Our final plan

Our Drainage and Wastewater Management Plan 2025-2050

Technical Appendices
Appendix D – Option Development and Appraisal

May 2023

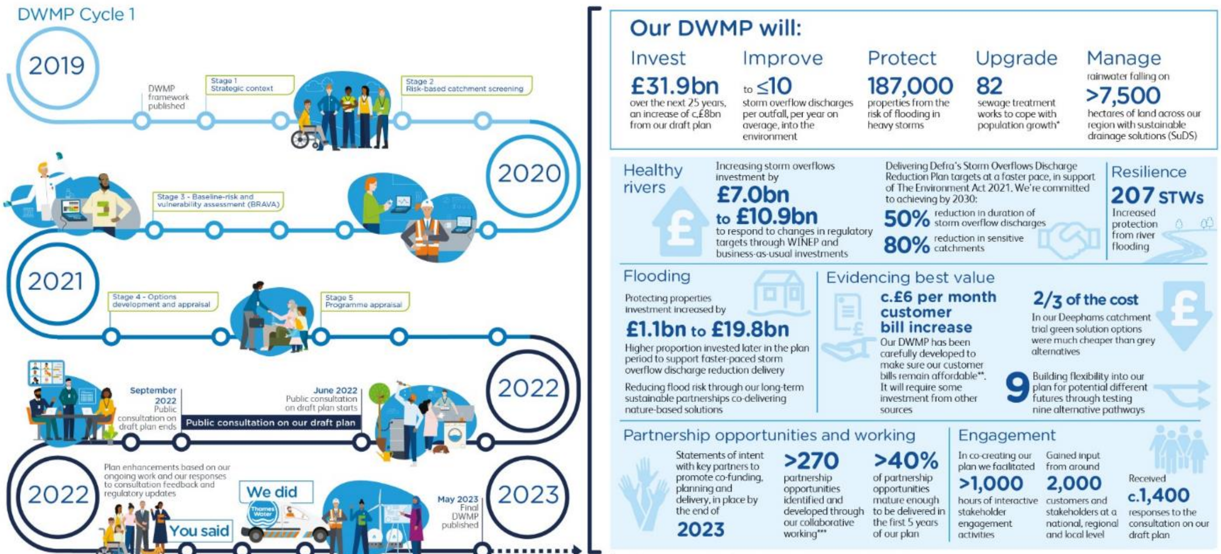
Contents

Figures

Tables

Preface

We're proud to present our first Drainage and Wastewater Management Plan (DWMP) and encouraged by the level of positive feedback we've received. Over the last four years, we've engaged and worked collaboratively with around 2,000 of our customers and stakeholders, to deepen our shared understanding and develop new ways to manage drainage and wastewater across our region. We illustrate our DWMP Cycle 1 and its headlines below.



* Including the potential new STW in the South East London area.
** Calculation based on the indicative customer bill impact (pounds per year per household), averaged across our region.
*** Including additional projects identified post publication of our draft plan and a number evolving from AMP 7.

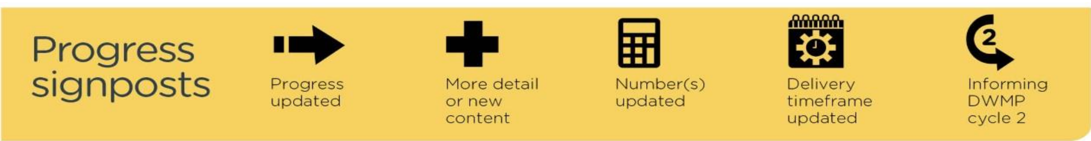
We've progressed and enhanced our DWMP since we published it for public consultation in June 2022. We were pleased to receive lots of positive comments and support on the quality and ambition of our draft plan as well as useful ideas for making our final DWMP even stronger.

We've updated our draft plan based on our ongoing DWMP work, regulatory updates and our responses to the consultation feedback wherever possible*. Our updates include providing more detail where you felt it was needed and creating new appendices to answer technical queries. For more details on how we've progressed our final plan and responded to the consultation feedback, please see our Non-technical summary and You said, We did Technical appendix.

* Some public consultation feedback didn't require further action or wasn't relevant to the DWMP process. Other feedback was relevant to future DWMP planning cycles and will be used to inform this work.

Progress signposts

We want to make it easy for you to see what's changed. You can spot all the places we've updated our draft plan with our 'progress signposts' which we've used across our final DWMP documents.



Here's where they'll be:

- Preface summaries – we've put a summary table in each document's preface (excluding Summary documents and CSPs)
- Relevant chapters – we've placed the appropriate signposts next to each relevant chapter (including Summary document and CSPs)

To help you find our progress signposts, here are examples of what to look out for:

Progress summary table

The progress signposts summary table for the chapters in this document is outlined below. We've used orange cells to indicate where our draft plan has been updated with progress.

Progress signposts summary: Technical Appendix D – Options Development and Appraisal	Progress updated	More detail or new content	Number(s) updated	Delivery timeframe updated	Informing DWMP cycle 2
2. Option Development and Appraisal (ODA)					
3. Identifying options to address our long-term strategies					
4. Engaging with our customers and stakeholders					
5. Aligning our final plans in response to feedback and legislative changes					
6. Building a best value framework					
7. Setting ambitious targets for our planning objectives					
8. Unconstrainted/constrained option development and screening					
9. Developing feasible options to achieve our planning objective targets					
10. Main outputs					

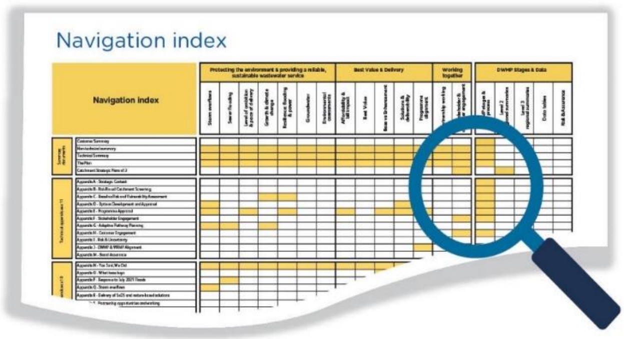
Key DWMP content

This document specifically includes the following key DWMP content:

- Protecting the environment and providing a reliable, sustainable wastewater service:
    - Storm overflows
    - Sewer flooding
    - Level of ambition & pace of delivery
    - Growth & climate change
    - Resilience: flooding & power
- Best Value and Delivery:
    - Solutions & deliverability
    - Programme alignment
- DWMP stages and data:
    - DWMP stages & process

Navigating our documents

To help you navigate around our final DWMP document suite and find where key DWMP content features, we've placed a Navigation index at the back of this document.



Executive Summary

Introduction to our DWMP

A Drainage and Wastewater Management Plan (DWMP) is a long-term costed plan that's focused on partnership working, which sets out the future risks and pressures for our drainage and wastewater systems. It identifies the actions that are required to make sure we can continue delivering our services reliably and sustainably, whilst also achieving positive outcomes for our customers, communities and environment.

Option development and appraisal (ODA) is one of the key stages within the DWMP Framework. This ODA Technical Appendix outlines how we have identified, assessed and developed possible options to address the risks identified in the previous BRAVA stage. It describes how we have compared and evaluated possible options by considering their performance within a best value framework to understand the benefits they might provide to communities and to our natural environment, as well as understanding their potential cost and feasibility. It then goes on to describe the process of further development to a concept design level.

How we developed and appraised our plan options

Our approach to ODA follows the DWMP Framework and aligns with the Government's Guiding Principles[1]. It follows a well-established, consistent approach to wastewater planning through a structured progression of development and appraisal of options, ensuring a level of effort proportionate to both the risk identified and the assessment stage in the planning process.

We commenced with a long list of 37 generic options. The options were assessed by our experienced System Planners to screen out those options that were not considered feasible for inclusion in our DWMP, based on them being disproportionately costly, technically infeasible or having significant and unacceptable environmental impacts.

The options selected reflect the different challenges for our London catchments, compared to those outside London. Our London networks are comprised of a mixture of combined and separate networks, while our catchments outside London are predominantly separate. The highly developed London catchments present numerous option deliverability challenges, such as congested utilities and lack of available space, when considering ambitious targets.

We undertook research to understand our customer's preferences, to find out, for example, if any options were unacceptable to them and why. No options were either universally supported or rejected. The views expressed by our customers, and the outcomes of the research, were considered when developing options and deciding which options to take forward and incorporate into our DWMP.

Working together with our stakeholders, through a series of webinars, one to one sessions and online workshops, we identified a set of clear planning objectives for our DWMP. Our planning objectives define performance criteria against which each of our options could be tested in relation to flood risk, sewer overflow performance and treatment works flow and quality compliance. Additional option metrics for environmental and social performance, natural capital,

[1] https://www.gov.uk/government/publications/drainage-and-wastewater-management-plans-guiding-principles-for-the-water-industry/guiding-principles-for-drainage-and-wastewater-management-plans

wellbeing, collaboration, asset health, reducing surface water runoff and reducing misconnections were also developed.

The development of our planning objectives and supporting metrics in collaboration with customers and stakeholders ensures that each of our options has been assessed taking into consideration the many competing factors, opinions, and influences encompassing technical, environmental, social and economic value. Each of our options progressed from the generic list has been developed to a conceptual design level and the performance assessed against our planning objectives and supporting metrics.

