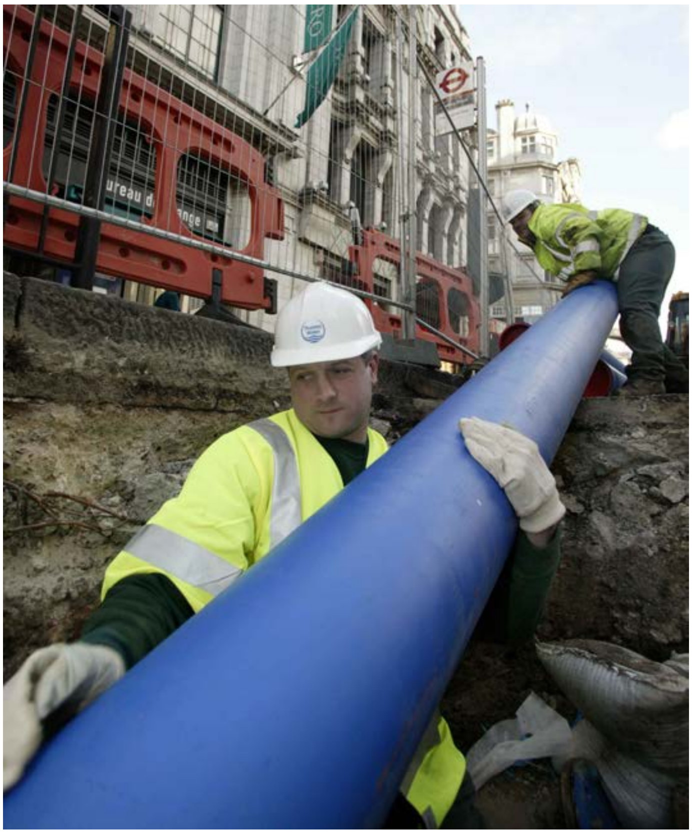
Thames Water

Final Water Resources Management Plan 2015-2040

Main Report



Section 7: Appraisal of Options

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Section 7 Appraisal of Options

The options appraisal process has been re-run for the final Plan. This has included:

- Additional options have been identified through consultation with stakeholders and appraised. Inter-company transfers including options arising from WRSE have been considered.
- The cost model and the Integrated Demand Management model have been refined, but overall the detailed environmental, cost and risk assessment processes are unchanged from the draft Plan.
- TW options have been included in the Water Resources in the South East modelling, the purpose of which is to determine a regional water resources strategy for the South East of England and inter-company transfers have been considered in the development of the plan.

In this section we describe the appraisal of water resource and demand management options available to close the supply and demand deficit identified in Section 6. We set out the principles and approach we have used for:

- Identification of potential options and development of an unconstrained list of options.
- Screening of the unconstrained list of options to identify feasible options.
- Economic appraisal of feasible options.
- Assessment of environmental and social impacts of options, including Strategic Environmental Assessment (SEA) and Habitats Regulations Assessment (HRA).

The constrained list of options available for consideration in the programme appraisal is presented.

We have examined more options in this plan compared to our WRMP09, and have examined wastewater re-use and transfer options in greater detail. We have passed our options to the Water Resources in the South East group to aid regional planning.

Options appraisal is the sequential process by which potential options to resolve a supply and demand deficit are identified and appraised. The Water Resources Planning Guideline (WRPG) sets out the stages in the process and we have followed this approach.

The options appraisal considers all options potentially available, including:

- Demand management options: leakage reduction, metering and water efficiency.
- Water resources development options: e.g. groundwater development, desalination, wastewater re-use, reservoir development and regional transfers.
- Network and operational measures: interconnectivity and trading of water supplies.

We have worked through a stepwise option selection process, moving from a wide range of generic options types, through an unconstrained set, to a feasible set and finally a constrained set of options. In this process, options are progressively reviewed and screened to ensure that only those that are practicable, cost effective and without major adverse environmental, social or carbon impacts are taken forward into the programme development and appraisal process.

The constrained list we have taken forward for the final WRMP programme appraisal includes 123 water resources options 48 demand management interventions and 6 transfer schemes (Appendix P).

The process to develop this list is set out in this section as follows:

- Options appraisal process
- Economic, environmental and social appraisal
- Water resource options
- Demand management options
- Summary of options for programme appraisal

7.1 Options Appraisal Process

7.1.1 Overview

Our supply and demand options appraisal process is summarised in Figure 7-1 and Figure 7-2. The approach consists of a multi-stage process, and comprises the following stages:

- Development of a ***'Generic' options list*** - defining the base list of water resources options identifying all plausible supply and demand-side options. A high level list of potential options by type is identified e.g. reservoirs, leakage reduction, metering etc;
- Development of an ***'Unconstrained' options list*** - a full list of potential options (by location) that could be developed under each of the generic options;
- Primary screening of options to refine the unconstrained list to produce a feasible options list. The ***'Feasible' options list*** is a refined set of options that have been assessed as feasible for taking forward for development within the WRMP.
- Secondary screening of feasible options (against environmental and social impacts, financial costs and risk and resilience – see section 7.1.5), where the range and number of potentially feasible options is still large, to produce a ***'Constrained' options list***. This makes up the suite of feasible options taken forward for economic analysis and assessment of environmental and social impacts, from which the preferred programme is derived. This list also features imports from the '*Constrained transfer list'* (see below).

We have presented and discussed each stage in the approach with stakeholders using dedicated forums.

7.1.2 Transfers

These are schemes planned to import or export water from our supply area. These have been developed through discussions between TW and neighbouring companies and also through the Water Resources in the South East (WRSE) group.

To aid understanding of this process, transfers between TW and neighbouring water companies, whether imports to or exports from a WRZ, have been dealt with separately, but in the same manner as other supply and demand options. A large number of potential options have been investigated and discussed with neighbouring companies with many of these not resulting in further developments. All potential transfer options have been subjected to the same screening process as set out above (7.1.1). Import options, those that yield a benefit to a TW WRZ, that pass through the process to the '***Constrained transfer list'*** have been included for consideration and inclusion in the programme appraisal process.

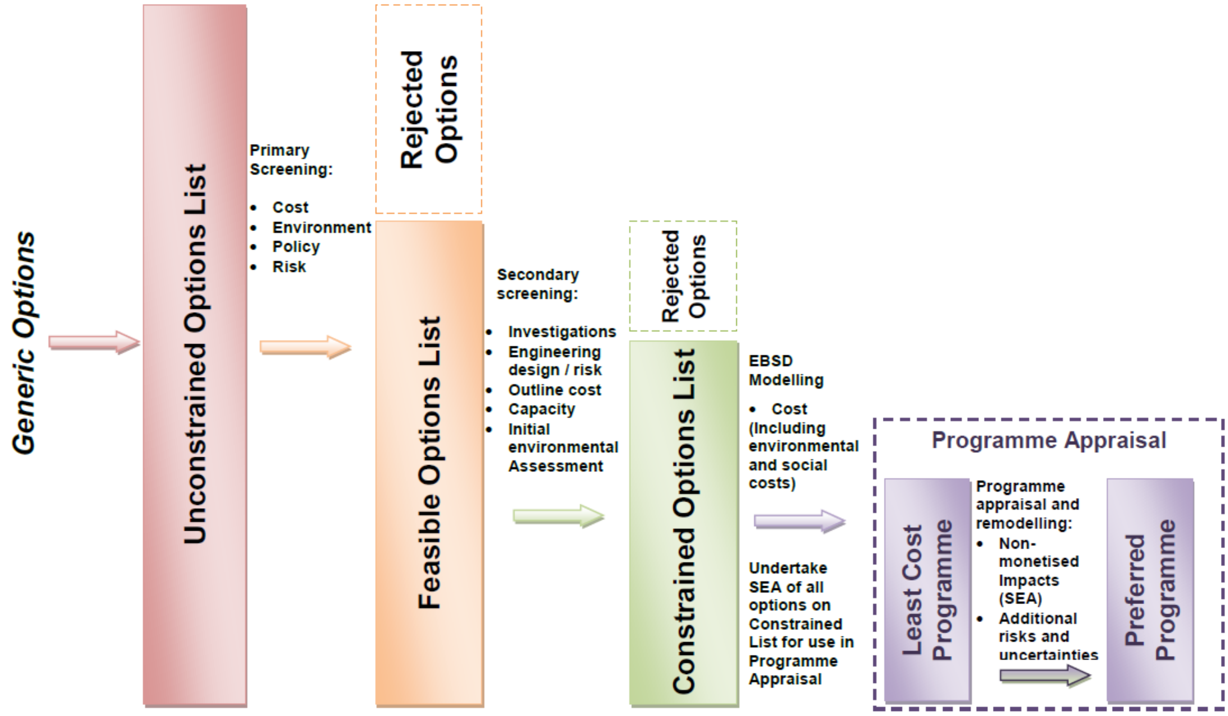
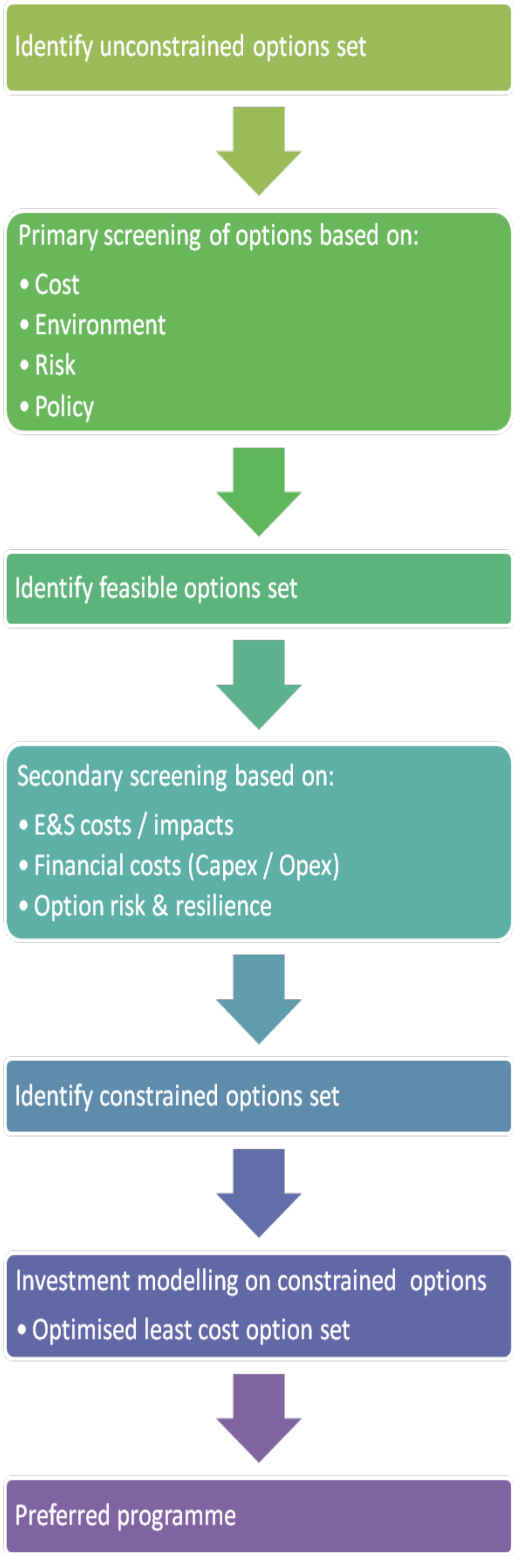


Figure 7-1: Options appraisal and screening



Process overview

The **unconstrained list,** derived from a **generic list** of possible option types, is a high level consideration of potential schemes to meet the shortfall in demand within the company / resource zone(s).

The unconstrained list is refined through a **primary screening** process based on four key criteria considering:

- Costs of a scheme
- Its potential for impact on the environment
- Risks and resilience in terms of security of supply
- Adherence to water resource management and environmental policy.

Some schemes are rejected due to not meeting regulatory criteria. These decisions are confirmed through consultation with the Environment Agency. The screening criteria are developed from the broad approach set out in the Environment Agency's Water Resources Planning Guidance.

The unconstrained screening is a high level exercise based on existing information.

The screening may provide an uncertain answer in which case the option remains within the feasible list but will require further investigation of environmental, engineering or related cost constraints.

Options which pass the unconstrained screening become part of the **feasible options list** and are subject to a greater level of engineering design, cost estimation and environmental assessment.

A secondary screening of the feasible options is undertaken based on a more detailed understanding of:

- The engineering design requirement
- Financial costs
- Option capacity (relative to supply demand gap)
- Environmental and social impacts.

Engineering and environmental appraisal of the feasible options may result in some options performing less favourably against the screening criterion.

The **constrained options set** is assessed through the investment modelling process to identify an **optimised least cost options set**. This is taken forward into Programme Appraisal (Section 8) to identify the Preferred Programme for the Water Resources Management Plan.

Figure 7-2: Overview of the options appraisal process

7.1.3 Generic and unconstrained options/ transfer lists

The full generic and unconstrained options lists can be found in Appendix P. The generic list provides the broad types of options that are considered within the WRMP and those that were not considered suitable or feasible. In the unconstrained option list generic scheme types are converted into more specific and defined options, either in terms of location or broad concept. The unconstrained list builds on and takes into account:

- Those options identified and developed for WRMP09;
- Key findings of the public inquiry into WRMP09;
- Options proposed in the WRPG;
- Options identified by water companies and third parties;
- Views of stakeholders, some of which were already set out in response to WRMP09;
- Responses to our dWRMP14 public consultation;
- Options proposed via the Water Resources in the South East (WRSE) initiative.

As discussed in Section 4 and Appendix L, for this plan we have undertaken additional work on wastewater re-use options and also water transfers. As shown in Sections 9 and 10 we consider that both of these generic options, as well that of storage, should continue to be examined as part of an on-going programme to ensure we (and the participating companies in the Water Resources in the South East group) have a robust and flexible plan which makes the best use of resources and provides a 'best value' solution. In Section 9 further details are given of the planned programme of work to be undertaken over the next five years to investigate the three large resource options of wastewater re-use, inter regional transfers and storage.

The Scheme Rejection Register identifies the reasons for the exclusion of certain options from the generic list, prior to the development of the unconstrained options list. This may be found in Appendix Q.

The unconstrained list consists of 169 water resources options, 71 demand management options and 31 transfer options. Included are a number of new water resource options along with some of the alternative option variants (size, engineering, treatment etc) of previously identified schemes. Demand management measures have also been assessed based on their potential individual contribution to reducing the supply-demand deficit. Demand modelling at District Meter Area (DMA) level has been undertaken to optimise the types and extent of demand interventions required and timing of those interventions to achieve a range of demand reduction targets, any of which can be selected by the Economics of Balancing Supply Demand (EBSD) model.

Supply options are categorised by generic option, sub option and specific option. For example, in the unconstrained options list, the generic raw water transfers option is comprised of the following 9 sub options:

Northern region transfers (4); Supported Severn to Thames transfers via Cotswold Canal (6) and Deerhurst Pipeline (6); Unsupported Severn to Thames transfers via Cotswold Canal (2) and Deerhurst Pipeline (2); Supported by flow augmentation of Severn (2) and other transfers from Craig Goch (1), Columbus (2); and via the Grand Union Canal (1) and the Oxford Canal (2).

The make-up of the unconstrained options list is shown in Table 7-1 & 7-2 below.

Table 7-1: Unconstrained Supply and Demand Options List Summary

Generic Option	Number of sub-options	Number of specific options
Demand Management	12	71
Development of groundwater resources	1	38
Raw water transfer	9	26
Indirect Potable Re-use	3	22
Intra-zonal Transfers	1	12
Aquifer storage and recovery (ASR)	1	10
Third Party Options	1	8
Licence Trading/Transfer	1	7
River Regulation Reservoir	7	7
River Regulation Reservoir and Direct Supply	6	7
Artificial recharge (AR)	1	6
Direct Supply Reservoir	6	6
Development of surface water sources	1	4
Imports by sea	1	4
Release of network/treatment constraints	1	3
Desalination	1	2
Gravel Pits as Reservoir	1	2
Sewage Transfer	1	2
Catchment Management Initiatives	1	1
Enhancement to Existing Reservoir Operation	1	1
Reduction of Supply-side Operational Use and Losses	1	1
Total	**58**	**240**

Table 7-2: Unconstrained Transfers Options List Summary

Type	Number of options
Import	7
Export	15
Bilateral	9
Total	**31**

The following sections discuss the option appraisal process in more detail.

7.1.4 Primary screening of options

Our approach to primary screening of options was developed in consultation with the Environment Agency, Ofwat and the Consumer Council for Water (CCW). The purpose of the primary screening stage is to remove any options considered unfeasible from the options list. At the unconstrained stage, each option is considered and assessed for suitability against a range of criteria including:

- Cost:
  - Does the option avoid excessive cost?
- Environmental and social impact:
  - Are there known environmental / social issues?
  - Does the option help meet Water Framework Directive (WFD) or other environmental objectives?
- Risk and resilience:
  - Is the option currently technically feasible?
  - Does the option improve resilience within the zone? Does this scheme help the 'planning problem'?
  - Is the option lead time sufficiently flexible to planning or other uncertainties?
  - Are there other risks and uncertainties? Are these within the control of the company?
- Policy:
  - Does the option align with national policy objectives?
  - Does the option provide flexibility / adaptability to climate change uncertainty?

Options which passed this screening step are passed forward to the feasible options list. The rationale, option by option, for screening and subsequent exclusion of those options not passed forward from the unconstrained to the feasible options list is set out within the Scheme Rejection Register (Appendix Q). Although we have a policy to assess and screen options on adaptability to climate change, no option was screened out at this stage because of this; poor potential adaptability to climate change does not mean a scheme is not feasible.

7.1.5 Feasible options list

The feasible options list can be found in Appendix P. This list identifies the options considered feasible for consideration within the WRMP to help address the supply-demand deficit. It is based upon those options that pass through the primary screening process. In some cases additional option variants that emerged during the initial investigations are included. The number of sub-options has decreased through the screening process, but the number of specific options has actually increased as more variants of given options have been identified.

The feasible list consists of 209 water resources options, 28 demand management options and 31 transfer options, as summarised in Table 7-3 and 7-4 below.

Table 7-3: Generic Options, sub options and specific options list

Generic Option	Number of sub-options	Number of specific options
Indirect Potable Re-use	2	38
Development of groundwater resources	1	31
Demand Management	8	28
Raw water transfer	7	28
River Regulation Reservoir and Direct Supply	6	25
River Regulation Reservoir	6	20
Direct Supply Reservoir	6	19
Third Party Options	1	11
Aquifer storage and recovery (ASR)	1	8
Intra-zonal Transfers	1	8
Artificial recharge (AR)	1	6
Release of network/treatment constraints	1	5
Desalination	1	4
Development of surface water sources	1	2
Licence Trading/Transfer	1	2
Catchment Management Initiatives[1]	1	1
Enhancement to Existing Reservoir Operation	1	1
[2]Gravel Pits as Reservoir	-	-
Sewage Transfer	-	-
Imports by sea	-	-
Reduction of Supply-side Operational Use and Losses	-	-
Total	**46**	**237**

[1] The Lower Lee surface water scheme is included in the feasible options list. The catchment management study has not been included as a separate feasible option but supports the on-going assessment of this scheme. The catchment management schemes have been included as they will continue to be examined but only 1 could be taken forward for modelling.

[2] Generic options which have been greyed out in Table 7-3 have been screened out

Table 7-4: Feasible Transfers Options List Summary

Type	Number of options
Import	7
Export	15
Bilateral	9
Total	**31**

The size of the feasible options list was considered unmanageable for programme appraisal modelling and further refinement was needed. This secondary screening refinement was intended to rationalise the large number of similar option variants within the feasible options list.

