, Ofwat has also detailed some common reference scenarios in their PR24 Long-Term Delivery Strategy that they expect all companies to use to examine high and low bounds around possible future climate change, growth, technology and environmental scenarios. Ofwat's common reference scenarios are shown below in Figure G2.2.

Figure G2.2: Ofwat's PR24 Long Term Delivery Strategy common reference scenarios



We have generated theoretical investment programmes that would be needed to accommodate the impacts of each of these different potential scenarios. Using the approach described in Appendix F, we have examined the outputs from these scenarios to inform our 'no / low-regret' investment decisions as well as the more uncertain investment decisions that we might need to take in the longer term.

We also used this full range of potential future scenarios to help us define a representative set of alternative pathways that show how our future investment plans might need to adapt as circumstances change over time. The fundamental uncertainties that have shaped our dWRMP24 adaptive pathways are:

- the magnitude of climate change impacts,
- how the long term environmental destination affects abstraction,
- whether SROs are approved for construction or not,

Exploring these fundamental uncertainties helps to expose the upper and lower bounds of required investment to meet the challenges that we are facing. The representative pathways we have used to test our dWRMP24 are summarised in table G2.1.

Table G2.1: Our WRMP alternative pathways

Pathway number	Pathway name	Description
0	Core pathway	The core pathway follows Ofwat's PR24 definition and includes all activities that need to be undertaken to be ready for all plausible future scenarios and should include: • investment required to keep future options open (such as enabling work or learning and monitoring) • No and low regrets investment decisions to meet the supply-demand deficit with best-value solutions: o in both benign and adverse scenarios; o across a wide range of plausible scenarios; or o need to be undertaken to meet short-term requirements The Ofwat core and the most likely WRMP (AP1) are the same for AMP8 and AMP9 due to certainty of SDB deficit in the short-term
AP1	Least cost	The most likely pathway follows the Environment Agency's WRMP planning guidelines and represents the activities that need to be undertaken to address our assessment of the most likely future supply and demand balance while also meeting our legal and regulatory policy requirements. This pathway includes activities needed: • To meet the EA obligations as per the WRMP guidance and other policy/statutory driven publications • The supply-demand balance exposed by following all of the regulatory guidance / policy, • Using 'best central estimates' of data and planning assumptions and assessments of most likely future scenarios. • Using the best understanding of the EA's BAU+ environmental destination scenario.
AP2	Environmental stretch	This pathway uses the 'enhanced' long term environmental destination scenarios.
AP3	Gated success	This pathway explores the decision points that will arise as the Strategic Resource Option projects progress through Rapid's gated process. In this pathway we may adopt the SRO solutions if they prove to be better value options than those in the most likely pathway.
AP4	Climate adjustment	This pathway includes the decisions that we will need to take under the more extreme climate change impacts that might arise under the RCP8.5 global emissions scenario.

By testing multiple alternative supply/demand futures through our investment optimisation modelling, we have a good understanding of what our alternative plans would look like under different scenarios, and what

our preferred alternative options might be. Our approach gives us the flexibility to change our plans over time as the uncertain becomes more certain.

We recognise that if an intervention is planned to address a shortfall in the future, there could be benefits of delaying a project where there was a significant degree of uncertainty. The use of an adaptive planning framework is a solution that offers customers the greatest protection from over-investment too early and bearing unnecessary risk.