What you said in our consultation about option development and appraisal

We published our draft DWMP for consultation on 30 June 2022. The feedback we received from regulators, stakeholders and customers has been used to inform our final DWMP. The response showed high levels of support for the use of the solutions we proposed, particularly our focus on surface water management approaches (including SuDS, rainwater harvesting, and grey water reuse) and addressing misconnections.

We received many positive responses from multiple stakeholders with suggestions for additional and alternative solutions that stakeholders believe will provide benefit as well as ideas about how we might improve our options appraisal/prioritisation process. These included alternative solutions of various types including traditional engineering, green/nature-based, community/stakeholder related and use of innovation/research. Some of these are included in our plan; however, others had already been screened out in previous option development phases primarily due to high cost or environmental/social impact for little increase in benefit. Options screened out at this point will be revisited and reappraised in our preparatory work for cycle 2 of the DWMP.

Stakeholders also asked for more evidence around the costs and benefits of solutions, and why alternative options, such as SuDS in London, were selected over others. We have subsequently undertaken a comparative assessment of nature-based surface water management options against more traditional sewer upsizing for one of our London catchments to support our options selection.

We have updated our ODA outputs to reflect feedback from our public consultation and from our regulators on our draft DWMP including:

- Alignment between the Water Industry National Environment Programme (WINEP) storm overflow performance and our final DWMP. This includes incorporation of revised targets in line with the Storm Overflows Discharge Reduction Plan[2] and new Environment Act (2021)[3] legislation issued since publication of our draft plan
- Incorporation of schemes that have been further developed as part of our business plan for the next planning period (2025 to 2030) into our final DWMP
- Inclusion of options to ensure our sewage treatment works are resilient to pluvial and fluvial flooding

[2] Storm overflows discharge reduction plan - GOV.UK (www.gov.uk)
[3] https://www.legislation.gov.uk/ukpga/2021/30/contents/enacted

Our feasible options

Our approach to option development recognises key differences in targets, options, extent and complexity between our catchments inside and outside of London.

Aligning our DWMP with our WINEP storm overflow obligations has introduced additional solutions, such as managed wetlands/reedbeds within our plan. In some cases, this has resulted in a change in option type selection from the DWMP unconstrained/constrained option development to focus on the solutions generated from the WINEP programme. For example, to meet the challenge of the legislative timescales for storm overflow discharge reduction an 'end-of-pipe' storage option has been identified at this point rather than a catchment wide surface water management scheme.

Feasible options taken forward for our London catchments include:

- Options with a total value of approximately £23 billion[4] to address flooding and storm overflow performance discharge targets (at 2050)
- Our options assume an ambitious level of SuDS implementation. Stakeholders have rightly challenged the scale of deliverability which we have considered further in our Programme Appraisal stage
- The overall cost of options to achieve both our sewer property flooding and storm overflow performance targets is more than double the cost to achieve storm overflow performance targets. This is due to climate change having a larger impact on our network performance and property flooding risk
- The network construction costs are primarily associated with two option types: traditional sewer reinforcement and attenuation storage (50%), and surface water management options including sustainable drainage systems (SuDS) (45%). Sewer lining to target infiltration hotspots is the third largest option type (4%)
- Investment to ensure compliance at each of our sewage treatment works over the plan period to 2050

[4] All stated costs in this Technical Appendix comprise construction costs only. Costs are presented at a 2020/21 price base, which aligns with costs submitted in the Ofwat data tables. Costs are subject to rounding, however totals are correct

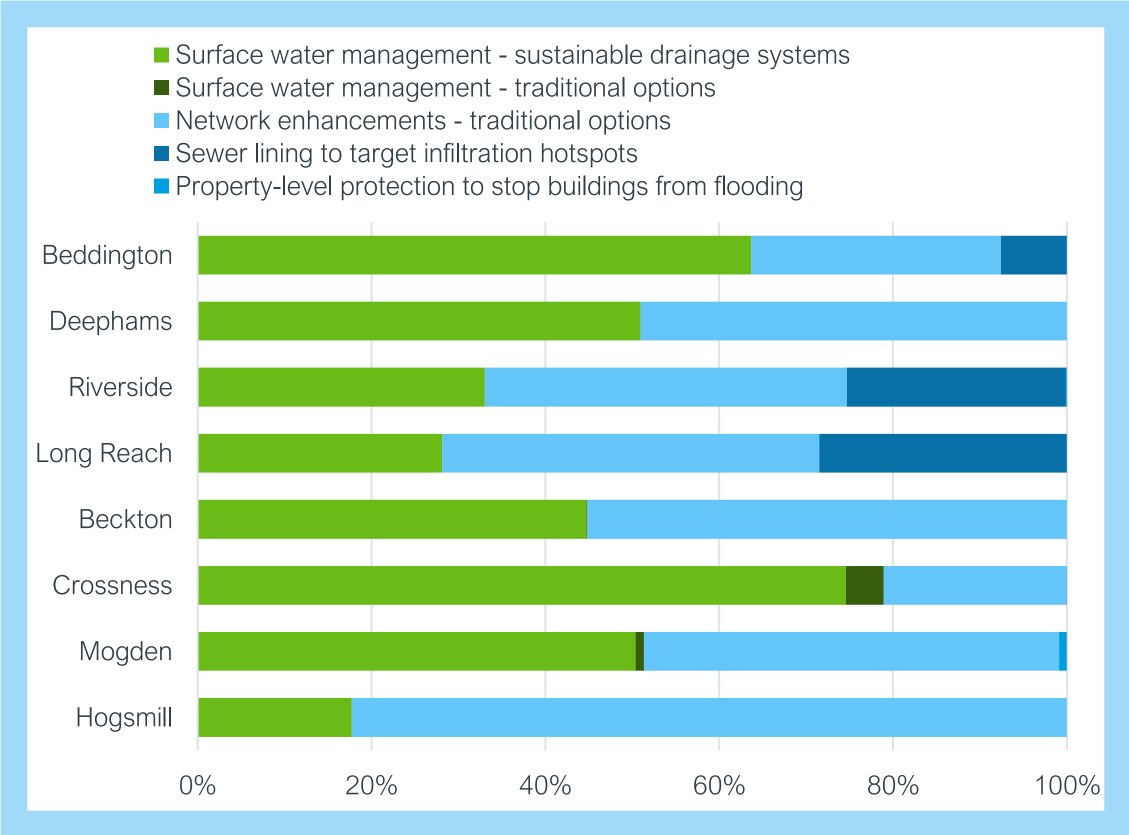


Figure 0-1 Network option types developed for London catchments as a proportion of total construction costs (to achieve planning objective targets by 2050)

For our catchments outside London:

- Options with a total cost of approximately £11.8 billion are required to address flooding and storm overflow performance targets (at 2050)
- The overall cost of options to achieve sewer property flooding targets is approximately four times that required to achieve storm overflows performance targets on their own
- The cost of options to maintain performance at current levels is approximately a third of that required to achieve our more stretching ambitious targets
- The network construction costs are primarily associated with traditional sewer reinforcement and attenuation storage (64%), surface water management options including SuDS (24%), and sewer lining to target infiltration hotspots (11%)
- Compared to London, the proportion of surface water management options proposed is lower, primarily due to our catchments outside London having separate networks
- Most of our surface water systems are not covered by verified hydraulic models; our plan is to map and model our surface water systems within the second cycle of our DWMP, to consolidate our knowledge of areas of the network where investment is needed and to increase confidence in our plans for surface water management solutions
- Investment to ensure compliance at each of our sewage treatment works over the plan period to 2050

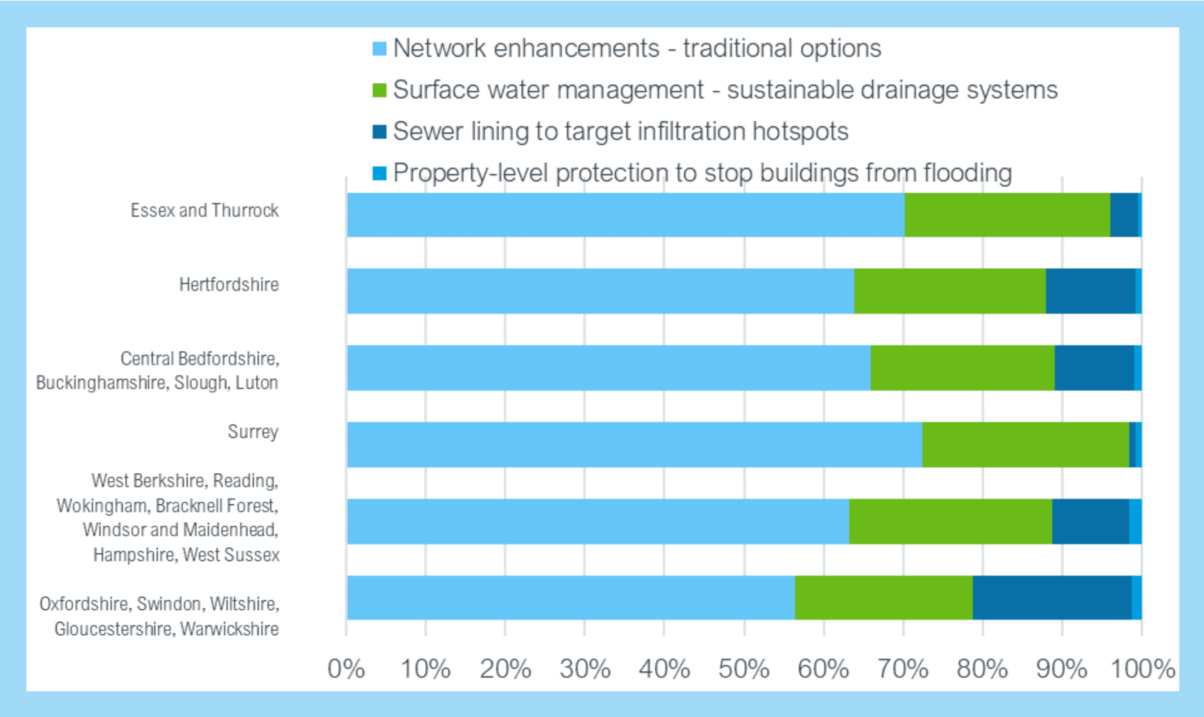


Figure 0-2 Network option types developed for L2 areas outside of London as a proportion of total construction costs (to address planning objective targets by 2050)