7.1.6 Secondary screening of options

Secondary screening provides a manageable, constrained list of options to take forward for detailed assessment prior to economic modelling[3], whilst at the same time ensuring that a sufficient range of schemes is retained to ensure that alternatives can be fully tested, and a full range of options is explored. This secondary screening draws on the findings of engineering, environmental and feasibility assessment of schemes to provide a more detailed option appraisal based on:

- Risk and resilience: capacity, engineering design and risk;
- Cost: using available outline cost information from WRMP09 or subsequent investigations;
- Environment: initial environmental assessment of schemes.

The rationale for scheme rejection at this secondary stage is also set out within the Scheme Rejection Register (Appendix Q).

Schemes taken forward to the constrained list are then scoped and assessed for cost, environmental and social impact (including carbon) before being passed on for comparative econometric assessment against demand-side options.

7.1.7 Options requiring further study

There are option types and individual options for which we do not currently have sufficient information to justify their inclusion in the constrained option list. These were therefore screened out, but this does not mean to say that they could not be included at a future date. Options include:

[3] as recommended in the WRPG and Stage 4.4 of the Economics of balancing Supply and Demand (EBSD) guideline

Gravel Pits as Reservoir

Gravel pits have been screened out due to low yield and environmental impact (Appendix Q 2.3)

Sewage Transfer

Sewage transfer schemes have been screened out because no schemes have been identified (See Appendix Q 2.8). Schemes providing benefit which involve sewage transfer are included as wastewater re-use schemes. Wastewater re-use is described in more detail in Appendix L.

Imports by sea

No schemes have been developed to a level to allow their inclusion on the constrained options list (See Appendix Q 2.10). Options identified for import by sea were reviewed through the OJEU process, described later in Section 7.4.

Reduction of Supply-side Operational Use and Losses

No specific schemes have been developed to a level to allow their inclusion on the constrained options list (See Appendix Q 2.13). As part of a business as usual improvement process we have developed resilience models for our surface water treatment works. This programme is being rolled out to include all our water treatment works. Going forward these auditable models will be used for asset investment planning and will provide our operational treatment works capability assessments and process losses. These outputs will be input into our new WARMS2 model. The existing WARMS model is currently being upgraded and the new model will be in AQUATOR. One of the benefits of the new model will be to give much greater transparency of modelling assumptions. We have evaluated the potential for reductions in supply side operational use using the models available to date. This has not resulted in the development of any viable options. Details of this process are given in Appendix K. We are however committed as a business to reducing operational use and losses across all of our company sites and have set a target to reduce our on-site use by 1Ml/d in AMP6.

Third Party Options

Many of the schemes submitted from third parties require further development to allow their inclusion on the constrained options list (See Appendix Q 3.10). We consider this to be an on-going process and will continue to work with providers to fully explore the options available. Third Party options were reviewed through the OJEU process as discussed below in Section 7.4.

Catchment Management Initiatives

No schemes have been developed to a level to allow their inclusion on the constrained options list (See Appendix Q 3.11). We are developing an option for the Lower Lee but this has not yet been developed to a level where it can be included as an option on the constrained options list. Further work on the feasibility of this option is anticipated to be undertaken in AMP6.

7.1.8 Constrained Options List

The final constrained options list can be found in Appendix P. The make-up of options within this final list forms the basis of more detailed programme appraisal and optimisation modelling.

The constrained lists consist of 123 water resources options, 48 demand management interventions and 6 transfer schemes, as summarised in Table 7-5 and Table 7-6. In total 177* options were taken forward.

Table 7-5: Constrained Options List Summary

Generic Option	Number of sub-options	Number of specific options
Demand Management	2	48
Development of groundwater resources	1	25
Indirect Potable Re-use	2	20
Raw water transfer	5	19
River Regulation Reservoir	3	11
River Regulation Reservoir and Direct Supply	3	10
Intra-zonal Transfers	1	8
Aquifer storage and recovery (ASR)	1	7
Artificial recharge (AR)	1	6
Desalination	1	4
Release of network/treatment constraints	1	3
Development of surface water sources	1	2
Direct Supply Reservoir	2	2
Third Party Options	1	2
External transfer	2	2*
Enhancement to Existing Reservoir Operation	1	1
Licence Trading/Transfer	1	1
Gravel Pits as Reservoir	-	-
Sewage Transfer	-	-
Imports by sea	-	-
Reduction of Supply-side Operational Use and Losses	-	-
Catchment Management Initiatives	-	-
Total	**29**	**171**

Table 7-6: Feasible Transfers Options List Summary

Type	Number of options
Import	2*
Export	4
Bilateral	-
Total	**6**

*Imports that pass the screening process to the constrained transfer list also feature in the constrained options list and have been included in programme appraisal and optimisation modelling.

7.2 Economic, Environmental and Social appraisal

7.2.1 Economic appraisal of constrained options

Approaches to the economic assessment of options are set out in the EBSD methodology[4]. All options that passed through the secondary screening process to be included in the constrained list have been assessed and wherever possible environmental and social costs monetised.

From these a simple measure of cost benefit can be calculated, called average incremental social cost (AISC). AISC is calculated by combining the net present value (NPV) of the following elements with the discounted scheme yield (maximum capacity):

- Capital costs;
- Operating costs and savings (if any);
- Assessment of likely variations in scheme effectiveness;
- Assessment of delivery risk;
- Assessment of cost estimation accuracy;
- Temporary and permanent environmental and social costs and benefits (if any).

A discount rate[5] of 4.5% is used and costs are expressed in 2011/12 price base[6].

It should be noted that AISC is only a guide. Since WRMP09 we have developed programmes that aim to minimise the overall NPV of a programme, rather than rank schemes in order of AISC. For this plan we have developed and employed a more sophisticated modelling approach to cost minimisation (see Section 8).

The final NPV costs and AISC for each option is provided within WRP Table 3 (Appendix A).

[4] UKWIR and Environment Agency (2002) *The economics of balancing supply and demand*

[5] Discount rate is defined in WRPG section 6.5.3.

[6]Price base - WRPG section 2.4.2 states that ideally 12/13 should be used. However this was not possible at the time of modelling. This is not considered material to the plan compared with other factors. See Section 10 for more detail.

Option cost estimating and uncertainty

Water resource options are inherently risky due to the long planning horizon and complex interfaces, and water quality and increased scarcity issues. Often the option scope or perceived benefit will change significantly during option development and implementation. Changes may be due to the uncertainty at the early option feasibility stages regarding the degree of benefit, the quality of the raw water, the treatment required, the technical standards, scheme interfaces and dependencies and geo-technical conditions. Therefore a degree of uncertainty exists which will typically be reduced through the project cycle.

The level of uncertainty differs across the wide variety of water resource options ranging in complexity from; large raw water transfers, storage reservoirs, wastewater reuse and desalination, groundwater development, inter-company transfers and removal of network constraints. This uncertainty has been acknowledged in the WRPG[7].

Our development of cost estimates for the water resource options follow industry best practice and are defined in our 'business as usual' procedures for investment planning, see Figure 7-3. The cost estimate data is entered into our corporate Asset Management database (Asset Planning System (APS)) that contains all the option information to enable the cost benefit analysis to be performed prior to optimisation within EBSD.

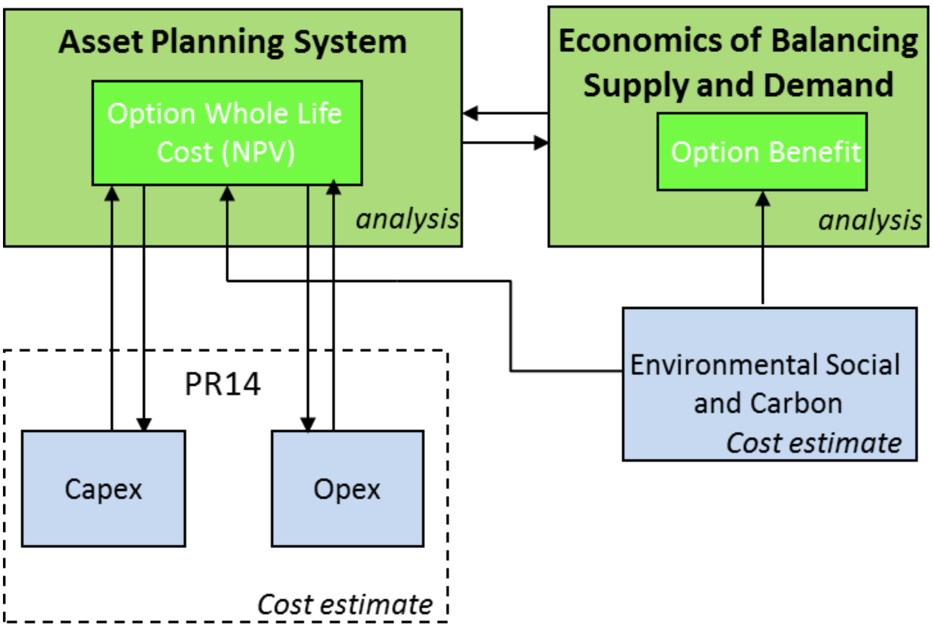


Figure 7-3: Water Resource Management Plan Option Development

[7] Appendix 10, Table 10.3

There are three main elements of an option cost estimate. The base cost is the basic cost estimate for an option before allowing for any risks, though these should incorporate realistic assumptions of changes in real costs over time, e.g. cost increases or reductions relative to RPI. An adjustment for risk is a known factor, it may be included within forecasting algorithms and also be present within typical input data. Uncertainty may be expressed as a range of cost estimates between the limits of which the ‘real’ or ‘eventual’ value may lie; another method is to express uncertainty as three input points (low, most likely and high), this is widely referred to as the “3 point estimating” technique.

Wherever possible the cost estimates have been prepared using our Engineering Estimating System (EES). The system uses tendered estimates and actual costs from completed projects. EES includes adjustments for realised risk and RPI. If the cost elements do not exist in EES or are outside the model range then a ‘bottom-up’ cost estimate is generated using supplier quotations and adjusted to include other option costs consistent with EES.

The development of the operational cost impact estimates are established by calculating the changes in power, chemicals, manpower and maintenance activities. These incorporate realistic assumptions of changes in real volumes over time. The volumes are entered into a standard Opex template which converts the volumetric data into costs, via an applied unit rate calculation within APS. Once in APS the Opex costs have upward cost drivers (cost increases or reductions relative to RPI) applied for the optimisation process. After optimisation the Opex volumes are then embedded into a financial modelling tool (ANAPLAN), which pulls together the overall PR14 Opex plan.

Resource option uncertainty

The uncertainty and hence risk associated with a resource option generally increase with the size and complexity of the project. Given the general tendency for option cost overruns[8], there is a need to ensure accuracy in option cost estimates. A systematic approach towards identifying and managing risk is followed and appropriate adjustments made to the cost estimate based upon the WRPG Appendix 10 Table 10.3.

[8] http://www.hm-treasury.gov.uk/data_greenbook_index.htm

Table 7-7: Cost and Scope uncertainty

Criteria	Score				
	1	2	3	4	5
Scope	Company has no previous experience of this type of activity.	Company has had some experience of delivering similar projects, but not within last 8 years.	Company has carried out similar projects but of significantly different scale.	Company has prior experience in similar projects, with similar scale. Company has standard solution/s for this type of activity which have been assessed as providing the least whole life cost solution.	Company has considerable experience in similar projects with similar scale. Company has standard solutions for this type of activity and a process for updating them. It has been assessed as providing the least whole life cost solution.
Cost	Cost data is from non-company sources. Used industry parametric data (e.g. TR61).	Significant use of non-company sources, costs from dissimilar projects or costs from projects completed more than 8 years in the past.	Company has some company specific data. And some non-company source data. (eg contractors' estimates with limited or no company specific input).	Cost represents activity where reliable company specific cost data is available (a few data points).	Cost represents activity where reliable company specific cost data is available (reasonable number of data points).

The robustness of each water resource option is assessed against the above criteria and an appropriate adjustment for optimism bias made to the cost estimate.

The process follows a determination of the risk level of the option by the Option Confidence Assessments undertaken using APS Forms F910J and F910K for deliverability and effectiveness of the solution.

Each form follows a set of structured questions to assess the proposed design solution effectiveness and deliverability respectively. The questions in each form are weighted according to their influence on confidence variability and are scored by checking the appropriate box for each question (H,M,L confidence). The Confidence Assessment results are used to calculate a 'Confidence Grade'. This score can then be translated into an Uncertainty Level, see Table 7-8 below.

Table 7-8: Determination of Option Uncertainty Level

Confidence Grade	Uncertainty Level
1	High
2	Medium
3	Medium
4	Low
5	Low

The level of uncertainty has been monetised and an 'optimism bias' see Table 7-9 below, has been applied to each water resource option. The optimism bias is a percentage adjustment to the base cost estimate based upon the confidence grade and consequent uncertainty level of the option. For example the most likely outturn cost for a medium risk option would require a 24.5% uplift to the base cost estimate. The optimism bias ranges for the high, medium, low uncertainty levels have been developed in line with the UK Treasury Green Book Guidance document and validated with our data where it was available, supported with wider industry data.

Table 7-9: Cost estimate percentage adjustment Optimism Bias ranges

	Optimism bias ranges (%)		
	Lower	Most likely	Upper
High risk projects	31	66	131
Medium risk projects	2	24.5	59.5
Low risk projects	-10	5	25

Therefore costs estimates are supported by assessments of likely variations in scheme effectiveness, delivery risk and cost estimation accuracy. This follows our approach to outline engineering design undertaken for all capital projects and is, therefore, consistent with the costs for other schemes included within the PR14 Business Plan.

The outline engineering design specifies all the key engineering components that will be required to deliver and implement a scheme. This includes pipelines, pumps, boreholes, treatment, storage, associated buildings and works and appropriate infrastructure for connection into the distribution network of the WRZ for which the scheme is intended. The costs of major environmental mitigation works (where not sufficiently scoped to explicitly define) are included within the risk scoring exercise.

Our process for assessing cost uncertainty was reviewed as part of the cost appraisal process for the Water Resources in the South East project. The review by Halcrow (the consultants commissioned for this project) stated that, apart from a query on the monetary unit of capital costs, (which was resolved) the entirety of the submission is of the optimum quality[9].

Demand management option uncertainty

The costs of demand management options such as metering, mains rehabilitation and pressure management have been taken from our actual contractual unit rates or our engineering estimation system (EES). We have considerable experience in these types of project and have company specific data (ranging from few to many data points). Given the programme nature of these activities and our delivery experience, no adjustment for optimism bias was made for these options.

Environmental, social and carbon appraisal of constrained options

An environmental, social and carbon assessment has been undertaken for each site-specific water resource scheme and demand management scheme identified on the constrained list of options. These assessments have provided information for the development of environmental and social costs, and for the SEA and HRA.

Environmental and social costs

The schemes have been assessed against a range of environmental and social criteria, including carbon, and where possible, their effects have been quantified and monetised using a technique called ‘value transfer’, following the updated Benefits Assessment Guidance User Guide[10] and original Benefits Assessment Guidance[11]. Valuations of environmental and social impacts are drawn from studies where people were asked how much they would be willing to pay to avoid particular environmental and social impacts occurring, or to achieve specific environmental and social improvements. Carbon impacts have been valued according to Government and Water Industry guidance. A full description of the environmental, social and carbon valuation methodology is reported in Appendix B.

[9] Arcadis Memo,WRSE Arcadis update 28 September 2012

[10] Environment Agency/Eftec (2012) *Benefit Assessment Guidance*

[11] Environment Agency (2003) *Assessment of Benefits for Water Quality and Water Resources Schemes in the PR04 Environment Programme*.

The environmental, social and carbon costs and benefits have been combined with the financial costs of a scheme within the AISC. A limitation to the AISC methodology is that it only takes account of those environmental and social impacts that can be ascribed a monetary value. A number of impacts are non-monetisable and are thus excluded from the AISC. A Strategic Environmental Assessment (SEA) has been used to consider the full range of impacts and benefits, thus aiding decision-making and contributing towards the wider objective of achieving sustainable development within the Thames Region. SEA has been used in our programme appraisal to assess the overall performance of different future programmes (see below).

Valuing carbon across the whole life of a project requires an assessment of carbon emissions from both the construction and operational phases. In the construction phase, embodied energy is the energy expended in the process of sourcing, manufacturing and supplying a product, material or service. This product, material or service may then expend further energy in its operation. The embodied carbon is a one-off cost that goes with the construction phase of the option. This cost is calculated off-line and is a unit rate, the values are in tonnes of carbon. These costs are included in our modelling.

Carbon that is produced during the operation of the plant is added automatically by APS based on the kWh power consumption profile.

Strategic Environmental Assessment (SEA)

We consider that the WRMP falls under the remit of the SEA Directive (Directive 2001/42/EC). An SEA has therefore been undertaken in compliance with the SEA Regulations (Statutory Instrument 2004 No. 1633) and has followed the methodology set out in the industry guidance published by UK Water Industry Research, UKWIR (2012). This guidance was developed by Cascade Consulting on behalf of the water companies, in collaboration with the Environment Agency, Natural England, English Heritage and Countryside Council for Wales, and is recommended by the WRPG.

The statutory authorities[12] in England and Wales as defined in the SEA Regulations and wider stakeholders were consulted on the scope of the SEA in May 2012. Responses to this consultation, and subsequent changes made to the scope of the SEA were discussed and agreed with consultees at a meeting in September 2012. The SEA Environmental Report (Appendix B) explains the methodology and the output of the SEA for all schemes on the constrained list. The SEA outputs have been used to develop the preferred programme as explained in Section 8. The SEA has included Water Framework Directive (WFD) status assessment as required by the WRPG.

[12] Environment Agency, Environment Agency Wales, Natural England, Countryside Council for Wales, English Heritage, Cadw and Welsh Government

Habitats Regulations Assessment (HRA)

As a competent authority, we must ensure that our WRMP meets the requirements of the Habitats Directive (92/43/EEC) prior to implementation. If the WRMP (i.e. one or more schemes within it) may cause a likely significant effect on one or more European sites, either alone or in-combination with other schemes, plans or projects, the WRMP must be subject to Appropriate Assessment. In accordance with the Habitats Regulations, we have undertaken a Habitats Regulations Assessment (HRA) of our final WRMP.

The HRA process has four stages:

1. Screening, which identifies likely impacts, alone or in-combination with other projects or plans, and considers whether these impacts are likely to be significant.
2. Appropriate assessment, specifically the assessment of the impacts of the WRMP (alone and in combination with other plans and projects) on European sites such that a conclusion can be made as to whether the WRMP will affect site integrity, taking into account potential alternative solutions and mitigation measures.
3. Assessment of alternative solutions, where alternative solutions are identified and consideration of their impacts is given in comparison to those in the WRMP.
4. Where no alternatives exist and adverse impacts remain, assessment of imperative reasons of overriding public interest and compensatory measures required.

The HRA report forms Appendix C of the WRMP.

SEA and HRA in Programme Appraisal

Programme appraisal is explained in more detail in Section 8. We have used the outputs from the SEA to refine the least cost programme to minimise its potential environmental and social impacts, as suggested by the guidance (UKWIR, 2012) and the WRPG.

Component schemes of each programme which have significant adverse impacts identified by the SEA have been noted. The significant impacts of each scheme have been examined and a judgement made as to whether those impacts have been effectively and completely considered through monetisation (if at all). Where this is judged to be the case, the particular impact is not considered further (as it is already fully considered through monetisation) to avoid double counting. Potential cumulative effects of schemes within the programme are also considered at this stage.