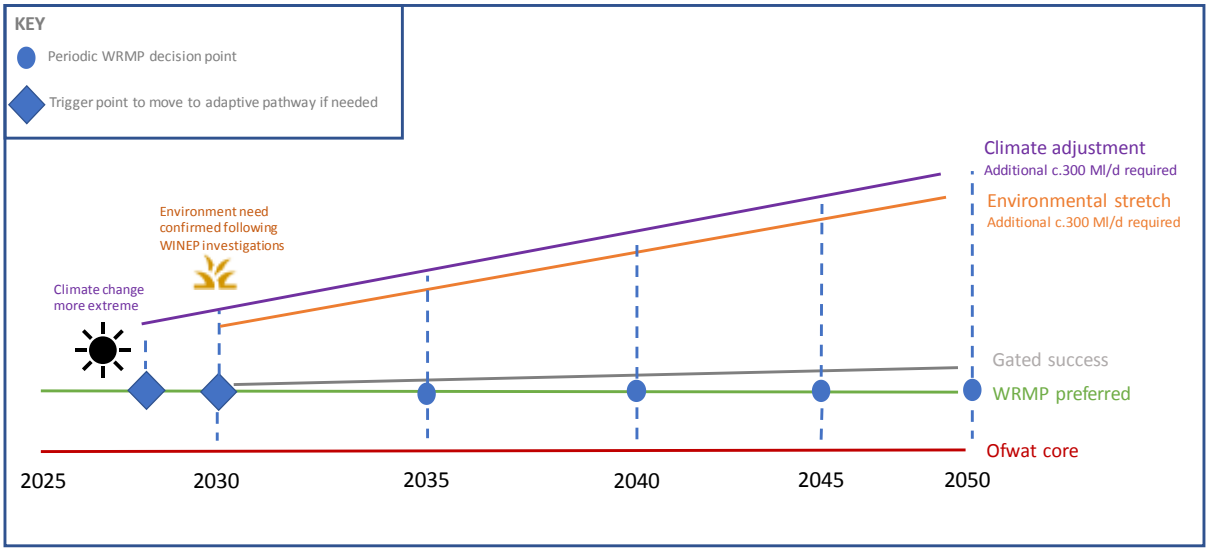
For us to understand which of these possible pathways is emerging over time, clear and observable metrics are needed supported by a monitoring plan. This way we can track these metrics through time and make decisions at defined moments in the future if it becomes clear we should be following an alternative pathway and this will allow us to navigate uncertainty in an effective way. The key trigger points (i.e., the circumstances in which an alternative pathway would need to be followed) that we consider should form part of our monitoring plan are in table G2.2.

Table G2.2: Key trigger points to understand if we need to move to an alternative pathway, and what we will monitor to understand if a trigger has been met

Key trigger point	What we will monitor	Potential trigger year	Which alternative pathway we move to if the trigger point is met
Outcome of our AMP8 WINEP investigations	WINEP investigations show cumulative net benefit of licence reductions tracking BAU	2028 (PR29)	AP2 – environmentally committed
Scale and pace of climate impacts	Latest climate science emissions scenarios (UKCP publications)	2028 (PR29)	AP4 – climate adjustment
The deliverability of complex, strategic new supply options	An approved (or not approved) SRO will impact our SDB	2028 (PR29)	AP3 – gated success

Figure G2.3 illustrates an example of the how the different possible pathways could diverge and shows how we might change our decisions at the key trigger points.

Figure G2.3: An illustration of our future adaptive pathways



G3 How our preferred plan compares to the alternative pathways

In Appendix F we have outlined our decision making and investment optimisation approach. Using this approach, we have derived alternative theoretical investment programmes that would be associated with the adaptive pathways outlined in section 2 above. We have also tested a wide range of plausible alternative supply and demand scenarios to test the sensitivity of assumptions around:

- the pace of implementing the EA's abstraction licence capping policy from 2030;
- the scale and pace of future climate change impacts,
- the scale of the potential abstraction reductions needed to meet the long term environmental destination goals.

Using this analysis we have gathered the evidence to support the no / low-regret investment decisions included in our Core pathway as well as the recommended longer term solutions outlined in our Preferred Plan.

A summary of those alternative pathways and the evidence to support our preferred plan is outlined below.

G3.1 Alternative Pathway 1: The Preferred plan

We have already outlined our preferred plan in section G1.4 above. This investment pathway uses the baseline supply / demand position reported in dWRMP24 table 3a for each WRZ, which is based on known legal and policy requirements for abstraction and demand along with 'best central estimates' of long term planning assumptions.

The scenario assumes that the effects of the EA's abstraction licence capping policy are introduced in two phases: 2030 and 2040. We have separately tested alternative scenarios to demonstrate the cost impacts of introducing these licence caps sooner.

This pathway incorporates our current understanding of the full impacts of the EA's BAU Environmental Destination Scenario and assumes that these abstraction reductions are required by 2050 at the latest.

The investment pathway makes provision for the target headroom quantities outlined in the dWRMP24 table G3a to reflect future planning uncertainties.

The solutions included in the preferred plan are based on analysis of a range of DMU scenario outputs but use DMU S4 and DMU S1 as their key references to test in particular how they perform against the Core and Baseline Most Likely scenarios. Schemes chosen in both scenarios are considered no / low regret and where common schemes have been chosen, we have applied engineering judgement to suggest the preferred delivery sequencing.