The ODA process has resulted in the development of feasible options to address the range of risks, identified at BRAVA stage, within a catchment. The feasible options, including their associated metrics, were taken forward into the programme appraisal stage to define the best value portfolio of options that provides resilience to future risks and delivers optimum outcomes for our customers, communities and the natural environment in our region.

1 Our Drainage and Wastewater Management Plan (DWMP)

Our DWMP vision

1.1 Working in partnership to co-create a 25-year plan for drainage and wastewater that sustainably benefits communities and the natural environment in our region.

Our DWMP aim

1.2 To identify future catchment risks to our drainage and wastewater treatment systems and develop sustainable, efficient solutions to address them.

What we're trying to achieve

Protection of our environment, looking after the health of our rivers (aiming for zero harm from spills), being resilient to the risks of flooding and generating wider benefits to the communities we serve. DWMP outcomes for:

- Customers and communities – fair charges, improved health and wellbeing, increased amenity, and a resilient service
- Drainage and wastewater services – reduce sewer flooding and achieve 100% Sewage Treatment Works (STW) compliance
- The environment – increase biodiversity, zero harm from storm overflow spills, and environmental net gain

Description of the plan

1.3 A DWMP is a long-term costed plan that is focused on partnership working, which sets out the future risks and pressures for our drainage and wastewater systems. It identifies the actions that are required to make sure we can continue to deliver our services reliably and sustainably, whilst also achieving positive outcomes for our customers, communities and environment.

1.4 Our long-term, collaborative plan aims to ensure a resilient and sustainable wastewater service for the next 25 years and beyond.

Framework

1.5 This is the first iteration of a long-term plan for our drainage and wastewater business following a consistent industrywide framework.

1.6 Our DWMP creates a roadmap for how we adapt our wastewater service to cope with future challenges based on:

- The national DWMP Framework that was developed jointly by regulators and industry bodies including Ofwat, Defra, the Environment Agency, Water UK, Welsh Government, Natural Resources Wales, Consumer Council for Water, Association of Directors of Environment, Economy, Planning and Transport and Blueprint for Water
- Guiding principles issued by Government; and,
- The framework for development of Long-Term Delivery Strategies for PR24 issued by Ofwat

2 Option Development and Appraisal (ODA)

Progress ✚

Purpose

2.1 Option development and appraisal (ODA) is one of the key stages within the DWMP Framework[5]. The previous stage, the baseline risk and vulnerability assessment (BRAVA), assessed how current drainage and wastewater systems perform, how risks will change in future under each time period being considered, and identified the principal drivers for changes in risk.

2.2 The objective of the ODA process is to identify and assess all possible options to address the risks identified through BRAVA and develop them. They can then be compared and evaluated by considering whether they offer 'best value'[6] to the communities we serve and the natural environment in our region. Once preferred options have been selected, these are further developed to a conceptual design level. This provides a consistent, high-level option definition for the comparable assessment of function, environmental and social performance, and cost.

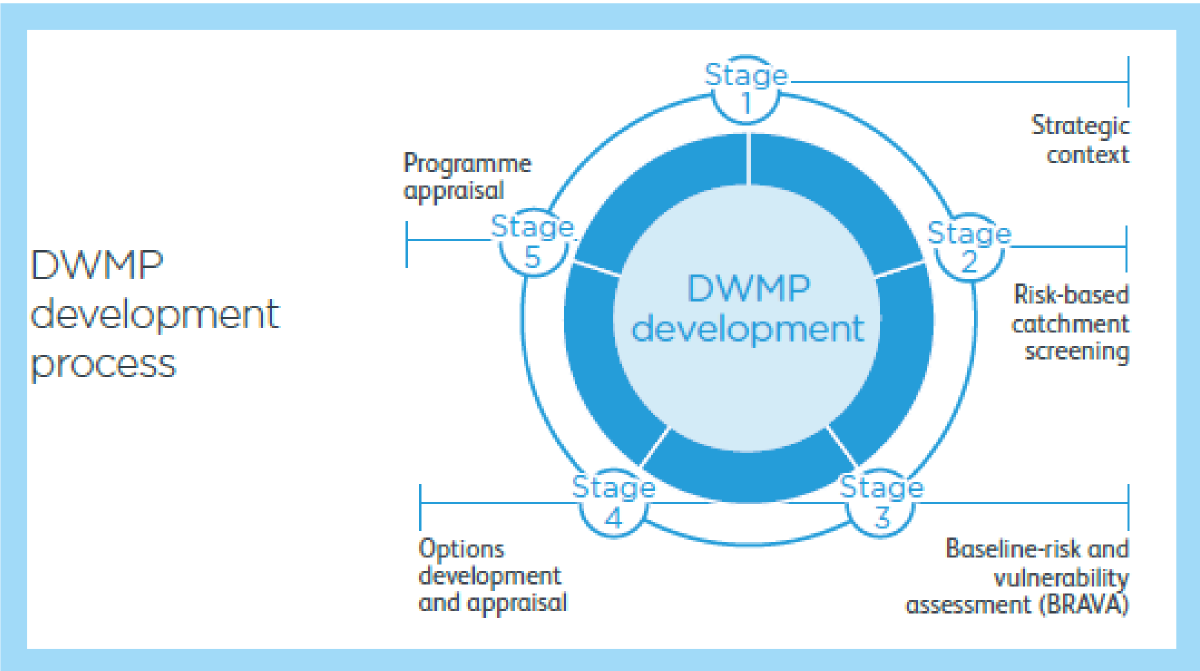


Figure 2-1 Position of the ODA stage within the DWMP development process

2.3 The strategic context, risk-based catchment screening (RBCS) and BRAVA stages are the critical pre-optioneering steps which effectively define the nature and complexity of the issues (risks) to be addressed. These pre-optioneering steps are covered elsewhere in

[5] https://www.water.org.uk/wp-content/uploads/2020/01/Water_UK_DWMP_Framework_Appendices_September-2019-D.pdf
[6] https://ukwir.org/eng/deriving-a-best-value-water-resources-management-plan

separate Technical Appendices, together with the subsequent stage of programme appraisal.

2.4 Besides defining the pressures and drivers of change impacting upon the DWMP, the strategic context stage defined the objectives to be addressed by the plan. These planning objectives each have one or more planning metrics by which current and future performance have been measured or forecast against target values.

Planning objectives set at a strategic context stage

2.5 The 12 planning objectives shown in Figure 2-2 have been developed in consultation with stakeholders at the strategic context stage.

2.6 Four bespoke objectives, not currently amenable to long-term forecasting and modelling, were identified through consultation with our stakeholders. These are considered as 'outcome measures', being objectives that the DWMP must address. The performance of options against these objectives has also been determined during ODA stage.

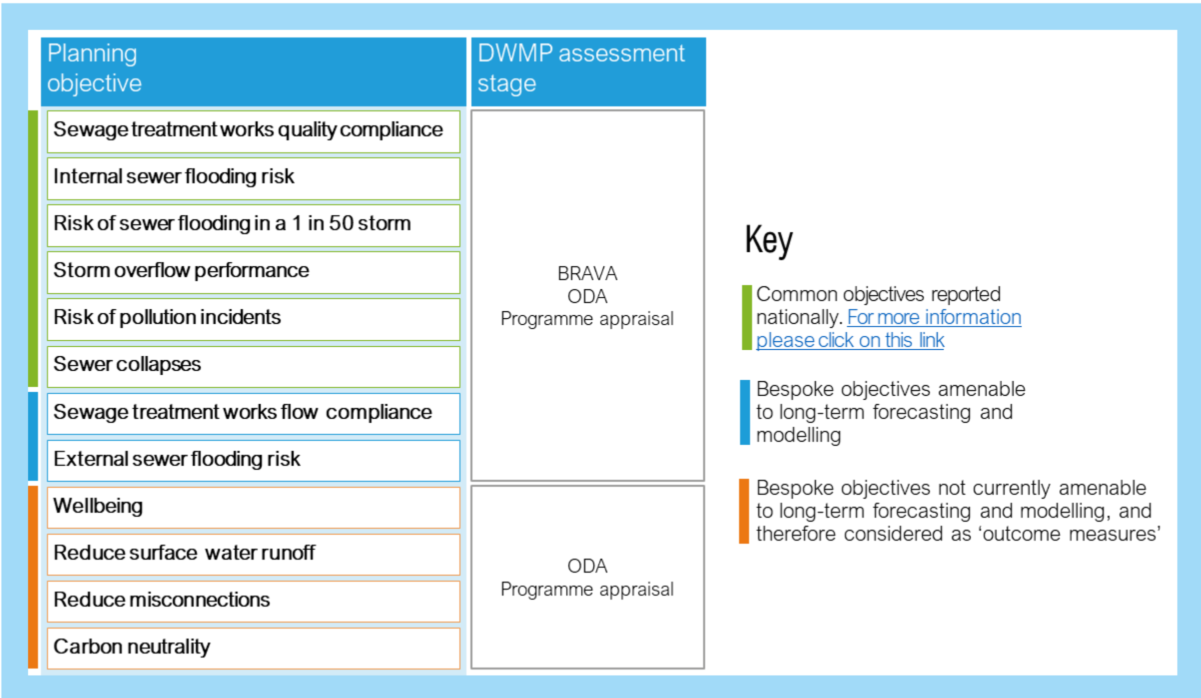


Figure 2-2 The 12 DWMP planning objectives set by stakeholders as part of the strategic context stage