Where impacts have not been fully monetised, they are considered further. Environmental and social effects (including cumulative and in combination effects) identified through the SEA and the HRA, that have not already been considered through monetary valuation, are used to help decide whether an individual scheme or schemes selected by the model for the least cost programme should be rejected. The model then selects a revised combination of schemes, excluding the rejected scheme or schemes, as an alternative programme.

In this way the SEA and HRA are used, at programme level, to develop the preferred programme according to environmental sensitivity alongside other parameters, such as customer preferences, Government priorities, resilience and reliability.

7.3 Water resource options

7.3.1 Summary

The range of water resource schemes we have identified has built on work undertaken over successive WRMPs, the Stage 1 Upper Thames Major Resource Development (UTMRD) Needs Case, the Reservoir Site Selection Report, issues raised at the public inquiry into WRMP09 and stakeholder responses, and subsequent investigations into the additional options identified for further assessment in the revised WRMP09 (published in 2012).

A total of 123 water resource development schemes are identified as being suitable for potential selection within a preferred options set following economic and sustainability-based analysis. 17 of these options are capable of supplying both the London WRZ and SWOX WRZ, which two of the WRZs that are forecast to have a significant supply deficit over the 25 year plan period. Indicative locations for these schemes within the WRZs are shown in Figure 7-4.

Supporting summary information for each scheme can be found in Appendix R. This includes:

- A description of the key features of the scheme including:
    - Type (surface / ground water abstraction, reservoir, artificial recharge (AR) / aquifer storage and recovery (ASR), wastewater reuse etc).
    - The WRZ it is intended to supply.
    - Engineering scope, including infrastructure links etc.
    - Benefits to deployable output.
    - Interdependencies and exclusivities: identifying where options are mutually exclusive, synergies
- An option schematic illustrating the main operational features, links etc. of the scheme, the scale, source of supply and supply zone for which the option is intended.
- Cost and confidence summary: in relation to deliverability of the scheme.
- Environmental impact summary summarising the findings of the SEA and HRA findings for the scheme (where appropriate).

Options identified in discussion with neighbouring companies and third party interests are also included.

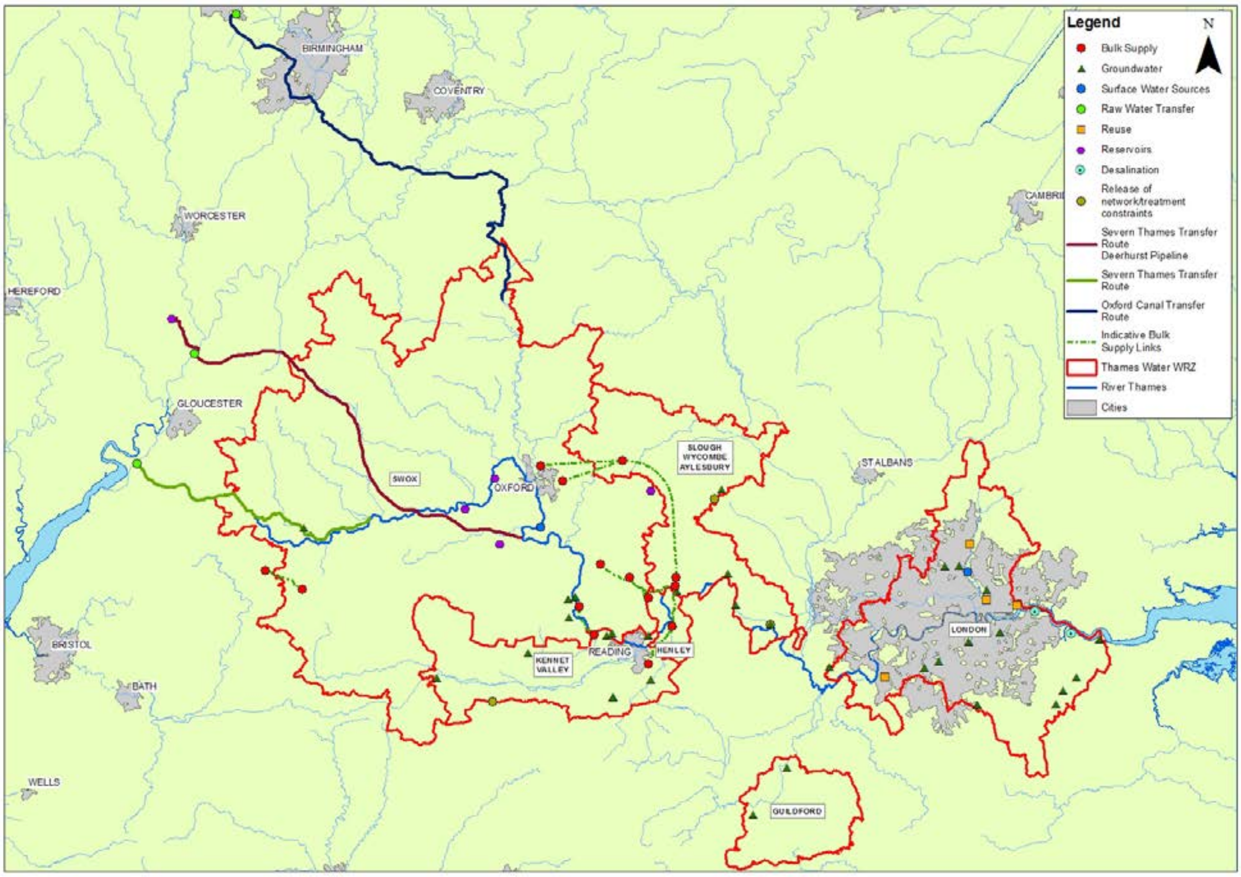


Figure 7-4: Overview of constrained water resources options

7.4 Awareness raising – Official Journal of the European Union (OJEU) Notice

On 1 June 2012 we published an OJEU Notice to invite third party organisations to register interest in providing bulk supply of raw or treated water.

We received 10 formal responses and when the opportunity has arisen the Notice has been discussed with a number of other individual companies to promote interest.

We subsequently contacted the organisations who had registered an interest to request further information on the potential options. Preliminary meetings were held with a number of the suppliers and confidentiality agreements were agreed with some to facilitate more detailed discussion.

The third parties, including other water companies who we engaged with as part of the OJEU process are listed below. The nature of the potential water supply options being promoted by these suppliers is also briefly described.

- Scottish Water Horizons Ltd - transport raw water to London WRZ using shipping tankers
- Iceland Ventures Limited - transport raw water to London WRZ using shipping tankers or towing bladders
- Albion Water Group Ltd – small groundwater sources in the London WRZ, recycled water from sources adjacent to the Thames Water supply area and transport raw water to London WRZ using shipping tankers
- Severn Trent Water Ltd – raw or treated water from Severn Trent's strategic grid zone to SWOX WRZ for local use or subsequent transfer to London WRZ.
- United Utilities Group Ltd – provision of raw water to SWOX WRZ for subsequent transfer to London WRZ.
- Subsea Infrastructure Ltd - mobile desalination plants for London WRZ.
- Morrison Utility Services – demand management through active leakage control in London
- Kingairloch Estate LLP - transport raw water to London WRZ using shipping tankers
- Stourbridge Water Direct Management Ltd – transport treated water using articulated tankers
- FGS Agri Ltd – transport water using articulated tankers from sources within the South East region WRZ.

- RWE N-Power – joint work with Thames Water to identify in-combination synergies to provide water resource options

A formal Request For Proposal (RFP) was issued to the suppliers in December 2012[13] which gave details of our specific information requirements in relation to the water supply options. Suppliers were asked to submit more detailed proposals by the end of January 2013. Table 7-10 gives summary details of the proposals that were submitted. Not all organisations that registered an interest provided a response to the RFP.

Feasibility of the delivery of potable water by sea

As a number of the applications were from companies offering water supplies using shipping tankers, we commissioned Arup to undertake a proof of concept study to determine the additional costs associated with delivering water into our network. The work was completed in December 2012[14] and Arup concluded that none of the technologies covered by its study are realistically suitable for direct application within our geographic area. The study has, however, identified that two technologies may provide a bulk water supply solution for other water companies in the wider South East. These are:

- provision of a new floating desalination facility or facilities
- an adaptation of the Excelerate Energy Gas Port model 'mother and daughter' gas supply concept[15].

[13] Framework Agreement No 1114 WRMP Request For Proposal December 2012

[14] ARUP (2012) Bulk Water Supplies – Technology Overview. Phase 1 – High Level Technology Review

[15] This method involves the at sea transfer of liquid cargo (in this example LNG) from larger "mother" ships to smaller "daughter" ships. This transfer takes place between the loading port and delivery port and allows access to docks with a shallower draught. Long haul transit is provided by the larger vessel while delivery is provided by the smaller.

Table 7-10: Summary of OJEU proposals to date.

Company	Nature of supply option	Source of water	Point of entry (WRZ)	Volume (Ml/d)	Earliest date of availability
Scottish Water Horizons	Raw water supply via shipping tankers	Loch Glass catchment, Scotland	London	5	2015
Albion Water	Multiple options including raw water supply via shipping tankers and a treated water option	Norwegian glacial meltwater	London	30 - 440	2015
Iceland Ventures Limited	Raw water via shipping tankers, bladders or pipeline	Icelandic glacial meltwater	London	>400	2015
United Utilities	Raw water via River Severn	Existing storage reservoir in River Severn	SWOX	=<180	2020
Severn Trent[16]	Raw water via River Severn	River Severn catchment	SWOX	128	2025
Severn Trent	Raw water via Pipeline	Treated effluent	SWOX	198	2025
Morrison Utility Services[17]	Treated water	Leakage reduction	London	10	2015
Subsea Desalination	Desalination product water – 2 options	Mobile desalination	London	20.5	2015
RWE Npower	Raw water via River Thames	Closure of Didcot A Power Station	London	17	2015

[16] Severn Trent Water's original submission included four different options however this has subsequently been refined to two options. Previously submitted options included transfer of treated effluent via canal, network transfers between adjoining zones by existing assets and bulk transfers via STWs strategic grid.

[17] The is being assessed as an operational means to reduce leakage in the current AMP period.

7.4.1 Assessment of potential options

All of the potential options from the OJEU process have undergone an initial assessment. We did not have the same level of detailed information to assess these options on a comparable basis to other options on the unconstrained list. The criteria used to assess OJEU options are the economic, environmental and social costs, technical feasibility and operational risk. This process follows the same principles as the screening of other options described in Figure 7-2. The information requested from third parties in the RFP to complete the initial option assessment includes:

- description of the scheme including information on the source of supply and water quality
- conceptual design outlining the main operational features
- schematic showing links or dependencies to other options
- output in terms of amount of water available, both peak and average, and the period of the year when it is available.
- lead time to investigate and implement the option and earliest start date
- risks or uncertainties associated with the option
- factors or constraints specific to the option.

7.4.2 Screening the Unconstrained OJEU options

We have continued to discuss options with OJEU providers throughout the on-going development of our final WRMP. Some of the other water company and third party schemes have not been developed in sufficient detail to fully evaluate the merits of the particular scheme through the programme appraisal process undertaken for the draft plan or the final plan.

Since publication of the draft Plan in May 2013 we have developed a scoring system to assess OJEU options based upon the screening criteria employed for other supply options (see Section 7.1). This has allowed us to assess OJEU submissions in a similar way as other supply options despite the relative paucity of detail received from providers.

Each OJEU proposal has been scored against the following criteria using a 3 point scoring approach, this was based on the primary screening criteria used for water resources and demand management options (see 7.1.4):

- **Avoids Excessive Cost -** Is the scheme competitive on cost, this is based on the cost per Ml/d relative to established water resource options.

- **Technically feasible -** Is this an established method that others or Thames Water have implemented and operated before. Is the risk of implementing this solution unacceptably high?
- **Meets supply-demand issues -** Will the option contribute to the supply-demand balance of the WRZ?
- **Lead time -** Time to implement the scheme is proportional to the size of the project and the benefits it will deliver.
- **Other risks -**Will the scheme provide a resilient supply of acceptable quality water?
- **Planning and environmental -** Has suitable consideration been given to the environmental impacts of the scheme implementation? Has the third party provided this assessment or supplied sufficient information for this to be undertaken?
- **WFD objectives -**Have impacts on the WFD status of donor and/ or receiving water courses been assessed?
- **Avoids social inequality -** Has suitable consideration been given to the social impacts of the scheme implementation?
- **National policy -**Does the scheme align with national water policy?
- **Climate change risk / adaptability -** Have the risks associated with climate change been adequately accounted for in the scheme proposal.

We consider however that the assessment of options is a dynamic and on-going process; information on new options as well as additional information on existing options will continue to be considered and discussed with providers between publication of our final WRMP14 and throughout the development of our WRMP19. Our Contact Plan gives details of Thames Water's approach to identify and investigate potential options to share or trade resources and was first published on our website in October 2012. We will continue to investigate additional options and will update this document to explain progress as our on-going discussions yield results.

New options will also be considered as part of the Annual Review process once our Plan has been approved by the Secretary of State. These options could be substituted at any time if they are considered to be particularly beneficial.

7.4.3 Findings

The scoring exercise has allowed us to better understand the potential of each OJEU option submitted. The process also identified where information provided by respondents was insufficient to make a full assessment. Based on the information and commercial conditions submitted, very few of the options submitted as part of the OJEU process had been developed in sufficient detail to enable their inclusion in the constrained options list. Therefore only one option was subsequently considered as part of the programme appraisal process for the final WRMP.

The exercise included an assessment of the costs proposed for each option. Although cost information was, in many cases, insufficient to make an equitable comparison with other water resource options many of the OJEU options are clear cost outliers in comparison to other schemes selected though our programme appraisal process.

The environmental and social costs of the OJEU options have also been assessed. The information submitted was of varying quality and did not allow an equitable comparison with other water resource options. We therefore engaged Cascade Consulting to make an assessment of the environmental and social impact of the OJEU options.

As a result of the assessment described above we are now able to identify which OJEU options to pursue further during AMP6 and those which we do not consider are likely to be selected as part of a best value plan in WRMP19.

We have now completed assessment of the responses received against the WRMP project number 1114. In line with the requirements of the WRPG, all respondents will be informed individually of the outcome of this assessment. Scores will not be published as part of our rdWRMP to preserve commercial confidentiality for all respondents. All unsuccessful respondees will be given the opportunity to receive individual feedback from this process.

7.4.4 Implications for our WRMP

One option originally identified through the OJEU process has been included in our programme modelling and appraisal process. RWE N-Power submitted a position statement related to an unused element of the Didcot abstraction licence associated with the closure of the coal fired power station, Didcot A.

Additionally the Morison Utility Services submission has been taken forward during AMP5. Elements of the submission are already operational while other elements will be commissioned in the near future.

7.5 Water Resources in the South East (WRSE)

7.5.1 Our involvement in WRSE

We have been working with five other water companies and our regulators on the WRSE project to identify potential opportunities for sharing of resources in the South East of England. WRSE is a regional least cost modelling project, the background for which can be found in Section 4.5. The modelling is designed to inform participating water companies of potential resource sharing options for consideration in their own water resource management plans and to provide a regional framework for the requirement for strategic resource development for the South East of England.

The modelling study was initiated prior to the publication of draft WRMPs in order to inform the preparation of draft plans through provision of information on options identified for sharing water between companies. This initial work consisted of two phases, the first was to build the water resources regional model and to carry out a number of tests to ensure the model worked and was fit for purpose. The second phase was to include the most up to date data available at the time in the model and undertake a number of model runs to show the results of a range of scenarios agreed between the companies. This second phase had to start in advance of the companies own modelling and so did not include the same input data as the companies included in their own draft plans because it was not available at the time the modelling exercise was undertaken. The results of phase 2 were available in February 2013[18].

The results of the WRSE modelling available in February 2013 were encouraging and our preferred plan aligned to the outcomes. At the start of March 2013 we were asked to include some specific transfers to neighbouring companies in our draft WRMP. However, due to additional work needed on the inter-company transfers on cost and the associated knock-on impacts on our plan, the timing of the requests so close to submission of our draft WRMP meant that we could not build the schemes into our preferred plan. However we analysed the potential implications of the transfers through scenario analysis. In addition to a baseline scenario which used water company baseline data, several scenarios were considered by WRSE to explore the uncertainty inherent in forecasting future water resource development requirements. Further scenarios proposed by the companies and the Environment Agency were also run to address specific issues that the companies wished to explore. A total of 47 scenarios were run.

[18] Water Resources in the South East. Progress towards a shared water resources strategy in the South East of England. February 2013.

7.5.2 WRSE Final Report and Summary Results – February 2013

The results of the WRSE modelling work completed in February 2013 can be summarised as follows for the SE region;

- In years 2015/16 to 2019/20 a large number of demand management schemes were selected, including metering, water efficiency and leakage reduction. These contributed to about 27% of the new capacity in this five-year period. Supply schemes including new groundwater supplies, river abstraction and treatment works expansion contributed about 36% (wastewater re-use and desalination options were only selected in about half of the scenarios in this period). Inter-company transfers contributed the remaining 37% of the new capacity.

- In years 2020/21 to 2024/25 there was a change, with the majority of the capacity provided by supply side schemes (57%) and transfer schemes (40%), and demand management schemes contributing about 3% of the new capacity. Two wastewater re-use schemes (20 and 150 Ml/d) were introduced in this period across most of the 10 scenarios.

- The remaining years of the plan saw a large number of inter-company transfers, with groundwater, two more wastewater re-use schemes, river abstractions, a reservoir and treatment works schemes providing the bulk of the increase in capacity.

WRSE Phase 3 Final Report and Summary Results – November 2013

Following publication of water company draft WRMPs a further phase, phase 3, of WRSE modelling was undertaken. This phase was required to update the model data and to test whether the WRSE model results were consistent with the water companies draft plans. Phase 3 of the modelling consisted of three main modelling runs and two secondary runs, these were:

- **Run 1** – The Base case for Phase 3. It selects the least cost portfolio of options with the Phase 3 data for supply-demand balances and all feasible options.

- **Run 2a** – Selects the least cost solution using just the preferred options contained in water company WRMPs. It uses water company preferred start dates (as detailed in their WRMPS) as earliest start dates for the options.

- **Run 2b** – Selects the least cost solution using water company preferred start dates as earliest start dates for options in WRMPs (as in Run 2a), but considered all feasible options in the optimisation.

- **Run 3** – Optimisation using Phase 3 supply-demand data and phase 2B options and cost data.

- **Run 4** – Optimisation using Phase 2B supply-demand data and Phase 3 options and cost data

The Phase 3 modelling used the updated data for supply-demand balances and options used by water companies in producing the draft WRMPs. The purpose of Phase 3 was to assess the consistency of the draft WRMPs with WRSE modelling. Analysis of the modelling results explored:-

- The degree of consistency between the phases, to check whether the modelling results based on updated draft WRMP data (Phase 3) is consistent with the range of scenarios considered in Phase 2.

- The degree of consistency between the three main Phase 3 runs, to check whether the water company preferred sets of options (Run 2a) are consistent with least cost optimisations using the same draft WRMP data (Runs 1 and 2b).

The results from the Phase 3 model runs are consistent with the results obtained during the earlier Phase 2B work. The Phase 3 costs lie between the total costs of two representative Phase 2B scenarios. The total costs of the three main Phase 3 runs are very similar to each other.. There is generally good consistency between the water company selection of preferred options in draft WRMPs (Phase 3 Run 2a) and the WRSE least cost optimisation using the same data (Phase 3 Run 1).