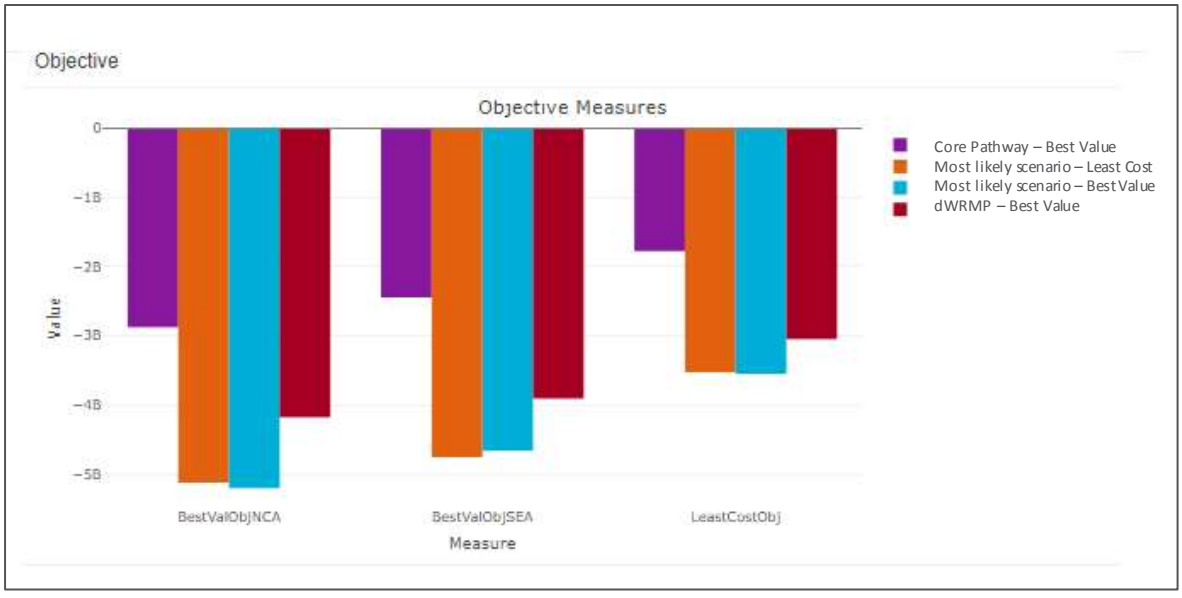
We have also included the scheme 303C Vyrnwy to River Severn SRO transfer of 25Ml/d via River Vyrnwy from 2030-31 as a low regret option.

We have also applied engineering judgement to review the selection of large / complex / uncertain solutions and in some instances, we have swapped them out for equivalent sized schemes where we have higher confidence. In these instances, we have done this for schemes chosen late in the planning horizon and these changes do not affect the AMP8 or AMP9 investment plan.

As a further test, the final chosen set of solutions in the preferred plan must address the baseline supply / demand challenge set out in the dWRMP24 data table 3a for each of the water resource zones.

We have compared the cost and best value performance of the preferred plan against a selection of alternative pathways. The preferred programme takes the outputs from the optimised best value and least cost programmes and applies engineering judgement to refine the decision points taken in the model. Figure G3.1 illustrates how the cost and value metrics compare across the core pathway and the optimisers' view of the least cost and best value programmes.

Figure G3.1: Comparison of the Preferred Plan programme costs



While the core pathway delivers the lowest whole life cost programme and has the least environmental / social cost, this planning scenario does not fulfil the EAs's dWRMP planning objective of delivering any abstraction reductions to achieve the long term environmental destination. Therefore, this investment programme cannot form the preferred plan but it does provide a benchmark against which we can assess the costs of achieving the environmental destination objectives.

The dWRMP24 preferred plan achieves the 'most likely' scenario planning objectives with a lower whole life cost programme than the modelled outputs. We recognise that this is in part due to the preferred plan applying a real-world engineering and delivery assessment to finesse the scheme sizes and timings that the

optimiser has available to it. We will to continue to refine recommended scheme scopes and explore synergies with the wider PR24 programme.

Table G3.1 shows the key comparisons across these potential investment programmes.