2.7 During the ODA stage, options were developed and their benefit (expressed as how effective they were in reducing common and bespoke planning objective risks) was assessed.

Main principles of an optioneering framework

2.8 The ODA process outlined in the DWMP Framework[7], and adopted for our DWMP, has followed the same method that has been developed and implemented successfully over many years for water resources management plans (WRMPs).

2.9 The benefits of the approach are that it:

- Is well established
- Involves movement through the various steps that follow a logical pathway
- Enables a level of effort proportionate both to the risk identified and assessment stage in the planning process
- Is relatively straightforward to present to non-technical stakeholders (or participants) as well as experts; and
- Provides a clearly consistent approach to both water and wastewater planning

2.10 The approach undertaken is a structured progression of development and appraisal of options as shown in Figure 2-3, commencing with the broadest possible range, culminating with a feasible set of options. In this first cycle of DWMP planning we have identified risks at a strategic scale. This means that our options are defined at a conceptual level where the spatial scale may be uncertain at this time.

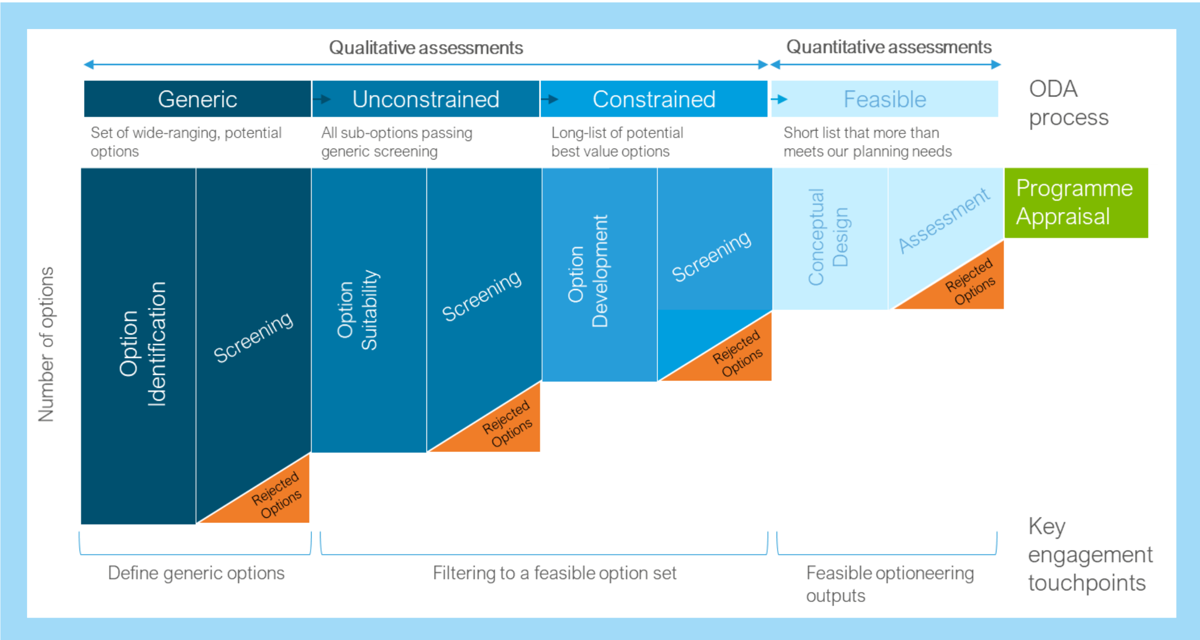


Figure 2-3 Overview of the ODA process

2.11 At each stage, the options are screened to remove those options that are not considered feasible for inclusion in the final basket of options to be assessed for the DWMP. The approach to screening options focused effort on defining feasible options, screening out at each stage those options assessed as disproportionately costly, technically infeasible or having significant and unacceptable environmental impacts.

[7] https://www.water.org.uk/wp-content/uploads/2020/01/Water_UK_DWMP_Framework_Appendices_September-2019-D.pdf

2.12 Options are developed through increasing the level of assessment through each of the following stages:

- Generic options: all options at a generic level that could potentially address risks arising from the drainage and wastewater service (potential risks across all planning objectives). Generic options are appropriate for engagement with internal governance bodies and external stakeholders. These options were further disaggregated into sub-options for application by DWMP planners
- Unconstrained options: this is a high-level list of options screened from the generic sub-options appropriate for consideration at a specific location(s) where risks have been identified within the BRAVA / problem characterisation process
- Constrained options: options that have passed through from the unconstrained screening, filtering out options that are impracticable, have an assessed excessive cost against benefits, or have unacceptable environmental or economic impact
- Feasible options: this is a final screened list that has been tested on grounds of both monetised and non-monetised costs and benefits. Feasible option development also included environmental and social assessments, using criteria aligned to those required in a Strategic Environmental Assessment and relevant to Habitats Regulation Assessment and Water Framework Directive assessments

2.13 This structured approach:

- Ensures that all options that could be used to address identified risks are considered
- Promotes options that could be delivered through co-creation / partnership working
- Enables the development of adaptive pathways to address risk uncertainty driven by different futures
- Enables greater stakeholder engagement at each stage and provides a decision-making process that is transparent and auditable

2.14 Internal and external stakeholder reviews, and the detailed assessments undertaken at the feasible stage, all provide check and challenge points to mitigate potential risk of bias from the use of engineering judgement in the early stages of the process.

2.15 The process of screening options (to derive a portfolio for consideration during programme appraisal) was followed for all catchments with risks identified at the BRAVA stage. The option screening takes a proportionate approach considering the scale of catchment risk against an appropriate level of assessment. The level of option complexity was determined during the problem characterisation stage of BRAVA, which identified catchments requiring complex, extended or standard approaches. This is in compliance with the DWMP Framework (appendix D, section D.3.1.3)[8] For example, for our catchments outside London, a more streamlined approach was taken that moved from the unconstrained to feasible options list in a one-pass assessment (see section 9).

[8] https://www.water.org.uk/wp-content/uploads/2020/01/Water_UK_DWMP_Framework_Appendices_September-2019-D.pdf

2.16 The level of optioneering effort was commensurate with the scale and complexity of the problems to be addressed. We expended most screening and optioneering effort in our London catchments, with some having adaptive pathway techniques applied.

2.17 The ODA process has resulted in the development of a range of feasible options to address the risks, identified at BRAVA stage, within a catchment. The feasible options were taken forward into the programme appraisal stage to define the best value portfolio of options that provides resilience to future risks and delivers optimum outcomes for our customers, communities and the natural environment in our region.

3 Identifying options to address our long-term challenges

Progress	No significant change between the draft and final DWMP

Generic option development

3.1 For our first DWMP, we've undertaken a comprehensive exercise to identify and develop a wide range of generic options that could address the risks assessed during the BRAVA / problem characterisation stage. We combined an industry derived list and our knowledge of our catchments with the feedback we received from our stakeholders to help us identify the options required to meet the future needs of the region.

3.2 Our structured approach resulted in the identification of 37 generic options that are listed in Table 3-2. This listing is expanded upon within Appendix A, where descriptions are provided for each. Generic options have been allocated to generic option management areas as shown in Table 3-1:

Generic option management area		Description[1]
A	Property and community level water management	Manage the use of water • in and arising from customer properties • at a community level
B	Surface water management	Manage surface water flows entering our sewer systems
C	Combined and foul sewer systems	Manage flows within our combined and foul sewer systems
D	Sewage treatment	Manage flows and loads at our sewage treatment works
E	Indirect measures	Manage flows indirectly through measures that will improve the performance of our wastewater systems
1 Adapted from the DWMP Framework		

Table 3-1 Generic option management areas

3.3 This aligns with the WRMP process[9] and also the indicative management areas as stated in the industry DWMP Framework, noting that the framework included the first four management areas listed above and also stated: '*Additional options may be considered that would apply at L1; these could include for example: customer engagement/education on what should or shouldn't be flushed down toilets….*', which covers the 'indirect measures' management area.