The WRSE phase 3 final report[19] includes the following statement:

‘’The WRSE modelling therefore examined 60 scenarios during Phase 2B. These scenarios explored a wide range of different visions of future demands and deployable outputs but, companies could explore other scenarios in their own work. For example, climate change allowances were included in the WRSE scenarios but the WRSE work did not go into such detail of investigating climate change scenarios as was explored by some companies.. The results helped water companies in the preparation of their draft WRMPs to understand how to mitigate the risks to future water supply and identify contingency options. It is important that suitable back up solutions are available that can be implemented quickly if circumstances change and the reliability of water supply is put at risk.

Water companies have explored the best mix of options in their areas to ensure their plans are robust and water supply resilience can be maintained. Thames Water’s preferred programme is not the base least cost but they consider it is more flexible, makes a better contribution to sustainable development, and more closely aligns with customer and stakeholder feedback. For instance, Thames Water has included some large schemes in its plan so that smaller-scale groundwater options, which could be developed in a short period, can be kept in reserve as contingency options if required. Therefore, the draft WRMPs include combinations of options that provide greater resilience and mitigation of risk than in nearest-equivalent WRSE scenarios.

[19] Water Resources in the South East, Phase 3 Report, November 2013

Key features of the options in the draft WRMPs that have been highlighted by examination of results from Run 2a are:-

- *Demand management features very strongly over the first five years. In years 2015 to 2019 a large number of demand management schemes are selected, including leakage reduction, metering and water efficiency. These contribute about 60% of the new capacity in this five-year period. The majority of the water saving arises from leakage reduction. Water efficiency activity saves relatively small quantities of water.*
- *Compulsory metering is proposed across the whole of the Affinity Water (Central) and Thames Water areas, and in the Sutton zone of Sutton and East Surrey Water by 2025. Compulsory metering is already complete in the Affinity (Southeast) area, and is progressing across Southern Water and South East Water, which are also areas that are designated as in serious water stress*
- *The draft WRMPs include enhanced sharing of available water between companies, by increasing inter-company and within-company transfers throughout the planning period. Water transfers are necessary to maintain the supply demand balance across the region and will also help to provide an increased level of resilience.*
- *New water resource schemes (wastewater reuse, groundwater, surface water, aquifer storage and recovery, and storage solutions) will make an important contribution to the provision of new water capacity, particularly during the 2020s when some major schemes will be required.*
- *As expected, there are differences between the results from regional least cost optimisation and water companies' own optimisation modelling. This is for several reasons, in particular water company's plans take account of aspects that are not directly covered by the WRSE model such as resilience requirements and the needs of customers and the environment, and take account of the commercial costs involved in sharing water.*

There are some key themes emerging from Phase 3 of the WRSE Group work. In particular, it has found that:

- *There is good consistency between the modelling results based on draft WRMP data (Phase 3) and the range of scenarios considered in Phase 2B, once changes to option costs and availability are taken into account.*
- *There is good consistency between the water company preferred sets of options in their draft WRMPs (Run 2a) and WRSE least cost optimisations using the same supply-demand and option data (Runs 1 and 2b).*

Phase 3 has therefore validated the consistency of the draft WRMPs with option optimisations using the WRSE model''

7.5.3 Implications for our WRMP

Alignment with our Plan

Each of the companies participating in the WRSE group has reviewed the outputs from the study, both of phase 2 and phase 3, in the context of their own WRMP. There was considerable alignment between the options selected by the WRSE modelling and those selected through our own water resources planning process. This is despite the observation that the WRSE modelling was completed on least economic cost planning principles without any of the additional complexity added to company water resource management plans through the requirement to identify 'best value' plans.

The results for the London WRZ in the base case scenario show a renegotiation of the existing bulk transfer arrangement to Essex and Suffolk Water (decreasing the existing export between 2015 and 2035), a significant demand management programme from 2015 to 2020, consisting of an integrated demand management option including mains replacement, metering and water efficiency.

Wastewater Re-use

The majority of WRSE scenario runs, undertaken in phase 2, focus on the deficit in London being met by an intensive period of building wastewater re-use options. There are 20 potential wastewater re-use options available for the model to select and in most scenarios (unless otherwise constrained) at least two are selected from 2020 onwards.

Relying on wastewater re-use to this extent is a risk intensive strategy. Wastewater re-use is a new type of resource option for us and one which is heavily dependent upon the catchment in which it is deployed to determine the treatment technology required. It has also attracted considerable opposition from customers when developed in other countries (e.g. Australia, United States).

For these reasons our preferred strategy for the promotion of wastewater re-use is to monitor the first plant installed, and be confident in both its operation and acceptability to customers before committing to building another.

Other strategic options

Scenarios run in phase 2 show there are two long term options selected to meet the deficit in London where wastewater re-use is not available, these are the unsupported transfer from the River Severn to the River Thames via the Deerhurst pipeline (71Mld), and a new surface water abstraction in the Lower Lee (75Ml/d).

In phase 2 we also requested that scenario B3 was run with a constraint applied to the amount of wastewater re-use in the Lower Lee catchment. In this scenario (K12), in addition to the unsupported transfer from the River Severn via the Deerhurst pipeline and the new surface water abstraction in the Lower Lee, a storage reservoir at Longworth (63 Ml/d) in the Thames catchment was also selected.

Our consideration of Transfer Options identified by WRSE

The model also selects bulk supplies from our supply area to neighbouring water companies. Since the publication of the WRSE report in February 2013 there has been an on-going dialogue with neighbouring water companies who, as a result of the study, are seeking to include options for transfers of supplies from our water resource zones to meet their own supply needs. Other neighbouring water companies had taken account of the output of the WRSE modelling in their draft Plans leading to inconsistencies between companies' draft plans. We therefore committed to explore these options in the preparation of our final Plan.

Following the consultation on the draft Plan, we have reviewed the outcomes of the WRSE modelling and discussed plans with neighbouring companies and confirmed where inter-company transfers should feature in our respective plans. These discussions have enabled us to identify the specific changes needed to ensure our final Plan and those of our neighbouring companies are aligned with respect to the transfers we jointly consider should be part of our preferred plans.

This process has resulted in the inclusion of new or increased options to share resources between ourselves and Affinity Water, South East Water and Essex and Suffolk Water.

The information that has been included is as follows:

- Transfer with South East Water (Windsor).
- Transfers with Affinity Water (Fortis Green, Ladymead and Iver).

A new trading agreement with Essex and Suffolk Water to reduce the amount of raw water supplied under the existing 1963 agreement relating to the supply from Chingford is also being agreed.

South East Water

Although a number of possible transfers between the companies were originally identified from the modelling work, the only bulk supply scheme to South East Water from the WRSE core list that remains viable is the supply from our SWA WRZ at Windsor to South East Water at Surrey Hills.

We have agreed to the provision of a transfer of 10 Ml/d from Windsor to Surrey Hills. This option is required to meet peak demands and commences in 2030 at 6.9 Ml/d increasing to 10 Ml/d in 2035 and remaining at 10 Ml/d until 2039.

Sutton and East Surrey Water

Prior to the submission of our SoR we had agreed to the provision of a transfer from our London WRZ of up to 5 Ml/d from Merton to Sutton although the requirement within the planning period only reached 4Ml/d by 2039. This option was required to meet both average and peak demands and commenced in 2036 at 1.2 Ml/d increasing to 4 Ml/d in 2038. However, Sutton and East Surrey has subsequently undertaken further modelling to inform its final WRMP requirements which has highlighted that it does not now require this transfer within the planning period and so we have removed it from our plan.

Affinity Water

Guildford - We have agreed to the provision of an additional transfer from our Guildford WRZ of up to 2.7 Ml/d from Ladymead to Affinity Water. This option is required to meet both average and peak demands and commences in 2036 at 1.11 Ml/d gradually increasing to 2.7 Ml/d at 2039.

Fortis Green - We have agreed to increase provision of an existing treated water transfer agreement from our London WRZ of 17 Ml/d to Affinity Water at Fortis Green. This takes the existing provision from 10 Ml/d to 27 Ml/d. This option is required principally to meet peak demands and commences in 2015 at 21.8 Ml/d and increases to 27 Ml/d in 2020 remaining at 27 Ml/d for peak until 2039. The provision required for average remains at 10 Ml/d for the majority of the planning period and then increases to 11.3 Ml/d in 2036 rising to 11.4 Ml/d in 2039.

In order to model the impact of the peak demand requirement on the average demand, we have had to make assumptions on the pattern of average demand arising from the peak requirement. We have used the DYAA data and added the annualised DYCP usage to increase the DYAA value. The DYAA usage then reflects the effect on DYAA utilisation from DYCP. The amendment to the DYAA profile is based on a 56 day critical period provided by Affinity Water for the period 1 April to 30 September.

The dry year annual average bulk supply provision is set to increase over the planning period as follows;

- in 2015 to 11.8 Ml/d
- in 2018 to 12.6 Ml/d
- in 2034 to 16.1 Ml/d

Iver

We have confirmed a revision to an existing raw water agreement with Affinity Water to reduce the raw water transfer at Iver from 10 Ml/d to 2 Ml/d.

Essex and Suffolk Water (E&SW)

The current 1963 Agreement is for the provision of 91 Ml/d average and 118.2 Ml/d peak to E&SW. TW and E&SW have agreed a new trading agreement to reduce the bulk supply provision. The agreed reduction in the provision of supply is:

- on average is to provide no less than 60 Ml/d for Jan-Mar each year and 75 Ml/d during the remainder of the year.
- at peak is to provide no less than 78 Ml/d for Jan-Mar each year and 97.5 Ml/d during the rest of the year.

This followed lengthy discussion with E&SW[20].

Transfers with Southern Water

Although transfers between Thames Water and Southern Water exist in the WRSE model these are rarely selected. We have confirmed with Southern Water that neither company will include transfers in their respective WRMPs.

Transfers with other parties

As discussed in Section 7.4, TW undertook a formal procurement process to explore opportunities for sharing and trading resources with other water companies, licensed water supplies and commercial organisations. This process identified several opportunities including potential large scale transfers with United Utilities and Severn Trent Water. There is insufficient information currently available on these options and they will be examined in detail as potential options in AMP6. In addition we identified an opportunity to make a commercial agreement with a local business and this has been taken forward as a short-term feasible option to deliver 17 Ml/d in AMP6 in our final Plan.

Alignment with WRSE outputs and regional water planning

It is clear there is a regional challenge, and there is a need for a long-term solution. Our own work reinforces the findings of the WRSE study; both forecast growing deficits and the promotion of water efficiency and demand management in the short term with larger, longer-term supply options in the future.

The WRSE study identified several key themes from this phase of the work which will be used to frame the on-going work of the group. These are outlined below.

A co-ordinated strategy by the WRSE Group for delivering an increased level of demand management activity across the South East of England will enable significant benefits from economies of scale and consistent activities, to maximise water savings and achieve more effective communications with customers.

[20] The Group Against Reservoir Development (GARD) has challenged both the amount and duration of the reduction in the raw water bulk supply to E&SW over the planning period 2015-2040. E&SW has rebutted GARD's challenge and explained the justification for the amount included in the new water trading agreement with us within their Draft Final PR14 Water Resources Management Plan November 2013 pages 24-28, and their Statement of Consultation Response to draft WRMP 2014, November 2013, Section 3.3.

There is an increase in inter-company transfers throughout the planning period. Although the costs in the model do not reflect the commercial charges and contractual arrangements required between companies, the WRSE Group plans to work together to ensure the strategy addresses how contracts can be agreed that are equitable for all companies and their customers. In terms of the transfers described above Thames Water is already liaising with each of the potential recipient companies to agree firm proposals.

Thames Water strongly supports the continuation of the work of the WRSE group. There is an opportunity for a joint implementation plan for wastewater re-use schemes by the companies involved, to evaluate the technologies involved that have not been previously used in the UK for this type of application, and to work with stakeholders and customers to promote such options.

The implementation of groundwater solutions will involve water companies, the Environment Agency and Natural England considering the long-term sustainability of some groundwater sources.

Several aquifer storage and recovery options are selected in the modelled scenarios. They would benefit from feasibility testing and evaluation by water companies before implementation. Sharing information from these studies would speed up the overall progress.

In view of the potential difficulties associated with the promotion and delivery of some option types, other solutions from within the pool of resource and transfer options need to be investigated to ensure that supply demand balances and resilience are maintained. These include some of the larger inter-company transfer options and storage solutions.

7.6 Demand management options

7.6.1 Approach

The identification and screening of demand management options followed an identical process to that for water resources options.

However, demand management options differ from resource options in three respects:

- Overlap with maintenance activity
- Geographic scale
- Range of potential programmes

Overlap with maintenance activity

Options to manage the demand for water are not only considered in response to growth i.e. to address a water resources deficit, but they are also techniques which are employed to help to maintain our existing assets. For example, measures to manage leakage will increase the amount of resource available for water supply and will also improve our assets which, without intervention, would deteriorate over time, i.e. our network will age and decay, resulting in an increased likelihood of bursts and an overall increase in leakage. Metering, whilst helping to manage demand for water, will also provide valuable information on asset condition and where to target maintenance activity.

As such it is the amount of each option that is critical to determine whether it will result in a reduction in leakage beyond the current level. We have taken this overlap into account in our plan (Sections 8 and 9).

Geographic scale

Water resource options have specific geographical locations. However, demand management measures can be implemented anywhere; on any property or any pipe on our network.

Therefore, it is not appropriate to model demand management interventions purely at a WRZ-level, we need to look in more detail, at smaller units in our water supply hierarchy. This is routinely done in operational planning (e.g. for leakage monitoring and control) and as such we have chosen to examine demand management measures at District Meter Area (DMA) level. There are 1,561 DMAs in our supply area, typically covering 2,500 properties each on average.

This more detailed modelling approach and the integrated modelling with capital maintenance requirements is a significant advance from WRMP09.

Range of potential programmes

There is a huge range of demand management interventions that could be put together in a large variety of potential programmes. Choices must be made between integrated solutions comprising a combination of leakage, metering and water efficiency, and those focusing on one particular demand management activity. Also, the total demand saving can be profiled differently so it is either flat, front end loaded or back end loaded and the size of the annual increments planned for can vary from say 0.1 Ml/d up to 10 Ml/d.

We have developed a pragmatic process by which we identify which demand management measure(s) to undertake to produce a desired saving. Subsequently a range of programmes has been developed to test how much demand management overall is cost effective and appropriate, in the context of other options, customer preferences and sustainability. The six predominant demand management options are shown in Figure 7-5 below.

	Costs	Constraints	Benefits
Water Efficiency	customer education	Metered properties only	Reduced customer use
	free issue water saving devices		Combined programme educates customer on consumption
	plumber assisted audit		Large programme drives customer awareness
			Media attention
Metering	Individual property meters	survey to fit ratio: ability to install a meter for each property type	Reduced customer use per property type per number of properties
	bulk meters for blocks of flats		Increased ability to find CSL
	bulk meter chambers	affordability	Enhanced detection of network leaks with sufficient meters
	re-lay of CSL found		Increased customer awareness
	contract costs		
Mains Replacement	streetwork costs for four different zones		Leakage reduction
	size and length of main		Increased ability to find CSL
	no of network monitoring meters, chambers, customer connections, additional connections		Increased efficacy of ALC
	re-lay of CSL found		Improve network condition
			Reduce number of bursts
			Aligned to customer preference
Pressure Management	number and size of pressure reducing valves	DMA can be pressure managed	Leakage reduction
	number of tall building booster pumps		Reduced burst frequencies
	additional network and valve information systems		Fewer customer supply interruptions
			Reduced customer calls
			Increased asset life
			Aligned to customer preference
Active Leakage Control	number and cost of leak detection hours		Leakage reduction
	number and cost of service pipe bursts		Fewer customer supply interruptions
	leak repair costs and streetworks		Reduced customer calls
Post-Metering Leakage Targeting	data management and network flow balancing	DMA has sufficient % meter penetration	Leakage reduction
	number and cost of leak detection hours		Improve network condition
	number and cost of service pipe bursts		Fewer customer supply interruptions
	streetworks and leak repair or pipe replacement costs		Reduced customer calls
			Increased asset life

Figure 7-5: Overview of demand management option costs, constraints and benefits

We use the options appraisal and screening processes to consider and refine the interventions to a manageable set for leakage reduction, metering and water efficiency. We then assess costs and benefits on a unit basis and use an optimisation model to select the right mix and amount of each intervention to achieve a desired demand reduction profile or programme.

Programmes are defined at WRZ level but the interventions are optimised at a DMA level in a model called AIM (Asset Investment Manager and translated to Local Authority area or borough for implementation.

In the remainder of this section we go through the options appraisal process for each type of demand management measure, to identify the unit interventions. We then explain how we model each intervention and how we identify how best to achieve a demand reduction profile.

7.6.2 Leakage reduction

Introduction

Leakage occurs as a result of the water pipes failing. It goes very much hand in hand with the occurrence of bursts and therefore the level of service that we provide to our customers in relation to the number of interruptions to supply. Additionally, the act of repairing a leak and reinstating the area can result in disruption for our customers and stakeholders.

Our experience over the last 16 years has shown that the most successful leakage control and reduction programme is a combination of:

- On-going leakage detection and repair activity to manage leakage recurrence; active leakage control (ALC);
- Enhanced active leakage control activity including pressure management, zonal reconfiguration and transmission (trunk) mains leakage management;
- Mains rehabilitation to improve asset performance to make significant and sustained leakage reductions.

'Enabling' activities such as meter improvements and DMA reconfiguration are also required to ensure that leakage activity is targeted to the right areas. We are also trialling a range of customer metering technologies to ensure we can maximise the benefits for leakage management as metering becomes more widespread.

To hold leakage at current levels takes considerable expenditure to detect and repair leaks as they occur, maintain our existing pressure management schemes and replace our pipework to stop its performance getting worse than it is today.

This section considers what options are available to us to go beyond this current expenditure in order to reduce leakage further. These are then incorporated within IDM to produce integrated solutions that incorporate customer metering and water efficiency. The principal options are:

- Mains replacement and rehabilitation beyond that required to offset network deterioration;
- Active Leakage Control;
    - Enhanced levels of 'Find and Fix' over and on top of that already being undertaken to maintain current levels of leakage;
    - Implementation of further pressure management and zonal reconfiguration schemes to further enhance pressure management and control;
    - Trunk mains leakage management;
- Customer supply-pipe leakage reduction with increasing opportunities becoming available through smart meter technology (as long as the meter is located upstream of the customer's supply-pipe).

Customers and stakeholders have clearly indicated to us that they wish to see leakage further reduced beyond the existing economic level and have recognised that this will have to be paid for (this is described in more detail in Section 1.5.2 and in Appendix T) .

Our ambition is to strike the right balance between our desire to further reduce leakage, the additional cost of this work, the need to maintain a robust and efficient water distribution network and the need to manage impacts on traffic congestion and household disruption. Our WRMP09 (July 2012) and Strategic Direction Statement 2007 set out our proposed plans to reduce leakage in our supply area from industry outlier to industry average levels by 2020. From the start of AMP5 in 2010 this equated to a total reduction of approximately 175 Ml/d over the planning period to give an average leakage level of 514 Ml/d (120 l/prop/day) in 2024/25. Ofwat did not support the proposed plan, considering that TW's costs for leakage reduction activity were too high and also that the proposed investment had not been determined using the recently published UKCP09 climate change scenarios. As such the Final Determination 2009 (FD09) did not include funding to reduce leakage below a target of 673 Ml/d in 2014/15.

A joint independent study was subsequently undertaken with Ofwat, the Mains Replacement Project Independent Review (MRPIR)[21], to examine the efficiency of TW's leakage reduction activities and its proposals for on-going reduction. The study concluded that TW's costs were high and that there were opportunities to improve targeting and efficiency of the delivery process. Consequently TW has revised its plans for leakage reduction and whilst the long-term strategic objective still remains to reduce leakage to industry average levels, the timescale at this stage is uncertain, and will be informed by the results of leakage control activity and data collected during AMP6.