Programme Measure	S1: No Environmental Destination impacts	S4: EA's BAU ED target (Best Value)	S28: EA's BAU ED target (Cost only)	dWRMP emerging plan
Cost Plan NPV*	£1.8b	£3.6b	£3.5b	£3.0b
Best Value Metrics NPV*	£2.4b	£4.7b	£4.8b	£3.9b
Non-financial 'cost'	£0.6b	£1.1b	£1.3b	£0.9b

**Note that the NPV calculation used in our DMU model follows the format used in the EA's WRMP19 data capture system. For final WRMP24 we will update the NPV calculation to match the changes that have been made for dWRMP24 table 5.*

G3.2 The Core Pathway

The core pathway follows Ofwat's PR24 definition and includes all activities that need to be undertaken to be ready for all plausible future scenarios and should include:

- investment required to keep future options open (such as enabling work or learning and monitoring)
- No and low regrets investment decisions to meet the supply-demand deficit with best-value solutions:
    - in both benign and adverse scenarios;
    - across a wide range of plausible scenarios; or
    - need to be undertaken to meet short-term requirements

The Ofwat core and the most likely WRMP (AP1) are the same for AMP8 and AMP9 due to certainty of the supply / demand deficit in the short-term but excludes the long term impacts of the Environmental Destination abstraction reductions.

The core pathway is based on known legal and policy requirements for abstraction and demand along with 'best central estimates' of long-term planning assumptions. The scenario includes future target headroom to reflect future planning uncertainties.

We have applied engineering judgement to suggest the preferred delivery sequencing of the schemes selected by the DMU optimisation.

We have included the scheme 303C Vyrnwy to River Severn SRO transfer of 25Ml/d via River Vyrnwy from 2030-31 as a low regret option.

The water resources investment programme included in the core pathway is set out in table G3.2 below.

Table G3.2: Summary of the schemes that make up the Core Pathway

AMP 8		AMP9		AMP10		AMP11		AMP12 and beyond	
Trimpley DO recovery	4Ml/d	Import to Mardy	1Ml/d	UU import to Shelton WTW	25Ml/d	Croxton BH to Hob Hill DSR	3Ml/d	Milton groundwater source	5Ml/d
Whitacre DO recovery	4Ml/d	Derwent Valley Storage Increase	-	Derwent Valley Storage Increase	-	Derwent Valley Storage Increase	-	Derwent Valley Storage Increase	60Ml/d
Expand Shelton	12Ml/d	Terminate DV export to YKS	35Ml/d			Ogston expansion	15Ml/d	UU Peckforton import	5Ml/d
Carsington to Tittesworth	30Ml/d*							Third Party Reservoir and new WTW's	18Ml/d
Transfers from Grid to Notts (Heathy Lea)	37Ml/d*							East Midlands Quarry	24Ml/d
Homesford expansion	5Ml/d							New groundwater near Soar	5Ml/d
Expand Strensham WTW	15Ml/d							Hampton Loade to Nurton	12Ml/d *
Little Eaton DO recovery	5Ml/d							Draycote DO recovery	4Ml/d
Draycote Reservoir expansion	9Ml/d							Transfers from Grid to Notts (Ambergate)	30Ml/d
UU Vyrnwy release to River Severn	23Ml/d							Bham to Wolves link	14Ml/d *
								Dam extensions at Whitacre, Stanford, Shustoke	9Ml/d
								Ruyton support link main	1Ml/d
								Oldbury to Meriden	15Ml/d
								UU import to Kinsall	1Ml/d
								Blackbrook Reservoir	8Ml/d
								Campion Hills DO recovery	2Ml/d
								Carsington expansion	75Ml/d
Total	**144Ml/d**	**Total**	**36Ml/d**	**Total**	**25Ml/d**	**Total**	**18Ml/d**	**Total**	**288Ml/d**

(These are internal transfers and the Ml/d shows the maximum expected utilisation in the planning period)*

G3.3 Alternative Pathway 1a: The least cost plan

Our decision-making approach uses multi-criteria metrics alongside the capex and opex of each water resource option to derive the overall best value set of solutions to meet the supply / demand balance scenario being tested. We have also assessed whether our investment choices would be materially different if we only considered the capex and opex associated with our water resource scheme options.

Figure G3.1 illustrates how our preferred plan as set out above in section 1.4 is both our best value and our least cost plan.