3.4 At a national level, a set of generic options was devised via an industry task and finish group to be used by all water and sewerage companies. These were approved by national DWMP

[9] UKWIR, 2012, WR27 Water Resources Planning Tools 2012, Economics of Balancing Supply and Demand (EBSD) Report

stakeholders. Our regional generic options list includes all options from the national list. It has also been further developed, with some generic options being sub-divided for clarity.

Option Reference[1]	Generic option title
A1	Water efficiency measures (property, community or industrial level)
A2	Rainwater harvesting (property, community or industrial level)
A3	Greywater treatment and re-use (property, community or industrial level)
A4	Blackwater treatment and re-use (property, community or industrial level)
B1	Surface water source control measures
B2	Surface water pathway measures
B3	Surface water receptor measures
C1	Intelligent automated sewer network operation
C2	Intelligent automated asset maintenance
C3	Increase sewer capacity (e.g., pipe replacement)
C4	Stormwater storage tanks and tunnels
C5	Sewer lining to target infiltration hotspots
C6	Utilise and optimise existing inter-catchment connections
C7	Create new inter-catchment connections
C8	Create strategic connections between sewage treatment works (STWs)
C9	Transfer wastewater across company boundaries
D1	Treat wastewater in the network
D2	Increase level of performance in existing STWs
D3	Increase treatment intensity at existing STWs
D4	Expand existing STWs
D5	Construct new/additional STWs
D6	Increase treatment centralisation
D7	River catchment-based discharge permitting
D8	Dynamic permitting
D9	Catchment management treatment initiatives
D10	Indirect re-use of effluent
D11	Wastewater treatment resource recovery
D12	Transfer sludge across boundaries
E1	Customer education and awareness
E2	Customer incentivisation
E3	New and amended wastewater and drainage regulations
E4	Alternative wastewater and drainage business models
E5	Integrate drainage and wastewater policy/management within local authorities or wider regional partnerships
E6	Influence where population growth can occur
M	Monitor risks
WC	'Wild cards' – options that may be identified by our stakeholders through engagement during the ODA process, which cannot be categorised as any other generic option
WRMP	Water Resource Management Plan integrated option
1 Option references incorporate the management area references as stated in Table 3-1. Key	
	Option currently considered viable for inclusion in our first DWMP

Option Reference[1]	Generic option title
	Option not currently considered viable: allocated for further investigation
	Option not currently considered viable: not progressed further during the ODA process

Table 3-2 Generic options list Generic options list

Generic option screening

3.5 The generic options include innovations which require significant development for them to become viable for inclusion in the portfolio of options for the DWMP. They are included at this stage to ensure broad thinking and consideration of the most promising options that may provide greater benefit or a more sustainable means to deliver our long-term DWMP goals.

3.6 In the latter stages of the ODA process, options have been evaluated against robust technical feasibility, implementation, cost and benefit information. Options to be considered for inclusion in our first DWMP need to be sufficiently developed to allow this to happen.

3.7 To ensure that the generic options fulfil the criteria for the latter stages, an initial generic option coarse screen was undertaken. Our screening process ensured that all potentially viable generic options can be considered within the context of the long-term vision of the DWMP.

3.8 Options that are not considered viable for our first DWMP have been allocated for further investigation or have not been progressed further during the ODA process (but will be considered again for the second cycle of our DWMP). These options are highlighted in Table 3-2.

Generic sub-options

3.9 Expanding on the generic options, a range of linked sub-options have been developed. These provide a more granular level of option definition to the range of risks we have identified in our catchments. For example, option reference A, water efficiency measures, is subdivided into A1.1 to A1.5 with A1.1 sub-option being metering. The generic sub-options are listed in Appendix A against their ‘parent’ generic option.

3.10 This step of the process resulted in 47 generic sub-options being taken forward to the next step (unconstrained option development) for consideration at a catchment level.

4 Engaging with our customers and stakeholders

Progress

Engaging with our customers

4.1 Having identified the types of options that can be used to address long-term challenges, we undertook research to understand our customer's preferences, to find out, for example, if any options were more or less acceptable to them and why. The 'generic' options were summarised into 16 categories and presented to six customer focus groups, during May 2021 (see Appendix B and our Stakeholder Engagement Technical Appendix for further details). This provided qualitative insights to understand the level of customer support for the main types of options.

4.2 The outcome of the research is presented graphically in Figure 4-1. Our customers were asked to assign each option as being a high, medium or low priority and the results are presented in the figure as the overall percentage assigned to each category.

4.3 The key findings were:

- No options were either universally supported or rejected. Customers showed strongest support for options that they considered to be realistic to implement and/or already proven to work. Customers preferred options that they considered were sensible and the right thing to do, such as managing rainwater (green infrastructure).
- Views on catchment management were mixed, with some participants supporting a natural solution approach whilst others were concerned about the effectiveness of relying on other parties.
- Participants supported larger 'new infrastructure' options, although their support tended to be more conditional as they recognised the practicalities of such options
- Customer support was more limited for options that they considered did not solve the underlying problem (flood mitigation for vulnerable properties and re-lining sewers) or options that they considered to be unproven and higher risk (real-time control in sewers, in-sewer treatment), or unrealistic to implement (alternative pathways for rainwater).

4.4 The views expressed by our customers, and the outcomes of the research, were considered when developing options and deciding which options to take forward and incorporate into our DWMP.

4.5 Further details of the engagement we undertook with our customers is provided in our Customer Engagement Technical Appendix.

Figure 4-1 Customer option preferences

Engaging with our stakeholders

4.6 We worked closely with our stakeholders in the ODA stage to co-create a set of preferred options to address the risks and vulnerabilities we'd identified together during BRAVA.

4.7 In February 2021, we delivered pre-recorded webinars to approximately 70 Level 1 and Level 2[10] stakeholders via Microsoft Teams and hosted five 1-2-1 sessions requested by stakeholders. The purpose was to explain the ODA process and our proposed approach to collaboratively deliver this stage.

4.8 In May 2021, we held four online workshops with Level 1 and Level 2 stakeholders to review the proposed feasible options, with one workshop each for the Thames Valley, Outer London, North London and South London regions. In the workshops, and additional breakout sessions (which were used to facilitate detailed local option discussions), we appraised the options against a number of factors including feasibility, effectiveness and investment requirements. The workshop outputs were used to inform the scope of the detailed feasible option development stage we undertook between May and September 2021.

4.9 Throughout November and December 2021, we hosted 13 interactive online workshops attended by over 100 Level 2 stakeholders. The purpose was to gain input specifically to our draft catchment strategic plans. These were drafted based on our optioneering work to provide an early view of the local plans that are an integral part of our shared DWMP.

4.10 Further details of the engagement we undertook with our stakeholders is provided in our Stakeholder Engagement Technical Appendix.

Feedback on the public consultation on our draft plan

4.11 We undertook a formal public consultation of regulators, stakeholders and customers to collect feedback on our draft DWMP. We published our draft plan for public consultation on Thursday 30 June 2022. The consultation closed on Monday 26 September 2022. Alongside this we also undertook customer research using an online survey to collect additional feedback from our household (residential) and non-household (commercial) customers. Details of each part of our consultation are provided in our Consultation Response - You Said, We Did Techical Appendix.

4.12 The feedback from the public consultation, together with new legislation, has been used to inform our final DWMP.

4.13 The consultation response showed general support for our draft preferred plan with more than 60% of our customers agreeing that our plan was acceptable. There was wide support for our focus on surface water management approaches (including SuDS, rainwater harvesting, grey water reuse) and addressing misconnections. Approximately 7 in 10 of the consultation responses supported our target for increasing the use of SuDS. The

[10] Our ODA is built up at three geographical levels: catchments that are served by our STWs (Level 3 - L3), Thames Regional Flood and Coastal Committee (TFRCC) sub-committee (L2) and overall region wide (L1).

consultation also indicated that we have high levels of support for the use of the solutions we proposed in our dDWMP.

4.14 We received many positive responses from multiple stakeholders with suggestions for additional and alternative solutions that stakeholders believe will provide benefit as well as ideas about how we might improve our options appraisal/prioritisation process. The majority of stakeholders responding to the consultation provided one or more suggestions. The number of stakeholders who provided suggestions for solutions is shown in Figure 4-2.