[21] Thames Water Mains Replacement Programme Independent Review Findings and Recommendations Report, Thames Water, Ofwat, July 2012, Black & Veatch

Our draft long term strategy and draft WRMP 2015-2040 published for public consultation recognised that our revised plans for leakage reduction were not sufficiently ambitious and stated that the improved knowledge of the water supply network we will gain from our progressive metering programme will enable us to reduce leakage further. It stated that we intended to publish a revised target when we have collected the necessary supporting evidence during AMP6.

In response to feedback we have received to the consultation, we have revised our draft WRMP and have included assumptions to reflect the additional savings that we expect our progressive metering programme to deliver in terms of better targeting of active leakage control and mains replacement activity. Further allowance is also included to reflect savings in customer side leakage that are forecast to be achieved through the installation of household meters and Automatic Metering Infrastructure (AMI), and the increased visibility that this gives of leakage on customer supply pipes. The assumptions are based on post construction assessments of the benefits delivered by the Victorian Mains Replacement (VMR) programme, where we have put in full customer metering for network management purposes, and initial findings and data that have recently become available from fixed network trials in five DMAs where we looked to meter all property connections and installed AMI. We recognise that this is a limited data set and that the widespread roll out of progressive metering in AMP6 will provide a more comprehensive database that we will subsequently use to review and as appropriate, revise our leakage targets and long-term plans in our next WRMP in 2019. Nevertheless, this newly available information has been used as part of our current planning assumptions in the Economics of Balancing Supply and Demand (EBSD) analysis to update and revise our long-term plans for leakage reduction and thereby respond to the concerns raised in response to the public consultation on our draft Plan.

As leakage is reduced further the uncertainty of delivery increases. Selection of the most appropriate options therefore needs to account for the confidence of delivery. The analysis to assess the confidence of delivery of the final leakage plan is included within Appendix M.

In relation to mains rehabilitation, we have been working jointly with Ofwat (as discussed in Appendix M) to challenge and develop our current approach of wholesale mains rehabilitation to identify how we can best target our mains replacement and rehabilitation at sub-DMA level. As a result our approach to optimising solution selection has been significantly enhanced from that used in WRMP09 and we will continue to implement improvements.

The principal leakage control options considered are summarised below with further detail provided in Appendix M. Willingness to pay and the social costs of leakage control are discussed in more detail in Appendix T.

Leakage detection and repair

We currently have a well-developed district metering system with our network split into 1,561 district meter areas (DMAs) covering our distribution mains and further metered areas covering our trunk mains system. Our district meters are on telemetry and allow us to monitor the flows into each DMA in real time. This allows us to target our leakage detection and repair activity on a weekly basis but also to react daily to any large increases in leakage.

Given the extensive work we already undertake on leakage detection and repair activity, there is considered limited scope to make significant further leakage reductions with leakage detection and repair alone. That said we have developed leakage cost relationships for each DMA across our supply area, calibrated against actual leakage performance, and these allow us to evaluate the costs and benefits of delivering further leakage reduction through increasing leakage detection and repair activity.

Trunk Mains leakage control activity

The water mains network outside DMAs also leaks. This is often the most difficult leakage to detect. Currently, trunk main leakage is detected by either Hydrophone surveys or noise logging. This activity is yielding over 100 hidden leaks per year on these larger mains, often with considerable leakage benefit and work continues to improve the targeting of these specialist surveys. This work must continue to ensure leakage is not allowed to increase on these parts of the network.

For high risk trunk mains we install real-time monitoring. These units record and transmit flow, pressure and noise data to the 24 hour control room. The units alarm if a failure occurs and can also provide predictive data, that gives early warnings that a failure may be about to occur.

Replacement or relining of trunk mains occurs at locations where there is either a proven history of poor performance, or there is information backed up by non-destructive testing results showing that a main is in poor condition.

Although we have a large on-going leakage management programme focused on our trunk mains to ensure that leakage on these mains does not increase, it has not been possible to identify specific schemes that would deliver a guaranteed leakage reduction below current levels.

Pressure Management and zonal reconfiguration

We have a long history of implementing pressure management, reducing excessive water pressure within the water mains to reduce the rate of leakage (pressure reduction) and installing schemes to better manage fluctuations in pressure through advanced pressure and pump control.

That said, we are continuously looking for new areas to employ pressure management, using the latest control technologies. For this review we have used radar surveys to identify potential areas where pressures can be further reduced without impacting on the level of service we provide our customers. Conceptual designs are then developed and costed. Where schemes look promising they are then verified through pressure logging surveys. In total 304 schemes have been developed through to this stage for evaluation in the plan.

Mains rehabilitation and replacement

Since the start of our current programme of mains replacement in 2002/03 we have replaced 2500km of our worst performing mains, mainly in central London. The majority of this activity has been focused at whole DMAs where we replace all mains that are not considered to be in "good" condition. This approach has been very successful at delivering sustained leakage reduction and reduction in busts, interruptions to supply and reduced customer contacts.

For IDM we have used actual costs and benefits to evaluate the costs and benefits of replacing the mains in the remainder of our network.

Customer side leakage and metering

Supply pipe leakage makes up over a quarter of our total leakage. Both our mains replacement programme and our current ALC programme target supply pipe leakage as well as company side leakage.

However, due to the potential opportunity that customer metering offers for the identification of customer side leakage we have been trialling a range of different meter reading technologies. In particular we have trialled "smart" meters and meters on fixed networks (Advanced Metering Infrastructure, AMI) to evaluate the benefits these systems offer in the identification of leakage. This has allowed us to both:

- identify long term continuous flows to individual customer properties, indicating customer side leakage or wastage within the property, and
- complete balances between the water going into the DMA and the water leaving through the customer meters to allow us to accurately determine losses from our pipe network.

Rolling out progressive household metering in the London WRZ is an essential pre-requisite for on-going cost effective leakage reduction. There are two main factors that account for this. Firstly, widespread household metering will facilitate better understanding of actual leakage levels. Evidence from DMA water balances derived following completion of mains replacement work in AMP3 and AMP4 has demonstrated that what is often considered to be leakage can sometimes be customer usage. Secondly, the widespread installation of household meters with AMI technology will enable better and more accurate targeting of leak detection and repair activity, both on our own mains and those of our customers. This was a key conclusion of the MRPIR and explains why when we first set out our draft WRMP14 we delayed specifying our long-term plans for leakage reduction until after we had rolled out household metering across our London WRZ in AMP6. The data and results from this programme will provide a detailed database and knowledge which will be used to inform estimates of the future sustainable economic level of leakage.

More detail about metering is provided in the following section.

7.6.3 Metering

Introduction

Metering is widely supported by Government and stakeholders as an essential tool to help the sustainable use of water. The GLA's water strategy 'Securing London's Water Future' called for greater resilience in the face of future pressures on water, and more focus on reducing leakage and increasing use of meters to ensure the most effective use of available resources. Metering also has broad customer support, recognising that it is fair to pay for the resources used, although some customers have raised concerns regarding potentially rising bills.

Water usage data collected from 110,000 household meters already installed across our supply area has demonstrated the benefits of meters for reducing water usage and this has also been reflected in metering programmes implemented in other water company supply areas. Increased and potentially more accurate meter reading data not only provides a fair method of billing, it is also an important 'enabler' for other demand management activities. Having more meters will enable us to manage leakage reduction more effectively, pinpoint where in the distribution system it is occurring, and reduce the time leaks are running. Metering is also a pre-requisite to water efficiency as it enables customers to see the impact of their water use behaviour both volumetrically and financially.

In the draft Plan we updated our assessment of the costs and benefits of different meter reading technologies (mechanical 'dumb' meters, automatic meter reading and advanced metering infrastructure) against suitable groupings of households. This provided a list of metering options which have been screened for inclusion in our Integrated Demand Modelling (IDM) tool against other options. The costs have again been updated for AMI meters for the final plan with the negotiated contract costs.

Appendix N has more information on our approach to metering.

Metering Options

We have considered a wide list of options to promote metering. This unconstrained list is shown in Table 7-12.

Prior to 2010 we had progressed metering via existing statutory powers to progressively (selectively) meter properties where a swimming pool is owned or sprinkler, through the promotion of meters giving customers the choice to opt for a meter (optants) and installed meters on the change of occupier, whilst these approaches helped to increase meter penetration they were difficult to manage and relatively costly. For WRMP09 we reviewed the range of methods to promote metering and on approval of the WRMP09 we were granted legal powers to implement compulsory metering and in AMP5 we have taken forward this approach.

For this Plan we have reviewed the options to promote metering (unconstrained options) and refined the options based on past experience to produce the constrained options for metering which are shown in Table 7-11. This list includes different metering technologies.

Table 7-11: Unconstrained and Constrained Metering Options for AMP6

Unconstrained	Constrained
Metering targeted at High Users	No
Change of Occupier	No
Optant	Yes
Progressive Optant	No
Progressive – Compulsory / Selective Metering	Yes
New Property / Conversions	Yes
Apportioned charging at Flats	No
Houses only	Yes
Houses and Individual Flats	Yes
Houses and Individual Flats and Non-Revenue Connections (bulk meters)	Yes
Dumb meter reading	Yes
Automatic Meter Reading (AMR)	Yes
Advanced Metering Infrastructure (AMI) – Fixed Network	Yes

The constrained options have been considered as three main categories;

1. New property / conversions
2. Optants
3. Progressive – Compulsory / Selectives

Note: The replacement metering solutions are covered within our maintenance work and are therefore not within this plan.

This section describes the metering categories we have considered, firstly covering the proven new property and optant options, then detailing the more complex subject of progressive metering (this term will be used to describe the compulsory or selective install of meters).

For progressive metering we will provide detail behind the costs and benefits of each option, the key customer considerations, synergies with other solutions and challenges we face in achieving the benefits.

New Property Metering & Conversions

Since 1989 all new properties and conversions are metered as a pre-requisite to providing a water supply. It is a cost effective approach to fit the meter at the time of building or conversion, and is more acceptable to customers as there will be no perceived change from an existing bill.

A drawback with this approach has been with conversions, as these do not always provide facilities for metering and it has proved difficult to enforce the requirement.

In AMP6 we expect approximately 36,000 new meters installed per year from this activity.

Optant Metering

This covers customers who consider they would be better off paying for water services by meter, and opt to switch and have a meter fitted. The installation of the meter is managed and paid for by us.

This approach is generally beneficial to customers, as they are making a conscious decision to have a meter fitted making the installation process more straightforward. It is considered a fairer approach for charging as customers pay for what they use.

From an industry viewpoint this means meter installations are scattered over our supply region, making an efficient installation programme difficult to achieve and therefore more expensive per installation, costing around £342 per install.

As our research on bill change due to metering has shown, approximately 51% of customers are likely to be better off under metered charging. Therefore optant metering will not deliver widespread coverage. However as customers' circumstances change or household occupancy changes we expect a continual and gradual take up of additional meters of approximately 34,000 per year. Within this figure we have taken account of the impact of our progressive programme in increasing the awareness around metering.

Progressive Metering (previously termed as Selective and Compulsory)

This provides a managed programme of meter installation for metered charging. Selection of target customers is made based on a cost beneficial approach to managing the supply demand balance and an approach that is fair and reasonable to customers and stakeholders. Widespread progressive metering is governed by secondary legislation. This sets out that a water company, if identified as being in an area of serious water stress, is required to build a business case for metering within its WRMP. If it is shown to be part of a cost beneficial and/or sustainable plan, the Secretary of State will grant approval for compulsory metering. Our entire supply area has been classified as being seriously water stressed[22] and we were granted legal powers for compulsory metering in 2012, on approval of WRMP09.

[22] Water stressed areas – final classification, July 2013

Key Customer Considerations for Progressive Metering

Based on our work to review the metering strategy, the development of the AMP5 programme and our work on metering cost effectiveness we have defined a series of key considerations for metering in future periods. These considerations are:

- Provide a clear message to customers and stakeholders on our approach to billing and the timing of our roll out plan. This is being achieved by building our external delivery plan into London Boroughs for AMP6.
- Provide fairness in billing to our customers, taking into account affordability, incidence effects and levels of water usage across our region

Fairness in billing

We have carried out detailed work using our property level support tool CustARD, to understand the impact on households across our region. This tool takes into account affordability, impact on bills and levels of water usage, among other parameters, to provide a balanced plan.

Affordability

Across our region around 5% - or 186,000 - of our water customers have bills that exceed 3 % of their household income, a measure described as 'water poverty'. We have introduced a series of measures to ensure we assist vulnerable customers and those customers who need support including the introduction of a social tariff.

Incidence Change in Billing Levels

We have always expected that wider metering will see some bills rise, while others will fall. We have analysed the impact of installing meters in every feasible property in London[23] and, by looking at their current bill and estimated usage, found that there will be a slightly greater number of customers whose bills fall than those whose bills rise (51% compared to 49%). The graph in Figure 7.6 below illustrates this point.

[23] This amounts to 1.3 million, and excludes Housing Association properties, and those that cannot have a meter fitted and are billed instead on the basis of the Average Household Charge.

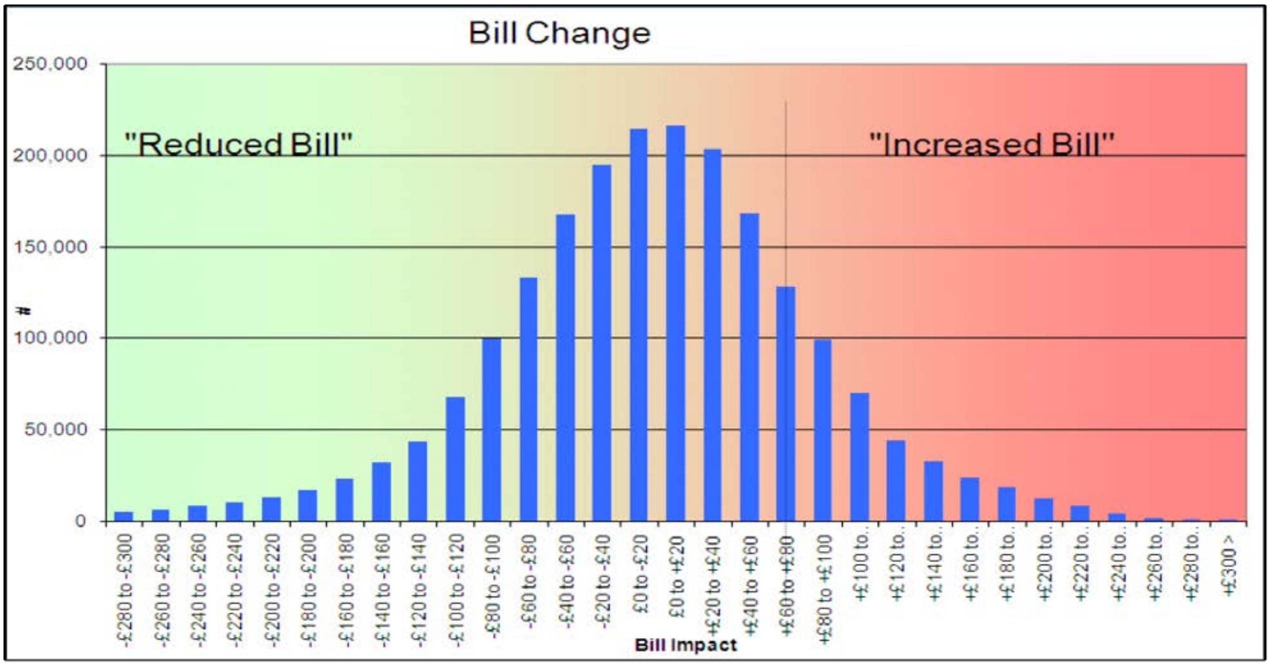


Figure 7-6: Unmeasured to metered change in customer's bill

Water Usage Levels

We have identified differences in water usage across London, Figure 7-7 illustrates the water usage in different DMAs across London, providing evidence of areas where usage is higher in east London and west London. This analysis helps us to manage the programme, in particular the correlation of areas of high usage and low household income, which could cause higher metered bills and affordability issues. We continue to review and refine our analysis to inform the roll out of the operational programme.

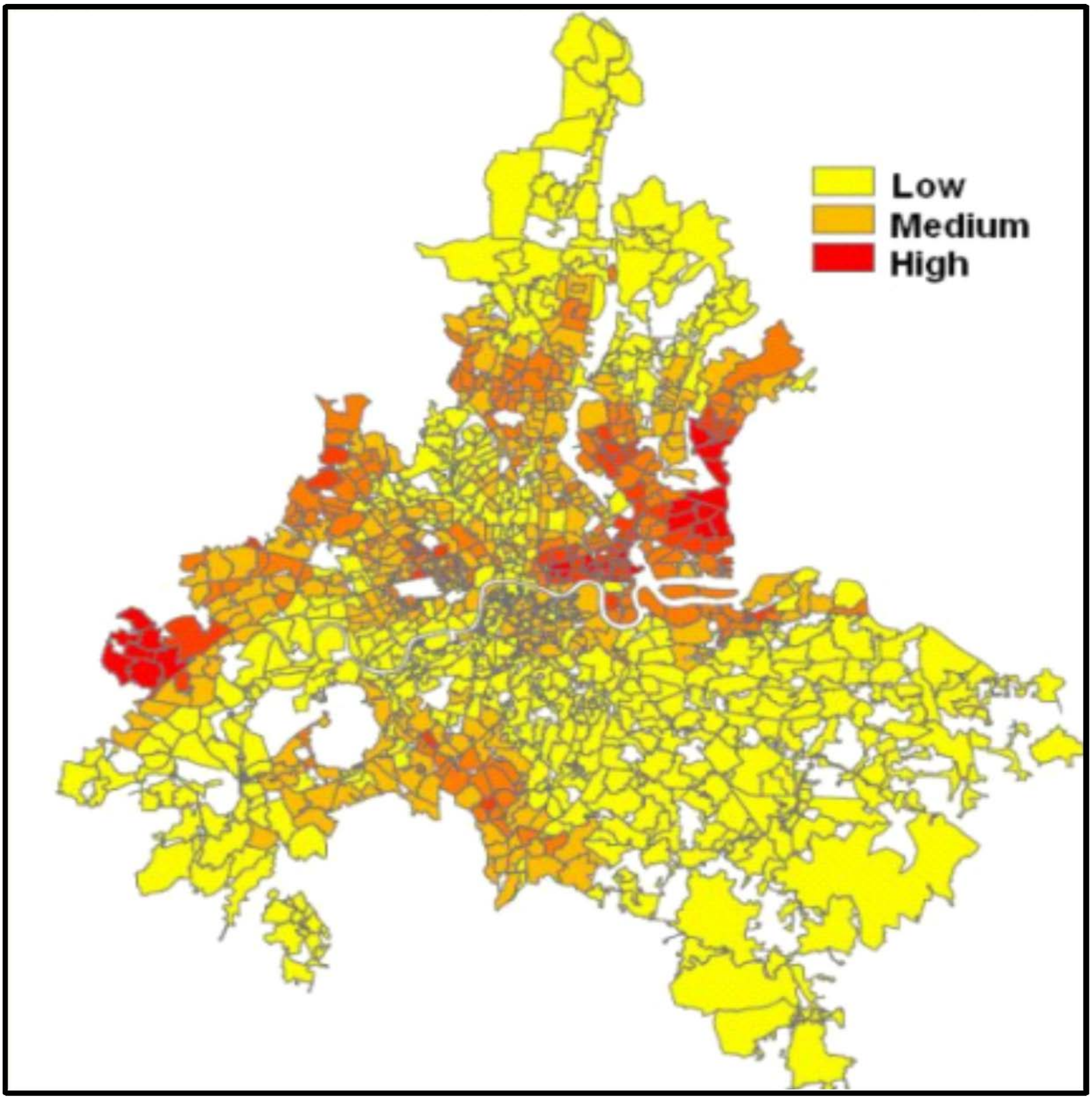


Figure 7-7: Levels of water usage across London

As part of the programme to be delivered in AMP5 we have introduced a '2 year delayed tariff' window once a meter has been installed. This allows time for householders to understand their new bill, water consumption and opportunities to reduce their usage as much as possible prior to billing on a metered tariff. Thames Water provides assistance to customers to manage their water usage with advice, information and free water saving devices, it also provides support to those customers who are considered disadvantaged or vulnerable.