In our DMU investment optimiser we first derived an investment plan to solve the baseline dWRMP24 scenario using scheme costs only as the decision metric. This is the same supply / demand scenario we have used to test the performance of our preferred plan and is based on known legal and policy requirements for abstraction and demand along with 'best central estimates' of planning assumptions. The scenario assumes that the effects of the EA's abstraction licence capping policy are introduced in two phases – 2030 and 2040 and it incorporates our current understanding of the full impacts of the EA's BAU Environmental Destination Scenario and assumes that these abstraction reductions are required by 2050 at the latest.

The solutions included in the least cost plan use DMU scenarios S28, S4 and S1 as their key references to test how they perform against the Core and Baseline Most Likely scenarios and how decisions might change when best value metrics are included in the optimisation. Schemes chosen in all scenarios are considered no / low regret and where common schemes have been chosen we have applied engineering judgement to suggest the preferred delivery sequencing.

We have tested how the NPV of the preferred plan performs against the optimised DMU outputs from S28 and S4 plus other adaptive scenarios to demonstrate how the preferred programme costs compare. Table 3.1 shows that when the DMU optimises a programme only using cost based metrics to solve the baseline 'most likely' scenario it can slightly outperform the optimisation using other metrics. However, this same cost-only programme performs slightly worse when the wider value metrics are taken into account. Overall, however, the differences are not material at between 2%-3% of overall NPV.

We then compared these optimiser outputs with the preferred plan, which has benefitted from engineering judgement to review the selected sequencing of large / complex / uncertain solutions as described in section G3.1. There are no decisions in the cost-only plan that would lead to changes in the sequencing or timing of the choices in the preferred plan.

G3.4 Alternative Pathway 2: Environmental Stretch

This pathway explores the impact of going beyond the requirements of the EA's BAU+ environmental destination scenario and gives even greater protection for Special Areas of Conservation (SACs). The EA have stated that we should use this scenario to target action in protected areas and Principal Salmon Rivers. More information about this environmental destination scenario can be found in Appendix D.

All other planning assumptions remain as per the baseline 'most likely' scenario described in dWRMP24 data capture table 3a. However, because this is an adaptive pathway scenario it excludes future planning uncertainties from target headroom.

The investment solutions included are based on analysis outputs from DMU S4 and DMU S11 as their key references to test how they perform against the Baseline Most Likely and Enhanced ED scenarios. Schemes chosen in both scenarios are considered no / low regret and where common schemes have been chosen, we have applied engineering judgement to suggest the preferred delivery sequencing.

Table G3.3: Summary of schemes that make up the Environmental Stretch Pathway

AMP 8		AMP9		AMP10		AMP11		AMP12 and beyond	
Trimpley DO recovery	4Ml/d	Import to Mardy	1Ml/d	UU import to Shelton WTW	25Ml/d	West Midlands Quarry	-	West Midlands Quarry	33Ml/d
Whitacre DO recovery	4Ml/d	Terminate DV export to YKS	35Ml/d	Raise Tittesworth	-	Raise Tittesworth	-	Raise Tittesworth	14Ml/d
Expand Shelton	12Ml/d	Derwent Valley Storage Increase	-	Derwent Valley Storage Increase	-	Derwent Valley Storage Increase	-	Derwent Valley Storage Increase	60Ml/d
Carsington to Tittesworth	30Ml/d*	New WTW near Stafford	-	New WTW near Stafford	-	New WTW near Stafford	23Ml/d	Milton groundwater source	5Ml/d
Transfers from Grid to Notts (Heathy Lea)	37Ml/d*					Third Party Reservoir and new WTW's	-	Third Party Reservoir and new WTW's	18Ml/d
Homesford expansion	5Ml/d					River Weaver new WTW	-	River Weaver new WTW	20Ml/d
Expand Strensham WTW	15Ml/d					New River Trent WTW at Notts	-	New River Trent WTW at Notts	30Ml/d
Little Eaton DO recovery	5Ml/d					East Midlands Quarry	-	East Midlands Quarry	24Ml/d
Draycote Reservoir expansion	9Ml/d					New groundwater near Soar	-	New groundwater near Soar	5Ml/d
UU Vyrnwy release to River Severn	23Ml/d					Ogston expansion	15Ml/d	Hampton Loade to Nurton	12Ml/d*
								Imports from UU to North Staffs	8Ml/d
								Draycote DO recovery	4Ml/d
								Elmhurst new borehole	2Ml/d
								Transfers from Grid to Notts (Ambergate)	30Ml/d
								Bham to Wolves link	32Ml/d*
								Dam extensions at Whitacre, Stanford, Shustoke	9Ml/d
								Ruyton support link main	1Ml/d
								Oldbury to Meriden	15Ml/d
								UU import to Kinsall	1Ml/d
								Blackbrook Reservoir	8Ml/d
								Campion Hills DO recovery	2Ml/d
								East Midlands Quarry	45Ml/d