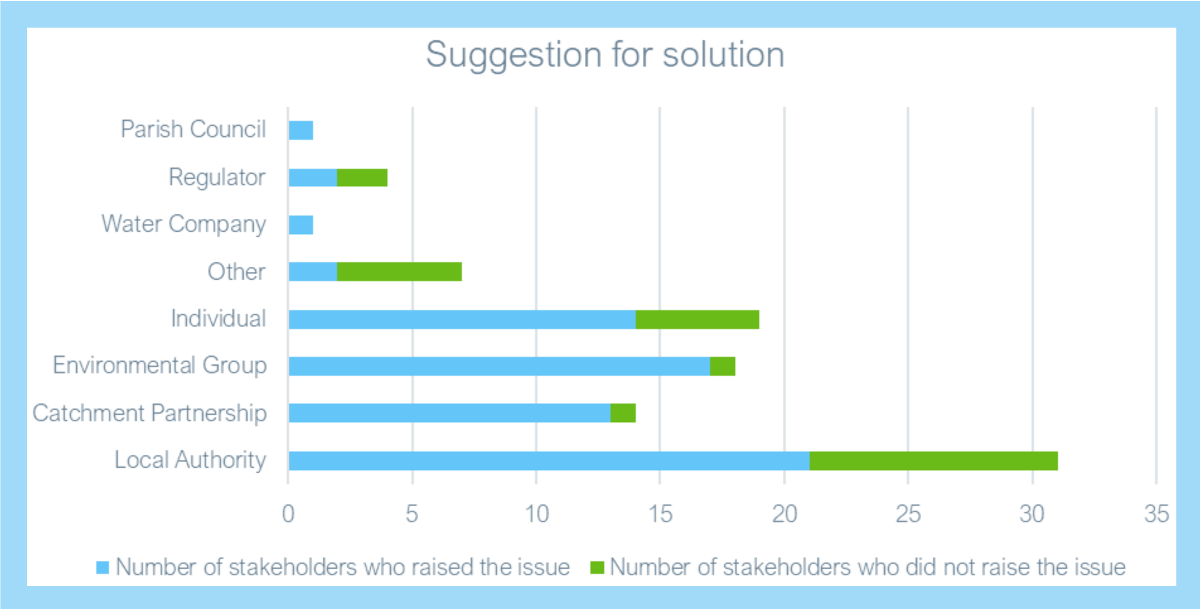


Figure 4-2 Number of stakeholders who provided suggestions for solutions

4.15 A full list of the suggested options can be found in Appendix F of [Consultation Response - You Said, We Did Technical Appendix.](#) These included alternative solutions of various types including traditional engineering, green/nature-based, community/stakeholder related and use of innovation/research. Some of these are included in our plan; however, whilst a number of these were considered viable they had previously been excluded in our unconstrained/constrained option development screening phase as discussed in section 8. These included:

- Focus on property and community level water management (generic option management area A as per Table 3.1). Examples included water efficiency measures, rainwater harvesting and greywater treatment and reuse.
- Indirect measures (generic option management area E as per Table 3.1) including customer education and awareness, customer incentivisation, integration of drainage/wastewater policy/management with local authorities and regional partnerships (e.g., to help address existing misconnections and surface water management for new developments).
- There was also a desire to consider wider land drainage options including natural flood management to capture and attenuate excess surface water runoff before it may enter the public sewer networks, and the use of constructed wetlands to treat flows discharging from storm overflows.

4.16 We will revisit these options and their applicability in our preparatory work for cycle 2.

4.17 Stakeholders also expressed concerns around the practicality of implementing such an ambitious SuDS plan and also asked for more evidence around the costs and benefits of solutions. We have provided more detail in our Delivery of SuDS and Nature-Based Solutions Technical Appendix and this Technical Appendix respectively in response to this feedback.

4.18 On ODA, Ofwat wanted us to provide:

- Further evidence in respect of costs and benefits of solutions, particularly schemes that deliver multiple benefits
- Evidence on why alternative options were discounted, particularly how multiple benefit solutions are being considered and how they compare to alternatives

4.19 We have enhanced this Technical Appendix in response to this feedback, including details of a comparative assessment of nature-based surface water management options for one of our London catchments to support our options selection.

5 Updating our DWMP in response to regulator feedback and legislative changes

Progress

5.1 During the public consultation on our draft DWMP, our regulators specified that we should make changes including some that directly affect the plan costs and benefits. Three important changes were:

- Alignment between WINEP and our final DWMP. Our WINEP now includes the Storm Overflow Discharge Reduction Plan[2] (SODRP) commitments to deliver improvements to our storm overflow performance. This legislative requirement has occurred during the public consultations on our draft plan and therefore replaces our planning objectives for storm overflows
- Incorporating schemes that have been further developed as part of our business planning for the next AMP (2025 to 2030), for example, options, with associated costs and benefits, for our STW that have been further developed. These schemes have a greater level of definition than our DWMP solutions
- Inclusion of measures to ensure our wastewater services are resilient to the risks posed by pluvial, fluvial flooding, coastal flooding and power supply interruptions. This better aligns our DWMP to our ongoing asset resilience framework

5.2 In addition, we have updated our assessment of flood risk and associated options to include protection from sewer flooding for non-residential properties.

5.3 The suite of options presented for our draft and final plans therefore differs. The key differences are described in the following sections.

Alignment between WINEP and our DWMP

5.4 Our draft DWMP was based on a storm overflow performance target at less than 10 storm overflow discharges on average in a typical year. Our options were generated to achieve this standard.

5.5 During the consultation on our draft DWMP, new legislation - the Environment Act - came into force and Government published the Storm Overflows Discharge Reduction Plan[2] imposing new obligations on water companies relating to performance targets for storm overflow discharges. The targets are summarised in Table 5-1 and Table 5-2 and more detail can be found in our Storm Overflows Technical Appendix.

5.6 The new obligations on us from the Storm Overflows Discharge Reduction Plan imposes new performance targets and timelines which we have included in our final plan. We continue to plan on the basis of delivering these obligations earlier than set out in the statutes.

Discharge targets	Storm Overflows Discharge Reduction Plan	Final DWMP
No ecological harm	No ecological harm by 2050	<10 discharges in a typical year by 2045
Discharges to sensitive waterbodies	No ecological harm by 2045	<10 discharges in a typical year by 2035
Discharges to designated bathing waters	<=3 discharges by 2035	<=3 discharges in a typical year by 2030
Storm overflow discharge frequency	<=10 discharges in a typical year by 2050	<10 discharges in a typical year by 2045

Table 5-1 Storm overflow discharge reduction targets

Year	2030	2035	2040	2045	2050
% of high priority site storm overflows improved	38%	75%	87%	100%	100%
% of total storm overflows improved	14%	28%	52%	76%	100%

Table 5-2 Storm overflow discharge reduction targets – by AMP

5.7 In addition, we have committed to reducing the total duration of storm overflow discharges by 50% buy 2030, rising to 80% in sensitive locations, against a 2020 baseline.

5.8 Our DWMP now fully aligns with our WINEP submission to the Environment Agency on storm overflows, which was completed on 23 January 2023, including sites previously screened out at BRAVA. As a result, a further five catchments have been included in our final plan.

Alignment between our business plan (2025 to 2030) and our DWMP

5.9 Our DWMP has been updated to incorporated schemes that have been further developed as part of our business plan for the next planning period (2025 to 2030). Our short-term plans for delivery of schemes to address sewer flooding risk and STW compliance have resulted in design development that has led to changes in scope, cost and benefit from our strategic options developed for our dDWMP. We have therefore updated our fDWMP to ensure alignment of these options with our short-term delivery plans.

Inclusion of Resilience (Pluvial, Fluvial, Coastal flooding and Power)

5.10 The Environment Agency specified that as part of our DWMP we should undertake resilience assessments for pluvial, fluvial and coastal flood risk, and power interruptions (electricity).

5.11 We have undertaken an assessment of risk to our STW assets from pluvial and fluvial flooding and included options for demountable flood defences at 207 sites. Further refinement of this approach will be considered as part of our cycle 2 planning.

5.12 Coastal flood risk impacts us through the influence of the tidal section of the River Thames. We have engaged the Environment Agency Thames Estuary 2100 team (who had a public consultation on the 10-year revision of their plan at the end of 2022). We have agreed a series of joint workstreams are required for both future DWMP's and improvement of the Tidal Estuary 2100 plan and that these will start in DWMP cycle 2.

5.13 We have historically implemented a power resilience programme for high consequence low probability assets at our treatment works and pumping stations. These assets serve large populations and are made resilient with standby oil/diesel generators. In some cases where land is limited, we procure two independent supplies from the electricity district network operator (DNO).

5.14 However, we have advanced electricity meters on our sites. These record minor disturbances in the electricity supply, often yielding higher resolution data than the electricity supplier holds.

5.15 This data changed our view on power resilience. It clearly identified that high frequency low risk assets are the largest contributor to service failures due to power. Many of these assets have limited or no automation and require manual intervention to reset them. There is a risk that pollution and flooding may occur due to the time it takes to attend these sites and to reset them.

5.16 We want to understand and develop this into a power resilience programme in the future. Our understanding of risk was too immature for inclusion in this DWMP and, as a result, we have deferred this activity to DWMP cycle 2.

5.17 Please refer to the Resilience Technical Appendix for more details.

6 Building a best value assessment framework

Progress

6.1 A best value plan is defined within the regulatory guidelines for water resources planning and is described as one that, "*considers factors alongside economic cost and seeks to achieve an outcome that increases the overall benefit to customers, the wider environment and society*"[11]. We have utilised this approach, as described in this section, in developing both our draft and final DWMP.

6.2 A best value approach therefore differs from a cost-benefit analysis in that it considers a broader range of factors, rather than just cost and monetised benefit. Some wider benefit factors cannot be easily monetised, for example natural capital, biodiversity enhancement and wellbeing, hence the best value assessment is based on a benefit scoring system. The selection of a best value plan takes into consideration many competing factors, opinions and influences (for example, encompassing technical, environmental, social and economic aspects).

6.3 By measuring the relative priorities of all factors (or criteria) that our customers and stakeholders value, these can be incorporated into the decision-making process, enabling a balanced plan to be created that provides acceptable 'trade-offs' between competing priorities.