Wider considerations for metering options

For progressive metering, we have taken account of property type and technology choices:

- Choice of meter reading technology – dumb, automatic meter reading (AMR) using walk by technology and use of a fixed network meter reading system (AMI)
- Choice of metering houses and flats, and metering of all connections by installing bulk meters, particularly focusing at blocks of flats in order to identify customer side leakage

This has provided a matrix of 9 options as shown in Table 7-12.

Property details, installation costs and demand reductions have been calculated at DMA level in our support tool, CustARD. A cost effectiveness assessment is made for each option and this data is fed into the Integrated Demand Management model to allow optimisation of the programme for future periods.

Table 7-12: Options Considered for Progressive Metering

Metering Intervention Options		Type of Meter Reading Technology		
Household Groupings	1. All houses and flats, and bulk metering of flats	1. Dumb	2. Smart – AMR	3. Smart – AMI
	2. All houses, and bulk metering of flats	1. Dumb	2. Smart – AMR	3. Smart – AMI
	3. All houses	1. Dumb	2. Smart – AMR	3. Smart – AMI

Meter Reading Technology Options

Three meter reading options have been considered, these are:

1. Dumb Meter Reading – a conventional meter is installed with a register dial. Meter reading is undertaken by a meter reader gaining physical access to the meter and visually recording the meter reading. Capture of the meter reading can be either written into a book or keyed into an electronic meter reading data capture devices. Some data capture devices have bar-code readers to record/check the meter serial number.

2. Automatic Meter Reading (AMR) – a meter with a short range radio is installed at each property. The meter reader equipped with a meter reading device is required to walk-by the meter in order to take a meter reading but does not require physical access to the meter. This process can also be achieved in certain circumstances in a vehicle application – known as drive-by reading. The data is captured electronically. Additional data may be stored in the meter and collected, such as a small number of historic meter readings, minimum and maximum flows and alarms for tamper, low battery and potential leakage found.

3. Advanced Metering Infrastructure (AMI) – using a fixed network meter reading system (usually radio based), meters are read electronically and do not require a meter reader. Electronic readings are passed from the meter through to utility offices for billing and network management purposes. With these systems it is possible to collect more frequent data on consumption and alarm conditions which can be used to provide additional benefits.

Household Groupings Options

The cost benefit of each meter technology type has been calculated for each property type, including house type (terraced, semi-detached, detached), flats and bulk meters for whole buildings that cannot be metered for billing purposes.

We have approximately 2.3 million unmetered properties, as shown in Table 7-13 below, compared to just over 1 million already metered.

Table 7-13: Metering Position on Households (2012/13)

Households (2012/13)	Currently unmetered	Metered	Total
Detached	119,880	186,492	306,372
Semi Detached	382,446	182,155	564,601
Terraced	652,440	275,101	927,541
Flats - Large Block	678,181	203,934	882,115
Flats - Small Block	481,640	108,251	589,891
Unknown and u/c Flat	18,192	58,402	76,594
Total	**2,332,779**	**1,014,335**	**3,347,114**

Three types of household groupings have been considered:

1. All houses, flats and bulk metering of flats – covers all unmetered houses and flats within each DMA, with the addition of bulk metering of blocks of flats.
2. All houses and bulk metering of flats - covers all unmetered houses and also the bulk metering of flats within each DMA
3. All houses – covers only the houses within each DMA

For each property type we can achieve a benefit in terms of the demand (usage) saving and also the ability to target customer side leakage or wastage within the property and grounds. Where we directly meter flats, we can also fit a bulk meter on the property to confirm any leakage on the pipework feeding the building(s).

We have included the bulk metering of blocks of flats as a further option. This is unlikely to deliver significant household demand reductions as it does not meter a single property and cannot be used for billing purposes. It will however, achieve relatively large customer side leakage benefits, and assist in the targeting of mains rehabilitation. This can be seen later in the increased benefits of bulk meters.

Evaluation of costs and benefits of metering

We have developed a model to enable a cost benefit calculation over 60 years at Net Present Value (NPV). This has been used in the design of the AMP5 programme and to assist definition of the programme for AMP6 and beyond.

To develop our approach we reviewed the model developed for the UKWIR report Smart Metering in the Water Sector, Phase 3 – Making the Case (2012). Although we did not directly use the supplied spreadsheet, our approach is consistent in terms of cost and impact categories as described by the model and the principles behind its approach.

We have developed the costs and benefits for each property type (i.e. Terraced, semi-detached, large block of flats, small block of flats etc.) rather than a house and flat, and providing a 60 year NPV calculation as required for the WRMP.

Costs and Benefits Used for Progressive Metering

We have built the analysis around the cost and impacts (benefits) as if metering were to be applied to a single property. An analysis of a range of property types and meter reading technology solutions has been developed as options. As an example the cost and impacts (benefits) have been calculated for a typical detached property where the meter is read by a dumb 'eyeball' reading, and so on for the other combinations. This approach is shown in Figure 7-8 below.

For an Individual Property

		Property Type				
		Detached	Semi Detached	Terraced	Flat - small block	Flat - large block
Meter Reading Technology	Dumb					
	Walk By (AMR)					
	Fixed Network (AMI)					

Base Data
Property counts
Survey to fit ratio
Properties per flat
Non-revenue connections
Discount rate

Costs
Meter & installation
Meter replacement life
Reading technology & installation
Technology replacement life
Meter reading
IS enhancements
Non-revenue connection meters
Supply pipe replacement

Benefits
Customer demand reduction
Customer side leakage reduction
Mains replacement targeting
Customer call reduction:
- accurate bills

Output
For each Property Type and Metering Reading Technology combination:
- NPV cost (£)
- NPV benefit (£)
- NPV demand reduction (Ml)
- Cost effectiveness (£/Ml)

Figure 7-8: Metering Cost Effectiveness Model Schematic

Costs of Progressive Metering

The costs considered within the 60 year NPV calculation took into account the following:

Installation and replacement costs – initial install costs dependent on the size and position of the meter, being in the pavement (hard dig), on soft verge (soft dig) or within the property. The replacement is assumed to be at 15 years, which is the life of the battery for a smart meter.

Bulk meter install costs include the cost of the meter and also the chamber, an extra cost against the standard rate.

Metering reading infrastructure – An AMI solution in AMP5 which covers the technology required to deliver the data back to a central collection database. Current costs used to provide a fixed network across Thames Water are £5m capital costs, with no requirement then for an operational read cost.

Meter reading costs – the costs of reading vary on the type of metering technology.

Customer side leakage (CSL) pipe repair costs – the costs for re-lay depend on the length of pipe, surface type, and geographical area.

The costs for the above, except the CSL relay and fixed network costs, are provided from the Managed Metering Service (MMS), a contract in place to deliver meter installations and data retrieval through AMP5 and 6.

Benefits of Progressive Metering

We have focused on four key benefits that are realised from a metering programme, being:

1. **Customer Demand Reduction (Usage)** – this covers the reduction in use by the household found from being billed on a metered basis. This is dependent on the type of property, not the meter reading technology, although smart metering systems can assist the customer by providing accurate information to confirm usage trends. Table 7-14 gives the reduction in usage per property per meter reading technology.

Table 7-14: Reduction in usage per property per meter reading technology.

	London			Thames Valley			TWUL		
	Dumb	AMR	AMI	Dumb	AMR	AMI	Dumb	AMR	AMI
Detached	8.4%	9.9%	12.4%	12.6%	14.1%	16.6%	10.9%	12.4%	14.9%
Semi Detached	12.6%	14.1%	16.6%	18.5%	20.0%	22.5%	14.8%	16.3%	18.8%
Terraced	8.1%	9.6%	12.1%	11.9%	13.4%	15.9%	8.8%	10.3%	12.8%
Flats - Small Block	10.1%	11.6%	14.1%	2.3%	3.8%	6.3%	9.1%	10.6%	13.1%
Flats - Large Block	4.0%	5.5%	8.0%	9.5%	11.0%	13.5%	4.3%	5.8%	8.3%
Unknown	12.2%	13.7%	16.2%	0.9%	2.4%	4.9%	11.1%	12.6%	15.1%
All unmeasured	7.9%	9.4%	11.9%	12.5%	14.0%	16.5%	8.7%	10.2%	**12.7%**
Meterable	8.3%	9.8%	12.3%	12.6%	14.1%	16.6%	9.2%	10.7%	**13.2%**

2. **Customer Side Leakage (CSL) Reduction** - this covers the losses within the customer's pipework. This is dependent on the type of meter reading technology allowing accurate targeting of the existing losses. Table 7-15 shows the reduction in CSL per Meter Reading Technology.

Table 7-15: The reduction in CSL per Meter Reading Technology.

IDM Metering Intervention Options		Type of Meter Reading Technology		
		1. Dumb	2. Smart - AMR	3. Smart – AMI
Household Groupings	1. All houses and flats, bulk metering of flats	24% of all CSL	56% of all CSL	76% of all CSL
	2. All houses, bulk metering of flats	24% of all CSL	56% of all CSL	76% of all CSL
	3. All houses	24% of CSL from houses	56% of CSL from houses	76% of CSL from houses

3. **Mains Rehabilitation Targeting Efficiency** – We will utilise meters to provide an understanding of the water balance within our DMAs or sub DMA areas within our network. This ensures we target where the leakage exists, either within our network or within the customer's boundary. A recent external review of our approach to meter rehabilitation, the Mains Replacement Programme Independent Review (MRPIR), produced with Ofwat, recommended the use of metering to target mains rehabilitation. The benefit is the reduction in mains rehabilitation required to achieve the same leakage target.

4. **Customer Calls Reduction** – The three metering technologies offer different capabilities in providing accurate data to our customers. Increased confidence in meter reading accuracy leads to a reduction in customer calls. This will occur with AMR and AMI, although it is expected dumb meters will lead to an increasing trend in calls. The benefit is the improved customer satisfaction.

There are additionally many other benefits from a metering programme but these are considered as secondary and have not been included in this cost benefit analysis.

The calculation approach carried out to monetise each benefit is shown below. The data sources are detailed in Appendix N.

Benefit 1 Demand reduction (£/property/year)

	Input Data		Calculation	Output
B 1.1	Household consumption (by property type)			
	x			
B.1.2	Demand reduction (%) (by property type and meter reading technology)	=	Annual saving (by property type and meter reading technology)	
	x			
B.1.3	Operational value of water (cost of pumping & treatment chemicals)	→	→	Monetary value of demand savings

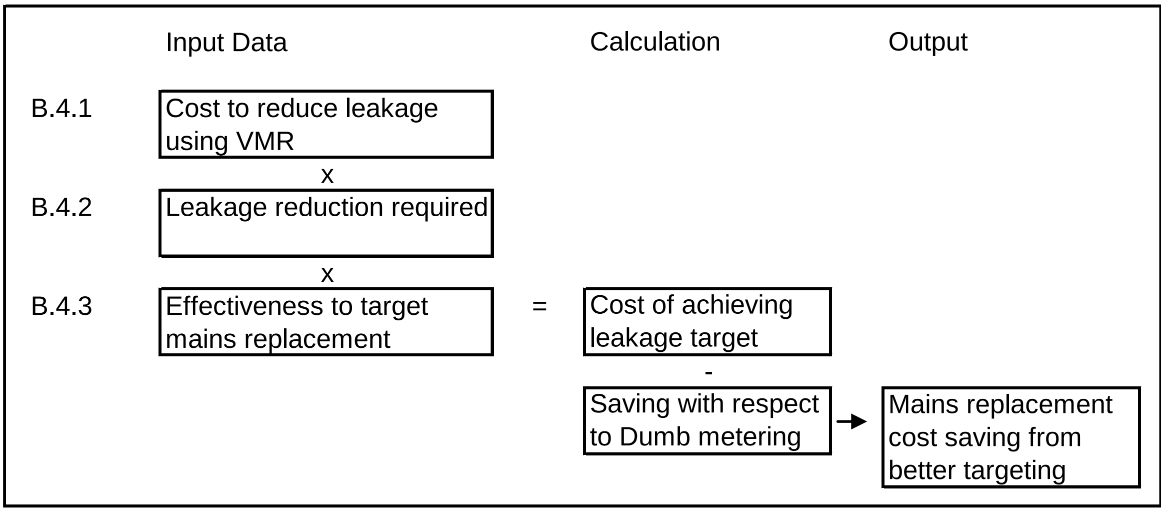
Benefit 2 Customer Side Leakage reduction

	Input Data		Calculation	Output
B.2.1	Total TW leakage			
	x			
B.2.2	Proportion on customer side	=	Customer side leakage	
	/			
N.6	Number of properties to be metered	=	CSL per property to be metered	
	x			
B.2.4	Proportion of CSL that can be identified (by meter reading technology)	=	CSL available for reduction	
	x			
B.2.5	Effectiveness of Leakage activity to reduce CSL	=	Reducible CSL per property	
	x			
B.2.6	Opportunity cost to provide water through Water Re-use	→	→	Cost saving for CSL reduction (per property)

Benefit 3 Customer calls

	Input Data		Calculation	Output
B.3.1	Total number of call for meter reading & billing			
	x			
B.3.2	Reduction in calls (by meter reading type)			
	/			
N.6	Number of properties to be metered			
	x			
B.3.3	Cost of dealing with each Call	→	→	Cost saving of calls per property (by meter reading type)

Benefit 4 Mains replacement targeting (WINS)



Cost and Benefit Outputs

The outputs are described below for each property type and meter reading technology, detailing the change in costs and benefits. Although we have broken out the property types to show the detail of our analysis, these are later combined to provide the 9 options for the Integrated Demand Management model.

To produce the outputs we have applied a 60 year NPV, using the 4.5% discount rate as required by the Water Resources Planning Guideline. Using a single semi-detached property as an example, the costs and benefits are produced against each meter reading technology, shown in Table 7-16 and Figure 7-9 below. The dumb costs are shown to be similar to the AMI solution due to the high meter reading costs for dumb compared to the inclusion of a fixed network for AMI. AMI provides the highest benefit due to the improved ability to target work.

Table 7-16: Outputs for 60 year NPV costs and benefits for a semi-detached property.

	Dumb	AMR	AMI
NPV cost	628.68	554.23	627.35
NPV benefit	119.00	323.26	427.89

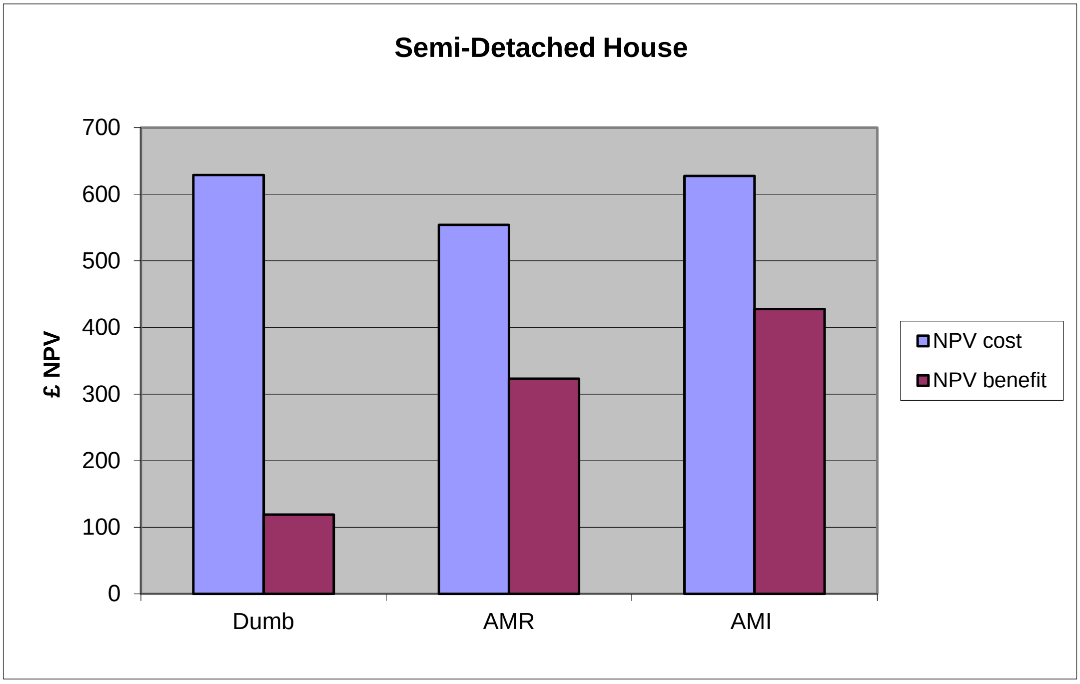


Figure 7-9: Graphical form of the 60 year NPV for a semi-detached property

The graph clearly shows the AMI, fixed network solution, provides the greatest benefits, with slightly higher costs. Dumb metering does not deliver the same degree of benefit as the more advanced technologies. AMR and AMI technologies are particularly effective at delivering customer side leakage reduction which makes up a significant element of the additional benefit.

We have considered the benefits according to four categories of demand reduction, CSL reduction, mains replacement targeting, and customer call reduction according to the different meter reading technologies of dumb, AMR and AMI technologies for a semi detached property. The majority of the benefit is delivered in terms of demand reduction and CSL reduction with the greatest benefit for AMI meters overall. For dumb meters there is no benefit for mains replacement targeting as it is not cost effective to install dumb meters for this purpose. Also, in terms of customer calls, the dumb meter is seen to provide an increasing number of calls due to a perceived worsening of service, leading to a negative benefit.

With AMI, the demand reduction is seen to give less benefit than CSL reduction. This is due to the increased ability to target CSL with a fixed network solution, as it provides much higher data granularity. This also causes the mains replacement targeting benefit to improve.

In AMP5, we are testing fixed network solutions and are expecting to install this as part of progressive metering roll out. The AMP5 analysis indicated that this provided the most benefit. Table 7-17 and Figure 7-10 below compares all property types against the AMI solution.

Table 7-17: 60 Year NPV Costs and Benefits for all property types using an AMI Solution

	Detached	Semi Detached	Terraced	Flat - Small Block	Flat - Large Block	Bulk
NPV Cost	652	627	586	498	495	1,215
NPV Benefit	406	428	376	168	113	951
Ratio	0.6	0.7	0.6	0.3	0.2	0.8

The table includes a ratio of benefit against costs, showing flats provide the least overall benefits and bulk metering the highest.