									Carsington expansion	110Ml/d
									Carsington to Tittesworth phase 2	16Ml/d*
Total	144Ml/d	Total	36Ml/d	Total	25Ml/d	Total	38Ml/d	Total	504Ml/d	

(These are internal transfers and the Ml/d shows the maximum expected utilisation in the planning period)*

G3.5 Alternative Pathway 5: Gated Success

This pathway explores how our choices might differ if the SRO projects are successful and proceed instead of the current preferred plan. At the time of producing this draft WRMP24 the uncertainties around some of the key aspects of the SRO projects meant that we could not include them in our preferred plan. Instead, we have assessed their impacts in this alternative investment pathway to demonstrate what choices would be affected. All other planning assumptions remain as per the baseline 'most likely' scenario described in dWRMP24 data capture table 3a.

As we gain more certainty around the SRO projects through Gate 2 and beyond of their reporting processes we will have more confidence about whether Alternative Pathway 5 might actually become our preferred plan.

The key differences between our preferred plan and Alternative Pathway 5 are:

- We assume that UDVRE SRO can successfully deliver an increase in Derwent Valley reservoir storage sufficient that SVT no longer needs to terminate the export to YKS. This means that:
    - A larger version of Scheme 6 (Derwent Dam raising) comes on-line in 2039-40.
    - Scheme 169 (Terminate DV export) is no longer included in either SVT's or YKS's preferred plans.

- We assume that the NWT Transfer SRO and STT SRO can successfully deliver up to 180Ml/d of water from Vyrnwy Reservoir into the River Severn. This means that:
    - Vyrnwy to STW is implemented in two stages:
        - Scheme 303C is on-line in 2030-31
        - Scheme 303B is on-line in 2049-50

Table G3.4: Summary of schemes that make up the Gated Success Pathway

AMP 8		AMP9		AMP10		AMP11		AMP12 and beyond	
Derwent Valley Storage Increase	-	Derwent Valley Storage Increase	-	Derwent Valley Storage Increase	60Ml/d	West Midlands Quarry	-	West Midlands Quarry	33Ml/d
Trimpley DO recovery	4Ml/d	Import to Mardy	1Ml/d	Raise Tittesworth	-	Raise Tittesworth	-	Raise Tittesworth	14Ml/d
Whitacre DO recovery	4Ml/d	New WTW nr Stafford	-	New WTW near Stafford	-	New WTW near Stafford	23Ml/d	UU Vyrnwy release to River Severn 75Ml/d	68Ml/d
Expand Shelton	12Ml/d	UU import to Shelton WTW	-	UU import to Shelton WTW	25Ml/d	Ogston expansion	15Ml/d	Milton groundwater source	5Ml/d
Carsington to Tittesworth	30Ml/d*					Third Party Reservoir and new WTW's	-	Third Party Reservoir and new WTW's	18Ml/d
Transfers from Grid to Notts (Heathy Lea)	37Ml/d*					River Weaver new WTW	-	River Weaver new WTW	20Ml/d
Homesford expansion	5Ml/d					New River Trent WTW at Notts	-	New River Trent WTW at Notts	30Ml/d
Expand Strensham WTW	15Ml/d					East Midlands Quarry	-	East Midlands Quarry	24Ml/d
Little Eaton DO recovery	5Ml/d					New groundwater near Soar	-	New groundwater near Soar	5Ml/d
Draycote Reservoir expansion	9Ml/d							Hampton Loade to Nurton	12Ml/d *
UU Vyrnwy release to River Severn	23Ml/d							Imports from UU to North Staffs	8Ml/d
								Draycote DO recovery	4Ml/d
								Elmhurst new borehole	2Ml/d
								Transfers from Grid to Notts (Ambergate)	30Ml/d *
								Bham to Wolves link	32Ml/d *
								Dam extensions at Whitacre, Stanford, Shustoke	9Ml/d
								Ruyton support link main	1Ml/d
								Oldbury to Meriden	15Ml/d
								UU import to Kinsall	1Ml/d
								Blackbrook Reservoir	8Ml/d
								Campion Hills DO recovery	2Ml/d
								East Midlands Quarry	45Ml/d
								Carsington expansion	110Ml/d
								Carsington to Tittesworth phase 2	16Ml/d *
Total	144Ml/d	Total	1Ml/d	Total	85Ml/d	Total	38Ml/d	Total	512Ml/d