6.4 For a balanced plan to be devised at the programme appraisal stage, a comprehensive assessment framework has been developed. This uses 'value criteria', representing the DWMP planning objectives, to assess the performance of each option, with additional criteria representing broader environmental impact from which we can then determine the best value plan.

6.5 The framework enables the data captured during ODA stage to be efficiently incorporated into programme appraisal activities. The structured approach is aligned with best practice[12] and provides transparency of decisions made and confidence in the robustness of the process taken.

6.6 Figure 6-1 below shows the steps we have taken in deriving a best value plan (in accordance with the WRMP guidelines)[13].

[11] Water resources planning guideline - GOV.UK (www.gov.uk)
[12] https://ukwir.org/eng/deriving-a-best-value-water-resources-management-plan
[13] Water resources planning guideline - GOV.UK (www.gov.uk)

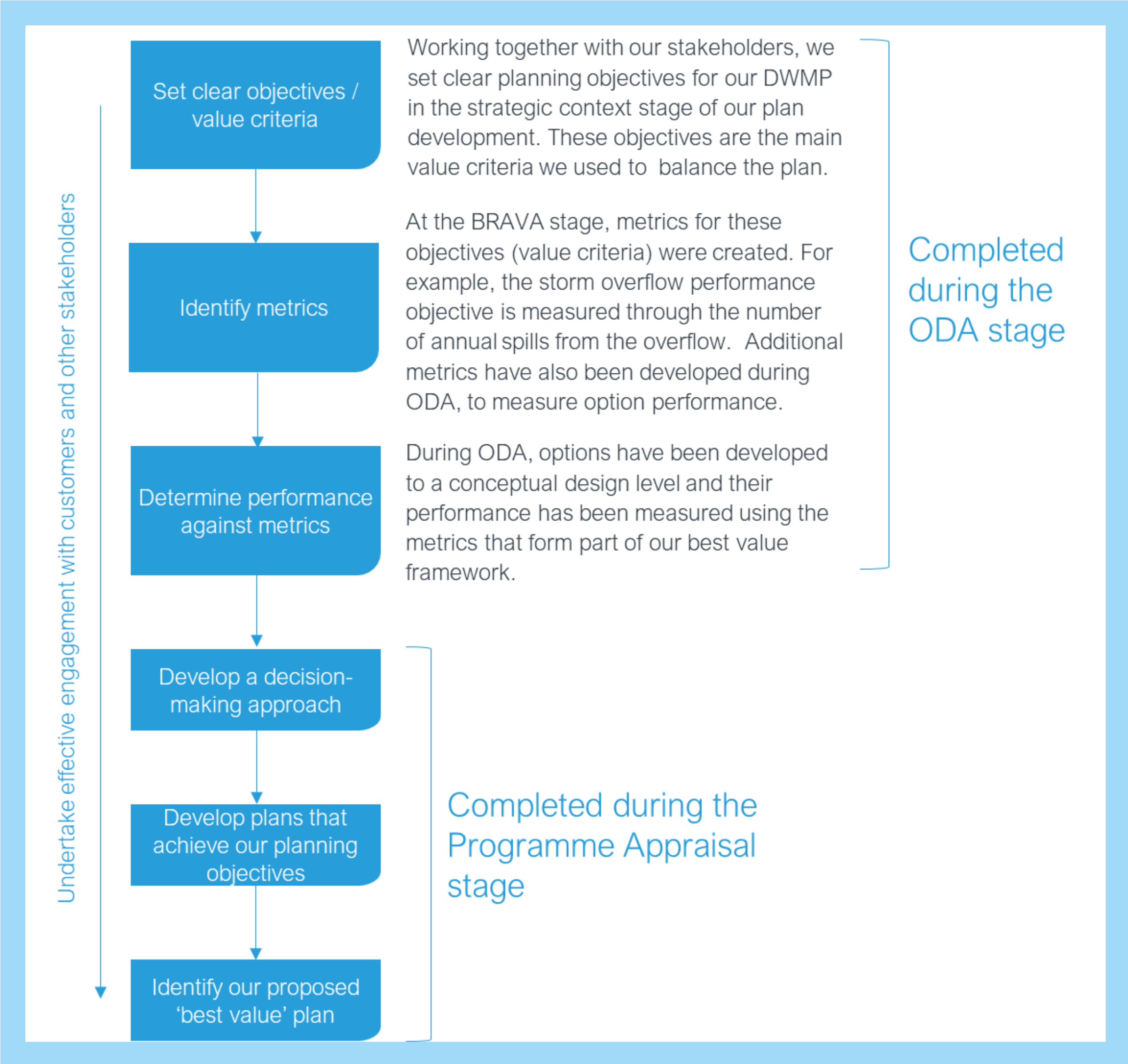


Figure 6-1 The steps we've taken when developing a best value plan

6.7 Figure 6-2 shows how the following metrics are aligned within our best value framework:

- Planning objectives defined at the strategic context stage of the DWMP
- The 'value criteria' used at programme appraisal stage
- Metrics that measure the performance of each option

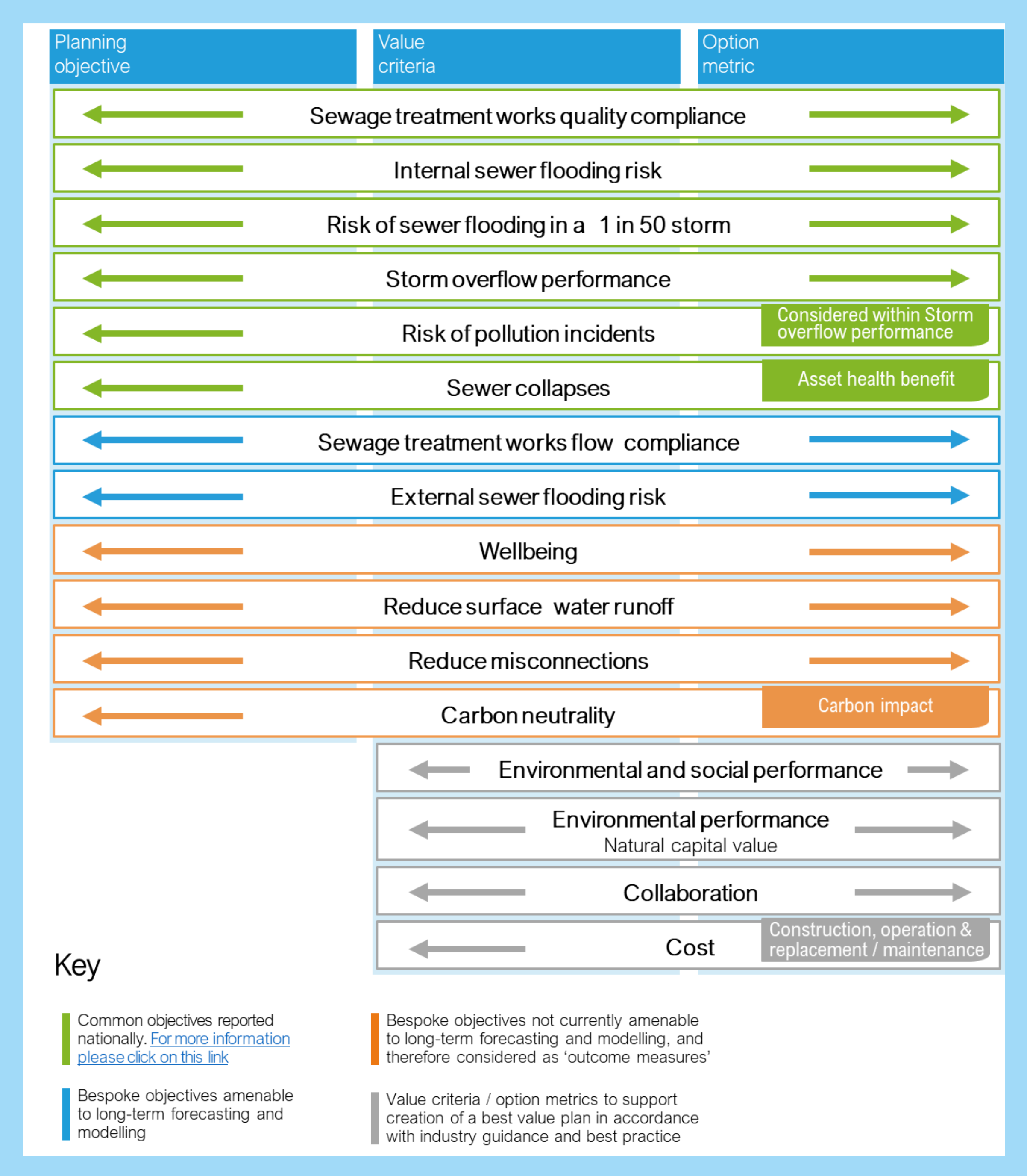


Figure 6-2 Alignment of metrics within our best value framework

6.8 The following sections describe each of the option metrics within our best value framework. The metrics have been used to measure the performance of options, to understand how options contribute to achievement of DWMP targets, as assigned to DWMP planning objectives.

Option performance measurement protocols for our planning objectives

6.9 Table 6-1 summarises how we measured option performance for each of the six common (national) and two bespoke planning objectives.