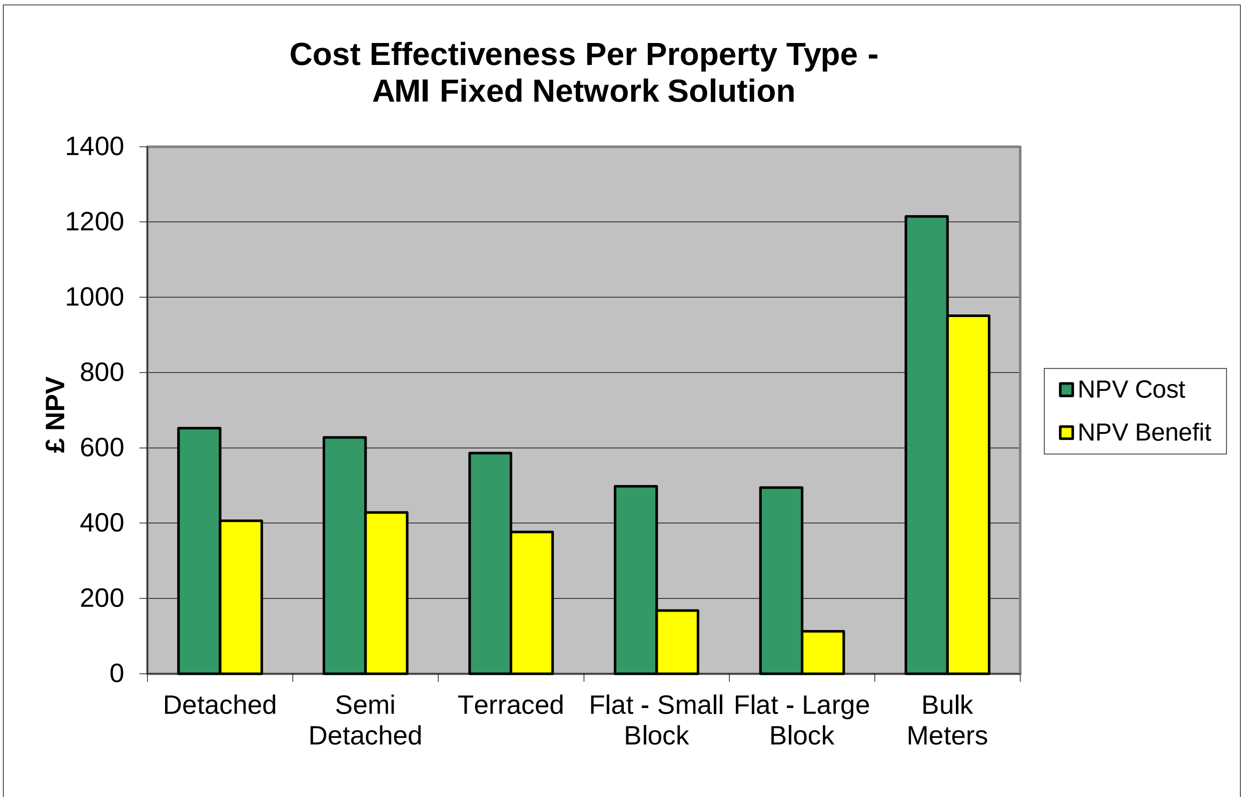


Figure 7-10: Cost Benefit by Property Type using an AMI solution

On all property types the costs outweigh the benefits, with the highest benefits against semi-detached properties. This clearly shows there is a much reduced benefit for flats, mainly due to the reduced CSL benefit as the meter is placed in the flat and not at the property boundary. There will also be a reduced benefit for the demand reduction, with the majority of flats not having gardens.

The bulk solution requires high installation costs, but also achieves a larger benefit due to the CSL benefits from a larger supply pipe and location and property boundary. In summary, we have calculated costs and benefits against each property type and meter reading technology using a 60 year NPV.

As shown earlier in Table 7-8, we have grouped the metering outputs into nine options for optimisation within the Integrated Demand Management model. The groupings are listed below:

1. All houses and bulk meter blocks of flats - AMI
2. All houses and bulk meter blocks of flats AMR
3. All houses and bulk meter blocks of flats - Dumb
4. All houses - AMI
5. All houses – AMR
6. All houses – Dumb
7. All houses, individual flats and bulk meter blocks of flats - AMI
8. All houses, individual flats and bulk meter blocks of flats AMR
9. All houses, individual flats and bulk meter blocks of flats - Dumb

This provides options on the grouping of housing relative to the options of meter reading technology. The grouping of properties provides the level of choice we would implement in each DMA.

Synergy with water efficiency

The options above are combined with water efficiency to provide improved benefit opportunity, allowing leaflet drops, free water efficiency goods and advice as we roll out progressive and optant metering options. The water efficiency options are detailed later in this section.

Challenges to the implementation of metering

The metering options provide relatively high benefits to other solutions, although will meet a number of implementation challenges in achieving our goals.

Although metering itself is not a new solution, the inclusion of smart metering is, and this achieves the increased benefit. Therefore the ability to provide a working smart metering technology, with suitable data collection and analysis is critical.

For a number of our customers, the ability to install progressive meters on their property may not be seen as acceptable for a variety of reasons. Our communication approach, with both customers and stakeholders, will be key to a successful outcome.

Also, the current survey to fit ratios for flats, being on average 35%, will require improvement to provide an installation rate more comparable with the rest of the industry and acceptable to our customers and stakeholders, this is discussed further in Appendix N.

Key Findings and Recommendations

Based on our work to develop the AMP5 programme and the metering cost benefit choices, we have defined a series of key considerations for metering in future periods. These considerations are:

- The costs and benefits of metering are developed on a DMA by DMA basis
- Provide a clear message to customers and stakeholders on our approach to billing and the timing of our roll out plan. We will build our external delivery plan on a Borough by Borough basis for AMP6.
- Provide fairness in billing to our customers, taking into account affordability, bill change and levels of customer water usage across our region.

The options we have chosen provide variation in costs and benefits due to the choice of:

- Meter reading technology – dumb, automatic meter reading by walk by technology and use of a fixed network meter reading system.
- Metering houses and flats, and/or metering of bulk connections, particularly focusing on blocks of flats in order to identify customer side leakage.
- Each DMA will have different numbers and types of property and subsequently there will be different costs and benefits for each intervention in each DMA.

We have considered for each property type four key benefits, being demand savings, CSL reduction, targeting of mains replacement and customer call reduction.

7.6.4 Water efficiency

Government has set out its aspiration to achieve a reduction in water use[24] and support for measures to promote the efficient use of water[25]. Our customers and stakeholders have also expressed their support for water efficiency, including more education to promote the efficient use of water as a priority following leakage reduction.

In response to the preferences of Government, stakeholders and customers, and our belief that water efficiency is important for sustainable management of water resources, we have considered a wide range of options to promote the efficient use of water. In this section we outline the activities to promote the efficient use of water, over and above the baseline, and the step-wise process followed to derive these options.

[24] The guiding principles for developing a water resources management plan, June 2012, Developed by Environment Agency, Ofwat, Defra and the Welsh Government

[25] Water For Life, Defra, December 2011

Unconstrained options

In line with the WRPG we developed a range of potential options to promote the efficient use of water to household and business customers. In developing these options we have considered activities undertaken previously by Thames Water, other water companies in the UK, together with findings from research studies and projects. These options are listed in Table 7-18 below and are included in the unconstrained options list as part of the options appraisal process.

Table 7-18: Unconstrained list of water efficiency options

1	Benchmark to help drive water efficient behaviours (domestic)	ADVICE AND GUIDANCE
2	Call Centre contact to customers giving water efficiency advice	
3	Company wide promotional campaigns	
4	Develop an AMR interface tool to help drive water efficiency behaviours	
5	Develop water certificates for customer properties	
6	Development and promotion of an online water use calculator	
7	Development of Smart Phone Applications	
8	Distribution of advice and guidance via Water Regulations visits	
9	Distribution of self audit packs	
10	Distribution of water saving information in customers' bills	
11	Distribution of water saving information via leaflet distribution	
12	Education in schools and provision of educational material	
13	Events and road shows	
14	Free water efficiency goods and advice to all newly metered customers	
15	Offer free water efficiency goods online	
16	Promotions via newspapers	
17	Water efficiency advice via an internet promotion	
18	Distribution of aerated shower head	SELF INSTALL
19	Distribution of cistern displacement devices	
20	Distribution of hose guns for self installation	
21	Distribution of shower timers	
22	Distribution of tap inserts for self installation	
23	Distribution of water gels to gardeners for self installation	
24	Distribution of water saving devices to businesses via Water Regulations visits	
25	Subsidy for water efficient white goods	

26	Installation of a water butt	DIRECT EFFICIENCY GOODS PLUMBER INSTALLATION
27	Plumber assisted domestic audit	
28	Plumber assisted installation of tap inserts	
29	Replacement - installation of a dual flush toilet	
30	Replacement - installation of a low-flush toilet	
31	Retrofit - installation of a dual flush toilet device	
32	Alignment of water efficiency activities with the metering roll out	PARTNER EFFICIENCY GOODS AND INSTALLATION
33	Partner controlled domestic plumbing installs	
34	Partnership projects with national organisations	
35	Partnership projects with public and third sector organisations	
36	Partnership projects with utility companies	
37	Partnership working benefits	
38	Benchmark to help drive water efficient behaviours (non-domestic)	NON-DOMESTIC ADVICE AND ASSISTANCE
39	Commercial water audits	
40	Exploit retail and loan funding opportunities for non-domestic water saving	
41	Free water efficiency goods and advice to all newly metered businesses	
42	Greywater recycling	
43	Introduce training for non-domestic customers about wise water use	
44	Non-Domestic water saving advice and assistance	
45	Optimising water using processes	
46	Rainwater recycling	
47	Continue to support ongoing research projects	RESEARCH
48	Ofwat water efficiency research fund	
49	Save Water Swindon and other flag ship research projects	
50	Support the leaky toilet valves project phase II	
51	Support the research undertaken by UKWIR	
52	Support the Waterwise evidence base	

Screening of the unconstrained options

In accordance with the screening process outlined in Section 7.1.4, the water efficiency options were appraised in terms of risk, environmental considerations and alignment with the company's wider strategy and programme. This process was completed by scoring the options with a grading of low, medium or high in terms of performance against these criteria. The combined scores then provided an overall ranking for each option. Options were then reviewed to identify those that can be included in the baseline water efficiency programme and those which are considered to be additional activity and therefore options to be assessed as constrained options for inclusion in the integrated demand management programmes. This scoring assessment is presented in Appendix O.

Constrained water efficiency options

The screening option appraisal refined the options for water efficiency, short listing four constrained options which we consider provide the best value in terms of cost benefit and a culture shift with respect to water use.

The four options are:

1. Provision of free water efficiency goods and advice to all newly metered customers;
2. Targeted domestic plumbing installations following progressive metering programme;
3. Partnership projects with public and third sector organisations (replicating the *Save Water Swindon* approach); and
4. Commercial or non-household water audits

Further information on each of these options is provided below. In developing each option we have drawn on information from studies and projects completed by us, the evidence base compiled by UKWIR[26] and Waterwise[27] [28] to inform assumptions on the magnitude and longevity of savings and costs.

1. Provision of free water efficiency goods and advice to all newly metered customers

   This option will target household customers who have recently had a meter installed either via the optant or progressive metering programme.

   A high level of customer engagement is required for a meter installation which would typically involve proving the supply to a given customer. The process of proving the supply requires some face to face customer engagement. It is intended to use this face to face engagement to talk to the customer about water efficiency, providing water efficiency information describing the free water saving goods and the water efficiency support available. The customer will be able to use the Waterwisely website and/or the leaflets' freepost request card to order their preferred items.

[26] UKWIR, 2012 The Links and benefits of water and energy efficiency joint working – Draft Final Report
[27] Waterwise, Nov 2009, Water Efficiency Retrofitting: A best practice guide
[28] Waterwise, Feb 2010, Evidence base for large scale water efficiency in Homes

2. Targeted domestic plumbing installs following metering

This option would be applied in conjunction with the progressive metering programme. Following meter installation, household consumption will be monitored. Households will be contacted and offered a plumber assisted audit. Through our Field Based Customer Engagement supplier we will offer bespoke advice on water use and will offer to install water-saving devices.

3. Partnership projects with public and third sector organisations

We have undertaken a wide range of partnership projects including 'London Renew', which targeted 45,000 London households with a combined package of energy and water efficiency advice, and Save Water Swindon (SWS), which challenged residents of Swindon to use water efficiently using multiple channels of communication and action.

Working in partnership with other organisations has multiple benefits:

- Public sector and third sector organisations often act as positive intermediaries and may be more trusted by a customer than a water company when communicating water efficiency messages
- Partners may also have good links with hard-to-reach sectors of the community and use different channels of communication or community contacts e.g. Age Concern, Citizens Advice Bureau, Housing Associations and the Horticultural Trades Association
- Customers can be offered an integrated package of measures in a clear way that minimises the inconvenience to customers
- Cost-effective engagement and installation approach as evidence by the London Renew project (See Appendix B for comparison of costs for different types of project)

A key component of the proposed partnership work is the use of trained installers to install devices in homes and provide bespoke advice on water using habits to householders.

4. Commercial or non-household water audits

This project proposes to offer targeted non-domestic customers the use of Automatic Meter Reading (AMR) equipment for 12 months with a web-based interface and a plumbing audit to be conducted approximately two months after the installation of the AMR equipment that will result in a site specific water saving recommendations report for the customer.

Water audits comprising investigation of domestic and process water consumption can often quickly identify measurable water savings at comparatively lower cost when compared to savings made by a Thames Water led installation project in domestic properties (See Appendix O for a comparison of costs for different types of project).

In addition to the above schemes to promote the efficient use of water to our customers we have also identified opportunities to:

- reduce water use on our own estate and have built a saving into our plan for this of 1Ml/d in AMP6 (INT-WE-TW-01); and
- Achieve reduction in use by commercial customers who are open to a competitive retail market for water and as a result are likely to be offered enhanced services including advice and support to achieve efficient use of water (INT-WE-NHH-01). We have forecast savings of 4.7Ml/d in AMP6.
- Identifying programmes of demand management

These activities and savings attributed to them are accepted at Thames Water's risk. These activities are forecast/ planned to occur in AMP6 and will be included in our preferred programme.

7.6.5 Integrated Demand Management (IDM)

Introduction

Demand management measures have traditionally been viewed in isolation from each other. In reality, all the options offer different but overlapping costs and benefits and can be promoted in combination. In this way we have sought an optimal solution among both individual and combined interventions rather than considering each individually. This integrated approach to Demand Management is called Integrated Demand Management (IDM) and takes into account the synergy between these interventions.

Integrating demand management options

Combination interventions allow a greater reduction in total demand for a DMA, and in some cases at reduced cost. For example, household water efficiency measures are only offered where a customer has been metered, so must be combined with a metering intervention, but can also be a cost-effective method to reduce overall water use. Metering and mains replacement both include bulk meter and customer supply pipe replacement costs, so combining the two interventions gives you the combined usage and leakage benefit, without double counting the CSL savings, at a reduced cost.

The IDM model produces an optimised set of demand management interventions in as many DMAs as are required to achieve a specified target. The target can be described in terms of a budget or activity such as water saving. These are applied to the model in the form of constraints on model output. By specifying a range of different constraints, a range of different demand management interventions can be generated for comparison with resource options as potential solutions to remove a supply/ demand deficit.

Appendix N sets out the detailed methods of calculating the total demand and costs and benefits of interventions but the approach is summarised in Figure 7-11.

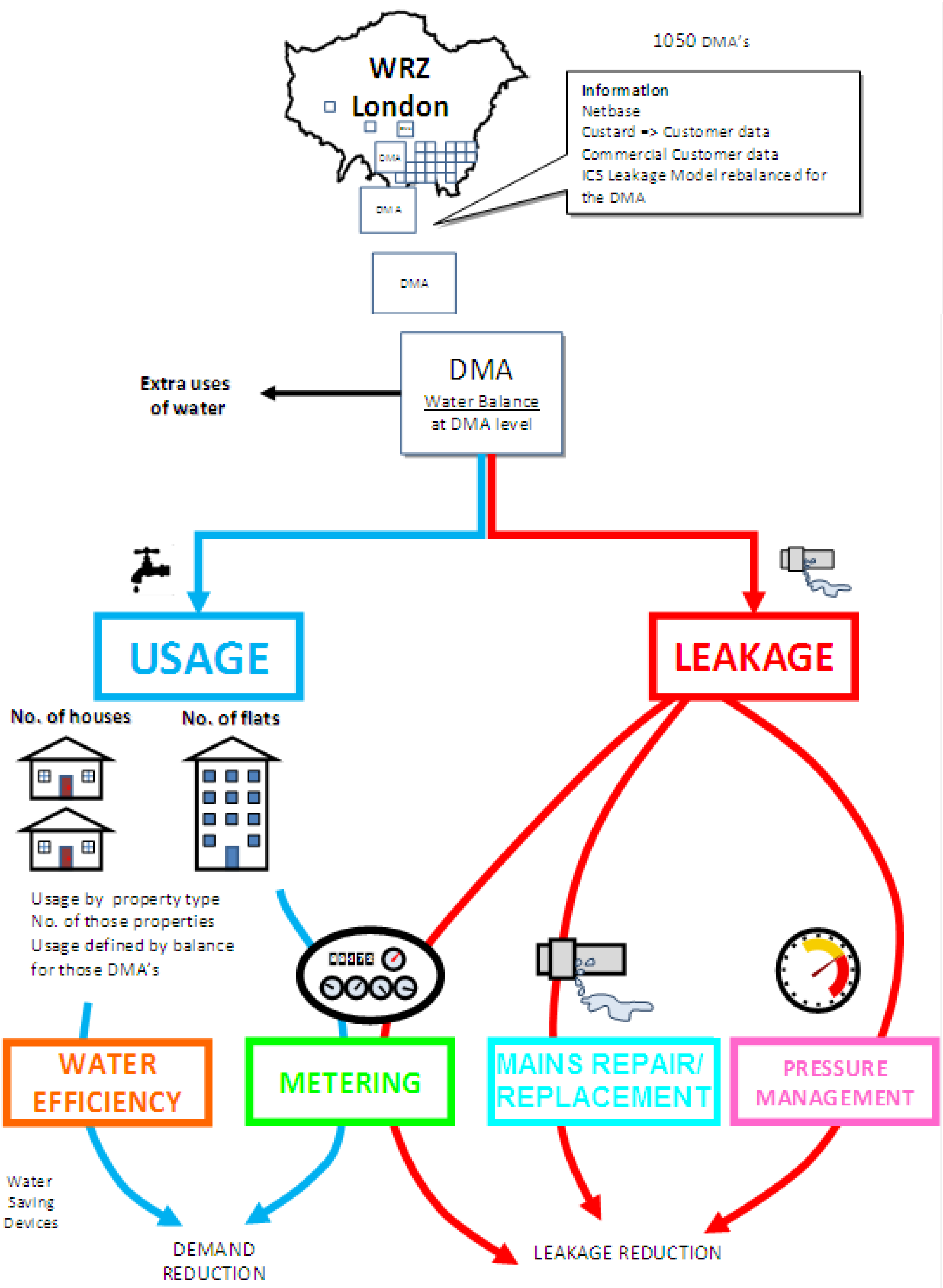


Figure 7-11: How the benefits of individual interventions are derived and combined

IDM Interventions

There are a wide variety of potential IDM interventions, the main types are shown in Figure 7-12.