(These are internal transfers and the Ml/d shows the maximum expected utilisation in the planning period)*

G3.6 Alternative Pathway 6: Climate Adjustment

This pathway explores the impact of climate change impacts that are greater than implied by the central estimates from the RCP6.0 emissions pathway. We have tested the impacts of the driest of the UKCP18 RCM model outputs on our supply / demand balance.

All other planning assumptions remain as per the baseline 'most likely' scenario described in dWRMP24 data capture table G3a. However, because this is an adaptive pathway scenario it excludes future planning uncertainties from target headroom.

The investment solutions included are based on analysis outputs from DMU scenarios S4 and S14 as their key references to test how they perform against the Baseline Most Likely and High Climate Change scenarios. Schemes chosen in both scenarios are considered no / low regret and where common schemes have been chosen, we have applied engineering judgement to suggest the preferred delivery sequencing.

Table G3.5: Summary of schemes that make up the Climate Adjustment Pathway

AMP 8		AMP9		AMP10		AMP11		AMP12 and beyond	
Trimpley DO recovery	4Ml/d	Import to Mardy	1Ml/d	UU import to Shelton WTW	25Ml/d	West Midlands Quarry	-	West Midlands Quarry	33Ml/d
Whitacre DO recovery	4Ml/d	Terminate DV export to YKS	35Ml/d	Raise Tittesworth	-	Raise Tittesworth	-	Raise Tittesworth	14Ml/d
Expand Shelton	12Ml/d	Third Party Reservoir and new WTW's	-	Third Party Reservoir and new WTW's	18Ml/d	Ogston expansion	15 Ml/d	Mythe DO recovery	10Ml/d
Carsington to Tittesworth	30Ml/d*			New WTW near Stafford	-	New WTW near Stafford	23 Ml/d	Milton groundwater source	5Ml/d
Transfers from Grid to Notts (Heathy Lea)	37Ml/d*			Derwent Valley Storage Increase	-	Derwent Valley Storage Increase	-	Derwent Valley Storage Increase	60Ml/d
Homesford expansion	5Ml/d					River Weaver new WTW	-	River Weaver new WTW	20Ml/d
Expand Strensham WTW	15Ml/d					New River Trent WTW at Notts	-	New River Trent WTW at Notts	30Ml/d
Little Eaton DO recovery	5Ml/d					East Midlands Quarry	-	East Midlands Quarry	24Ml/d
Draycote Reservoir expansion	9Ml/d					New groundwater near Soar	-	New groundwater near Soar	5Ml/d
UU Vyrnwy release to River Severn	23Ml/d							Hampton Loade to Nurton	12Ml/d*
Minor dam extension at Stanford	3Ml/d							Imports from UU to North Staffs	8Ml/d
								Draycote DO recovery	4Ml/d
								Elmhurst new borehole	2Ml/d
								Transfers from Grid to Notts (Ambergate)	30Ml/d
								Bham to Wolves link	32Ml/d*

									Dam extensions at Whitacre, Shustoke	6Ml/d
									Ruyton support link main	1Ml/d
									Oldbury to Meriden	15Ml/d
									UU import to Kinsall	1Ml/d
									Blackbrook Reservoir	8Ml/d
									Campion Hills DO recovery	2Ml/d
									East Midlands Quarry	45Ml/d
									Carsington expansion	110Ml/d
									Carsington to Tittesworth phase 2	16Ml/d*
									ASL Hallgates to Oldbury	15Ml/d*
Total	**147Ml/d**	**Total**	**36Ml/d**	**Total**	**43Ml/d**	**Total**	**38Ml/d**	**Total**		**508Ml/d**

(* These are internal transfers and the Ml/d shows the maximum expected utilisation in the planning period)