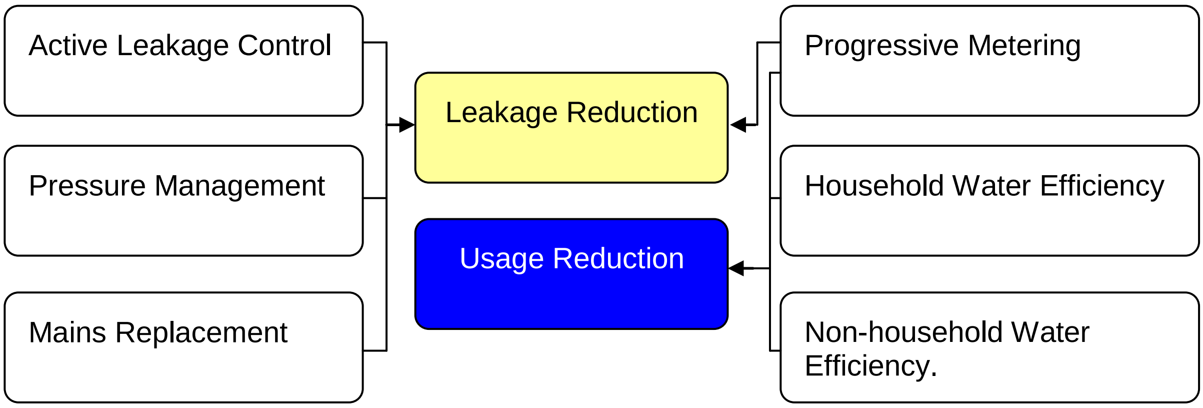


Figure 7-12: Types of Intervention available for demand reduction

Each intervention entails a capex cost to implement, and can also have an associated opex cost or opex saving. The capex and opex calculations for each type of intervention are provided in Appendix N.

Scenarios

A scenario is a run to calculate the optimal solution for the model based on a series of constraints. Two types of scenario are available:

- Minimise Investment
- Minimise Whole Life Cost

Specific constraints can be added to any scenario to evaluate different possibilities. The types of constraint available for any scenario are:

- Budget: to constrain the total intervention budget Capex or Opex
- Risk: to constrain the output from any Risk Node (e.g. Demand or Leakage)
- Intervention Budget: to constrain the budget for any individual intervention Capex or Opex
- Intervention Length: to constrain the total number of DMAs which can be selected for any scenario

Once all the constraints have been added for any scenario the model can be run to generate an optimal solution of demand management interventions.

As such a series of programmes for demand management with different constraints have been defined and optimised.

IDM program outputs

The scenarios run to generate demand management programmes for input into the EBSD optimiser have searched for a minimum whole life cost solution over the entire scenario planning period, within the constrained profile for water savings and budget limits.

The draft WRMP optimised over 200 individual demand management programmes in London, from a target of 25 Ml/d demand reduction in AMP6 only to 295 Ml/d spread across the 25 year planning scenario. The preferred plan for the draft was 100 Ml/d in AMP6 and 25 Ml/d in AMP7, selected by the EBSD optimiser. In view of this and the change in deficit between draft and final plan, the new set of programmes designed for the AIM_IDM optimiser were set to targets with smaller intervals in AMP6 to give greater granularity. In response to feedback from the public consultation on the draft Plan, further leakage work following metering was included in AMP7 and AMP8 for the final plan.

These solutions were then run through the Thames Water Demand Forecasting System (TWDFS) to evaluate the effect on the Optant metering programme and build in future demand trends. The policy to meter all households outside London by 2030 was decided as an outcome of the draft WRMP, and as such one demand management programme for each additional WRZ was created and run through TWDFS. Two distinct sets of all 24 IDM options were developed for inclusion in EBSD, one to include the introduction of tariffs in AMP7, and one without tariffs. Table 7-19 shows the demand management programmes for London.

The 48 IDM demand forecasts as a result of each programme were then appraised in the EBSD optimiser in conjunction with the water resource options, the baseline supply and demand, the target headroom and the headroom uncertainty as outlined in Figure 7-13, and a preferred plan identified. The process for definition of the preferred plan through options appraisal is detailed in Section 8 of the Plan.

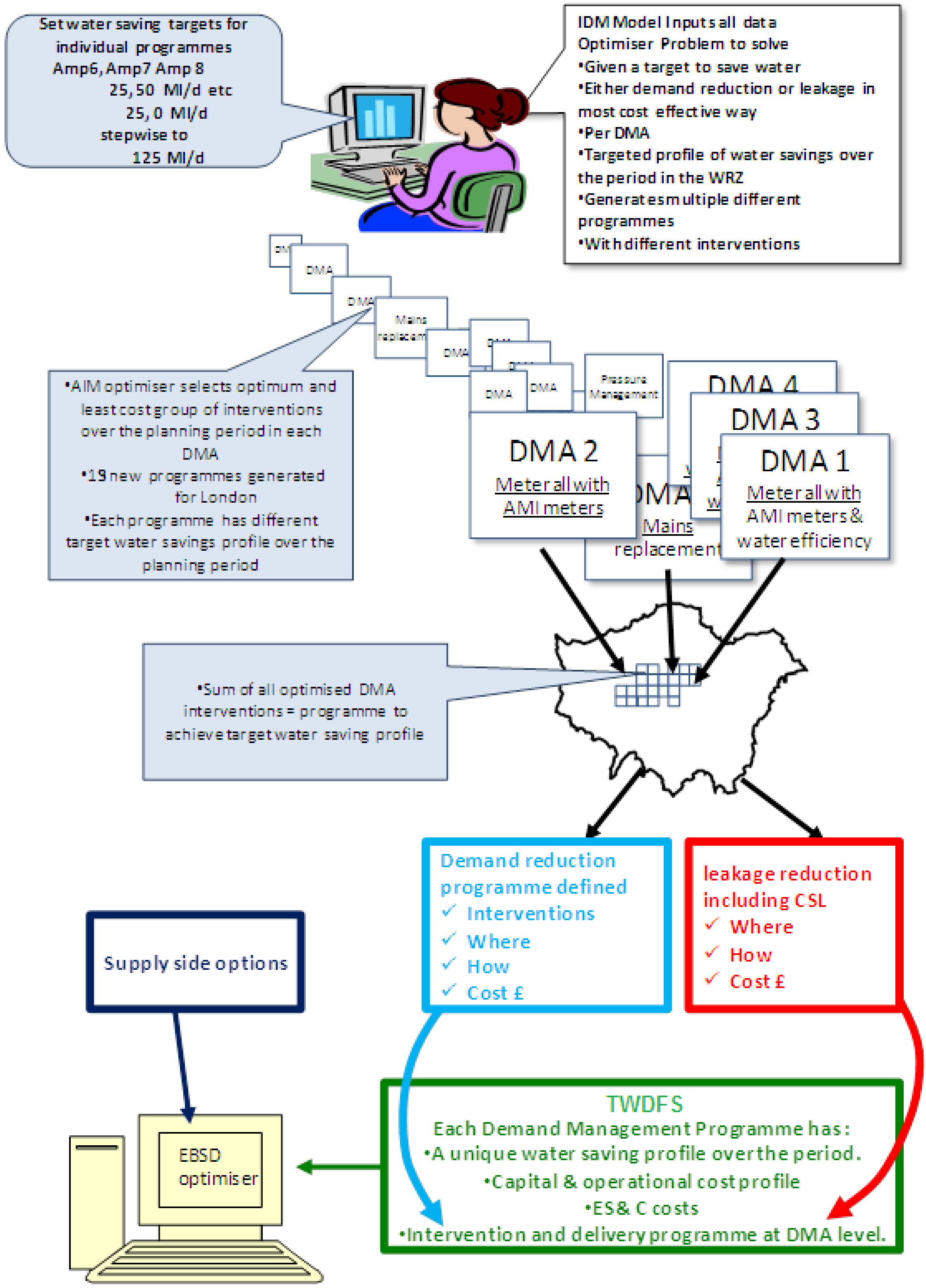


Figure 7-13: The development of IDM programmes and adoption in programme appraisal

Table 7-19: IDM Demand management programmes for London (Ml/d).

Profile of water savings	AMP6	AMP7	AMP8	AMP9	AMP10
Potential scenario targets per planning period for London	25	0	0	0	0
	25	25	0	0	0
	50	0	0	0	0
	50	25	0	0	0
	75	0	0	0	0
	75	25	0	0	0
	90	0	0	0	0
	90	25	0	0	0
	95	0	0	0	0
	95	25	0	0	0
	100	0	0	0	0
	100	25	0	0	0
	100	35	20	0	0
	105	0	0	0	0
	105	25	0	0	0
	110	0	0	0	0
	110	25	0	0	0
	125	0	0	0	0
	125	25	0	0	0

7.7 Summary of options for programme appraisal

A summary of the constrained options which have been taken forward for consideration in the development of the preferred programmes is provided in tables 7-20, 7-21 and 7-22.

Table 7-20: Summary of constrained supply options

Generic option	Sub-option		Specific option	WRZ
Raw water transfers	Severn-Thames Transfer (STT)	Supported STT - Longdon Marsh (via Cotswolds Canal)	50 Mm3 Reservoir (Transfer 50-300Ml/d)	London
			89 Mm3 Reservoir (Transfer 50-300 Ml/d)	London
			50 Mm3 Reservoir (Transfer 50-300 Ml/d) 2 Zone	London/SWOX
			89 Mm3 Reservoir (Transfer 50-300 Ml/d) 2 Zone	London/SWOX
		Supported STT - Longdon Marsh (via Deerhurst pipeline)	50 Mm3 Reservoir (Transfer 50-300Ml/d)	London
			89 Mm3 Reservoir (Transfer 50-300 Ml/d)	London
			125 Mm3 Reservoir (Transfer 400 Ml/d)	London
			50 Mm3 Reservoir (Transfer 50-300 Ml/d) 2 Zone	London/SWOX
			89 Mm3 Reservoir (Transfer 50-300 Ml/d) 2 Zone	London/SWOX
			125 Mm3 Reservoir (Transfer 400 Ml/d) 2 Zone	London/SWOX
		Unsupported STT (via Cotswold Canal)	Transfer 50 Ml/d	London
			Transfer 100 Ml/d	London
		Unsupported STT (via Deerhurst pipeline)	Transfer 100 Ml/d	London
			Transfer 200 Ml/d	London
			Transfer 300 Ml/d	London
			Transfer 200 Ml/d, 2 Zone	London/SWOX
			Transfer 300 Ml/d, 2 Zone	London/SWOX
	Other Canal Transfers*		Oxford Canal Transfer A - London supply	London
			Oxford Canal Transfer B - SWOX supply	SWOX
New Reservoir Storage	Direct Supply	Abingdon	Abingdon 30 Mm3	SWOX
		Longworth	Longworth 30 Mm3	SWOX
	River Regulation and Direct Supply	Abingdon	Abingdon 30 Mm3 2 zone	London/SWOX
			Abingdon 50 Mm3 2 zone	London/SWOX
			Abingdon 100 Mm3 2 zone	London/SWOX
			Abingdon 125 Mm3 2 zone	London/SWOX
			Abingdon 150 Mm3 2 zone	London/SWOX
			Abingdon 75 Mm3 + 75 Mm3 2 zone	London/SWOX
		Chinnor	Chinnor 75 Mm3 2 zone	London/SWOX
			Chinnor 100 Mm3 2 zone	London/SWOX
		Longworth	Longworth 30 Mm3 2 zone	London/SWOX
			Longworth 50 Mm3 2 zone	London/SWOX
	River Regulation Reservoir	Abingdon	Abingdon 30 Mm3	London
			Abingdon 50 Mm3	London
			Abingdon 75 Mm3	London
			Abingdon 100 Mm3	London
			Abingdon 125 Mm3	London
			Abingdon 150 Mm3	London
			Abingdon 75 Mm3+75 Mm3	London
		Chinnor	Chinnor 75 Mm3	London

Generic option	Sub-option		Specific option	WRZ
			Chinnor 100 Mm3	London
		Longworth	Longworth 30 Mm3	London
			Longworth 50 Mm3	London
Enhancement to Existing Reservoir Operation			Farmoor	London
Aquifer recharge (AR)			AR Kidbrooke (SLARS 1)	London
			AR Streatham (SLARS 2)	London
			AR Merton (SLARS 3)	London
			AR Kidbrooke	London
			AR HARS (Hornsey)	London
			AR Cricklade (alternative to ASR)	SWOX
Aquifer storage and recovery wells (ASR)			ASR South East London (Addington)	London
			ASR Thames Valley/Thames Central	London
			ASR Hampden Bottom-Wendover	SWA
			ASR Guildford (Abbotswood)*	Guildford
			ASR Horton Kirby	London
			ASR Darent Valley (Eynsford)	London
			ASR Darent Valley (Lullingstone)	London
Groundwater			Mousehill and Rodborough	Guildford
			Sheeplands Licence Disaggregation	Henley
			Datchet (pumps)	SWA
			Bourne End (increased licence)	SWA
			Medmenham (increased licence)	SWA
			Taplow (increased licence)	SWA
			Purley	Kennet
			Mapledurham	Kennet
			Cold Ash disused source (recommission)	Kennet
			Arborfield disused source (recommission)	Kennet
			Mortimer disused source (recommission)	Kennet
			Mortimer (transfer peak licence from Arborfield)	Kennet
			Hungerford (licence increase)	Kennet
			Playhatch (increased licence)	Kennet
			Woods Farm (Increased licence)	SWOX
			South Stoke 1	SWOX
			South Stoke 2 (with treatment)	SWOX
			Moulsford 1	SWOX
			Moulsford 2 (with treatment)	SWOX
			Addington	London
			Honor Oak	London
			ELRED	London
			Southfleet/Greenhithe (disaggregation)	London
			GW West Marlow groundwater development	SWA
			GW Bibury source enhancement	SWOX
Direct River Abstraction: Development of surface water sources			Lower Lee SW Abstraction	London
			Culham (resource only - treatment at Farmoor)	SWOX

Generic option	Sub-option	Specific option	WRZ
Reclaimed Water: Indirect Potable Reuse	Using Reverse Osmosis	Deephams 25Ml/d	London
		Deephams 60Ml/d	London
		Beckton 50 Ml/d	London
		Beckton 100 Ml/d	London
		Beckton 150 Ml/d	London
		Hogsmill 15Ml/d	London
		Hogsmill 35Ml/d	London
		Abbey Mills (Luxborough Lane) 50Ml/d	London
		Abbey Mills (Luxborough Lane) 100Ml/d	London
		Abbey Mills (Luxborough Lane) 150Ml/d	London
	Non-Reverse Osmosis	Deephams 25Ml/d	London
		Deephams 60Ml/d	London
		Beckton 50 Ml/d	London
		Beckton 100 Ml/d	London
		Beckton 150 Ml/d	London
		Hogsmill 15Ml/d	London
		Hogsmill 35Ml/d	London
		Abbey Mills (Luxborough Lane) 50Ml/d	London
		Abbey Mills (Luxborough Lane) 100Ml/d	London
		Abbey Mills (Luxborough Lane) 150Ml/d	London
Desalination		Estuary South Desalination 150 Ml/d (estuarine)	London
		Estuary South Desalination 100 Ml/d (estuarine)	London
		Estuary South Desalination 50 Ml/d (estuarine)	London
		Long Reach Desalination (brackish GW)	London
Release of network/treatment constraints		Hampden	SWA
		East Woodhay	Kennet
		Datchet NC	SWA
Bulk Supply	Internal Intra-zonal transfer	SWA to SWOX 1	SWOX/SWA
		SWA to SWOX 2	SWOX/SWA
		SWA to SWOX 3	SWOX/SWA
		SWA to SWOX 4	SWOX/SWA
		Henley to SWOX	SWOX/Henley
		KV to SWOX	SWOX/Kennet
		SWA to Henley	SWA/Henley
		Henley to KV	Kennet/Henley
	New External Transfer	Wessex Water - Minety to Flaxlands SR	WSX/SWOX
	Renegotiation of existing transfer	Essex & Suffolk Water - Essex to London	ESW/London
OJEU Options		RWE Didcot licence transfer	London
		Leakage reduction	London
Licence Trading/Transfer		Tottenham BH	London

*Note: The EA have raised some issues on these schemes. The EA is satisfied that these schemes are included in the plan in view of the lead-time however we will work with the EA to address the associated issues over the next 5 years.

Table 7-21: Summary of constrained demand options

Generic Option	Sub-option	Specific Option	WRZ
Demand Management	Demand Management with Tariffs	LON-25-0-T	London
Demand Management	Demand Management with Tariffs	LON-25-25-T	London
Demand Management	Demand Management with Tariffs	LON-50-0-T	London
Demand Management	Demand Management with Tariffs	LON-50-25-T	London
Demand Management	Demand Management with Tariffs	LON-75-0-T	London
Demand Management	Demand Management with Tariffs	LON-75-25-T	London
Demand Management	Demand Management with Tariffs	LON-90-0-T	London
Demand Management	Demand Management with Tariffs	LON-90-25-T	London
Demand Management	Demand Management with Tariffs	LON-95-0-T	London
Demand Management	Demand Management with Tariffs	LON-95-25-T	London
Demand Management	Demand Management with Tariffs	LON-100-0-T	London
Demand Management	Demand Management with Tariffs	LON-100-25-T	London
Demand Management	Demand Management with Tariffs	LON-100-35-20-T	London
Demand Management	Demand Management with Tariffs	LON-105-0-T	London
Demand Management	Demand Management with Tariffs	LON-105-25-T	London
Demand Management	Demand Management with Tariffs	LON-110-0-T	London
Demand Management	Demand Management with Tariffs	LON-110-25-T	London
Demand Management	Demand Management with Tariffs	LON-125-0-T	London
Demand Management	Demand Management with Tariffs	LON-125-25-T	London
Demand Management	Demand Management with Tariffs	GUI-0-3-0-T	Guildford
Demand Management	Demand Management with Tariffs	HEN-0-1-0-T	Henley
Demand Management	Demand Management with Tariffs	KEN-1-6-3-T	Kennet
Demand Management	Demand Management with Tariffs	SWA-1-8-4-T	SWA
Demand Management	Demand Management with Tariffs	SWOX-2-14-8-T	SWOX
Demand Management	Demand Management without Tariffs	LON-25-0	London
Demand Management	Demand Management without Tariffs	LON-25-25	London
Demand Management	Demand Management without Tariffs	LON-50-0	London
Demand Management	Demand Management without Tariffs	LON-50-25	London
Demand Management	Demand Management without Tariffs	LON-75-0	London
Demand Management	Demand Management without Tariffs	LON-75-25	London
Demand Management	Demand Management without Tariffs	LON-90-0	London
Demand Management	Demand Management without Tariffs	LON-90-25	London
Demand Management	Demand Management without Tariffs	LON-95-0	London
Demand Management	Demand Management without Tariffs	LON-95-25	London
Demand Management	Demand Management without Tariffs	LON-100-0	London
Demand Management	Demand Management without Tariffs	LON-100-25	London
Demand Management	Demand Management without Tariffs	LON-100-35-20	London
Demand Management	Demand Management without Tariffs	LON-105-0	London

Generic Option	Sub-option	Specific Option	WRZ
Demand Management	Demand Management without Tariffs	LON-105-25	London
Demand Management	Demand Management without Tariffs	LON-110-0	London
Demand Management	Demand Management without Tariffs	LON-110-25	London
Demand Management	Demand Management without Tariffs	LON-125-0	London
Demand Management	Demand Management without Tariffs	LON-125-25	London
Demand Management	Demand Management without Tariffs	GUI-0-3-0	Guildford
Demand Management	Demand Management without Tariffs	HEN-0-1-0	Henley
Demand Management	Demand Management without Tariffs	KEN-1-6-3	Kennet
Demand Management	Demand Management without Tariffs	SWA-1-8-4	SWA
Demand Management	Demand Management without Tariffs	SWOX-2-14-8	SWOX

Table 7-22: Summary of constrained transfer list

Option	Specific option	Import/ Export	Water Resource Zone
New transfers	Sutton & East Surrey - Merton to Sutton	Export	SESW/London
	South East Water - RZ4 Surrey Hills from Windsor (10 variant)	Export	SEW/SWA
	Wessex Water - Minety to Flaxlands SR	Import	WSX/SWOX
Renegotiation of existing transfers	Affinity Water from London (Fortis Green)	Export	AfW-Lon
	Affinity Water from Guildford (Ladymead)	Export	AfW-Gui
	Essex & Suffolk Water - Essex to London	Import	ESW/London