Planning objective (and option performance metric)	How we measure option performance
Risk of flooding in a 1 in 50 storm The risk of properties experiencing flooding in a storm that might be experienced once on every 50 years on average, equating to a 2% probability of the rainfall event occurring in any given year.	Modelled percentage of population at risk of flooding, in a 1 in 50-year rainfall event in 2020 (BRAVA baseline), 2035 and 2050.
Storm overflow performance The ability of the wastewater system (including Sewage Treatment Works (STW)) to operate in storm conditions with an acceptable frequency of overflow to the environment.	Modelled annual average frequency of discharge (number of events) from storm overflows using forecast rainfall data in 2020 (BRAVA baseline) and 2050. Results extrapolated to assess 2035 performance. Observed spill data from our event-duration monitors (EDM) is used where available to reflect the actual overflow discharge performance.
Sewage treatment works quality compliance The ability of STWs to treat and dispose of sewage in line with the current discharge permit quality conditions.	Modelled STW compliance against current permit quality conditions in 2020 (baseline) and in 5 year increments up to 2050[1].
Internal sewer flooding risk The risk of properties flooding internally from our sewers.	Modelled based on internal escape locations in a 1 in 30-year event in 2020 (BRAVA baseline), 2035 and 2050.
Risk of pollution incidents The risk of polluting discharges to the environment (classed as Category 1 to 3 by the Environment Agency) arising from either network or STW sites.	Risk of pollution incidents arises from multiple factors, and many are outside scope of this DWMP. For our first DWMP, we've prioritised the scope to focus on three future pressures: climate change, population growth and urban creep. In relation to this planning objective, the aspect considered is pollution risk arising from increase spill frequency and volume from storm overflows, due to the future pressures listed. This is indirectly measured through the storm overflow performance planning objective (reducing frequency of spill to protect river quality) and maintaining compliance with our permits at STWs.
Sewer collapses The risk of a sewer collapsing so that its ability to convey wastewater is compromised, specifically defined as the number of sewer collapses.	Risk of sewer collapse arises from to multiple factors, the majority of which are outside scope of this DWMP. As stated above, we've prioritised the scope to focus on three future pressures: climate change, population growth and urban creep. Options to address these future pressures (as expressed through other planning objectives) have been assessed to consider whether they will offer benefit or

Planning objective (and option performance metric)	How we measure option performance
	not to overall asset health, which would reduce sewer collapse risk.
Sewage treatment works (STW) flow compliance The ability of STWs to treat and dispose of sewage in line with the current discharge permit dry weather flow (DWF) conditions.	Modelled STW compliance against current DWF permit conditions in 2020 (baseline) and in 5 year increments up to 2050[2].
External sewer flooding risk The risk of sewer flooding to gardens and other land within the property boundary.	Modelled based on external escape locations in a 1 in 30-year event in 2020 (BRAVA baseline), 2035 and 2050.
1 Where quality permits were revised due to forecast dry weather flow permit exceedance, the new permit quality conditions were used for modelling. 2 If DWF was forecasted to be exceeded within the design horizon (2050), the permit revision was included in options and STW flow was modelled on this revised flow.	

Table 6-1 Our planning objectives and how we measure option performance against them

Option performance measurement protocols for additional option metrics

6.10 Table 6-2 summarises how we measured option performance for our additional option metrics.

Option performance metric	How we measure option performance
Environmental and social performance[1] The potential of the option to provide beneficial or adverse impacts on the existing and future environment, and to the communities we serve.	Options have been scored based on the baseline environmental designated sites in the vicinity of the option geographical boundary, and the impacts of the option(s) selected to meet the performance targets.
Environmental and social performance (natural capital) The potential of the option to provide beneficial or adverse impacts on the existing and future natural capital.	Options have been scored based on the baseline natural capital within the option geographical boundary, and the impacts of the option(s) selected to meet the performance targets. Where natural capital is created the effective ‘green area’ is used to scale the metric.
Wellbeing The potential of the option to provide beneficial or adverse impacts on population and human health.	Options have been scored based on the baseline environmental factors in the vicinity of the option geographical boundary that influence population and human health, and the impacts of the option(s) selected to meet the performance targets.

Option performance metric	How we measure option performance
Collaboration The potential of the option to generate opportunities to collaborate with other stakeholders.	Options have been scored, with reference to a standardised scale, based on the collaboration potential they offer.
Reduce surface water runoff The potential of the option to reduce the volume and/or flowrate of surface water run-off into our combined and surface water sewer networks, to levels equivalent to runoff from greenfield areas.	Modelled based on measurement of the extent of surface water runoff removed/ attenuated, as defined within the scope of options to address planning objective targets.
Reduce misconnections The potential of the option to reduce the number of misconnections of surface water entering our foul sewer network, or vice-versa (foul water entering surface water networks).	Foul misconnection to surface water networks: options have been assessed to consider whether they will offer benefit or not to reducing misconnections. Surface water misconnections to foul networks: modelled based on measurement of the extent of surface water runoff removed/ attenuated, as defined within the scope of options to address planning objective targets.
1. We measured the environmental impacts of options according to the framework of topics considered within an Environmental Assessment.	

Table 6-2 Additional option metrics and how we measure option performance against them

6.11 Our methodology enabled these aspects to be scored or evaluated, to support the relative comparison of options as part of a multi-criteria decision analysis undertaken at programme appraisal stage.

6.12 The following sections expand on the summary table above, providing further detail on how we measure our option performance against the additional metrics.

Assessing environmental and social impact

6.13 The environmental and social performance of each option has been assessed to identify the potential impacts on DWMP objectives. This has included a full Environmental Assessment and Habitats Regulation Assessment which are provided as separate Technical Appendices.

6.14 A benefit (positive) score and a dis-benefit (adverse) score has been determined for each option.

6.15 The environmental performance of options has been determined by using a framework of 11 criteria considered within the Strategic Environmental Assessment as detailed in Table 6-3.

6.16 The environmental and natural capital sensitivities of each catchment within our region have been assessed, as well as the magnitude of impact for each proposed option type in each. This allows us to understand the relative significance of the impacts across our region.

6.17 Our assessment process has been undertaken at an appropriate level to the definition of options. This assessment can be updated as options are progressed, and further details are defined.

Data collation and review

6.18 A review of the plans and policies of relevance to the DWMP, baseline information and other assessments related to the water industry was undertaken. From this we derived a series of environmental and social indicators for the assessment that are in line with latest best practice in Strategic Environmental Assessments. These are shown in Table 6-3.

6.19 Spatial environmental datasets were then collated and reviewed to provide the inputs for the environmental baseline. These are also shown in Table 6-3.

Indicator	Objective	Environmental datasets used to form environmental baseline
Biodiversity	To protect and enhance biodiversity, ecological functions, capacity, and habitat connectivity within water company's operating area	Local Nature Reserves, National Nature Reserves, National Forest Inventory, OS Open Green Space, Priority Habitat Risk Scores, Ramsar Sites, RSPB Reserves, Special Areas of Conservation, Special Protection Areas, Sites of Special Scientific Interest, Priority Habitats
Community health and wellbeing	To strengthen the connections between people and nature and realise the value of biodiversity	Urban Areas, Country Parks, Open Access Land, Hospital, Noise Important Areas, schools, sports facilities, noise maps, public paths, public transport, relevant census data, Public Right of Ways
Population and human health	To improve human health and well-being of the area, improve access to recreation and the environment, and reduce inequalities	
Water quality and resources	To maintain or improve the quality of rivers, lakes, groundwater, estuarine and coastal waterbodies	Surface water bodies, Water Framework Directive / River Basin Management Plan data, groundwater abstractions
Flood risk	To reduce and manage flood risk	Flood zones
Soil	To protect and enhance geology, the quality and quantity of soils and promote a catchment-wide approach to land management	Active and historical landfill sites, agricultural/urban land classification, mines and quarries, mineral resources, built-up areas
Material assets	To reduce, and make more efficient, the domestic, industrial and commercial consumption of resources, minimise the generation of waste, encourage its re-use and eliminate waste sent to landfill	
Air and climate	To reduce air pollutant and greenhouse gas emissions	Air Quality Management Areas (also links to some of the biodiversity datasets, e.g., Special Protection Areas, Ramsar Sites), Flood Alert Areas, Flood Warning Areas, communities at risk
Infrastructure	To adapt and improve resilience to the threats of climate change	Healthcare facilities, emergency services, waste and recycling, utilities, road network, rail network, electricity network, water treatment works, sewage treatment works
Cultural heritage	To conserve and enhance the historic environment, the heritage assets therein and their setting	Areas of Significant Archaeological Interest, Areas of Archaeological Potential, Grade I, II, II* Listed Buildings, Registered Battlefields, Historic Parks and Gardens, sites and monuments, known archaeological sites, Conservation Areas, Defence Heritage Records, industrial heritage, Historic Environment Scheduled Zones, World Heritage Sites
Landscape	To protect, enhance the quality of, and improve access to designated and undesignated landscapes, townscapes and the countryside	Landscape and Seascape Character areas, Areas of Outstanding Natural Beauty

Table 6-3 Environmental and social indicators used in our assessments and environmental datasets used to form environmental baseline

Conceptualisation

6.20 A GIS model was used to interrogate the option boundaries and the suite of environmental datasets. Due to the level of design development our option boundaries are typically the same as our catchment boundaries. An example is shown below.

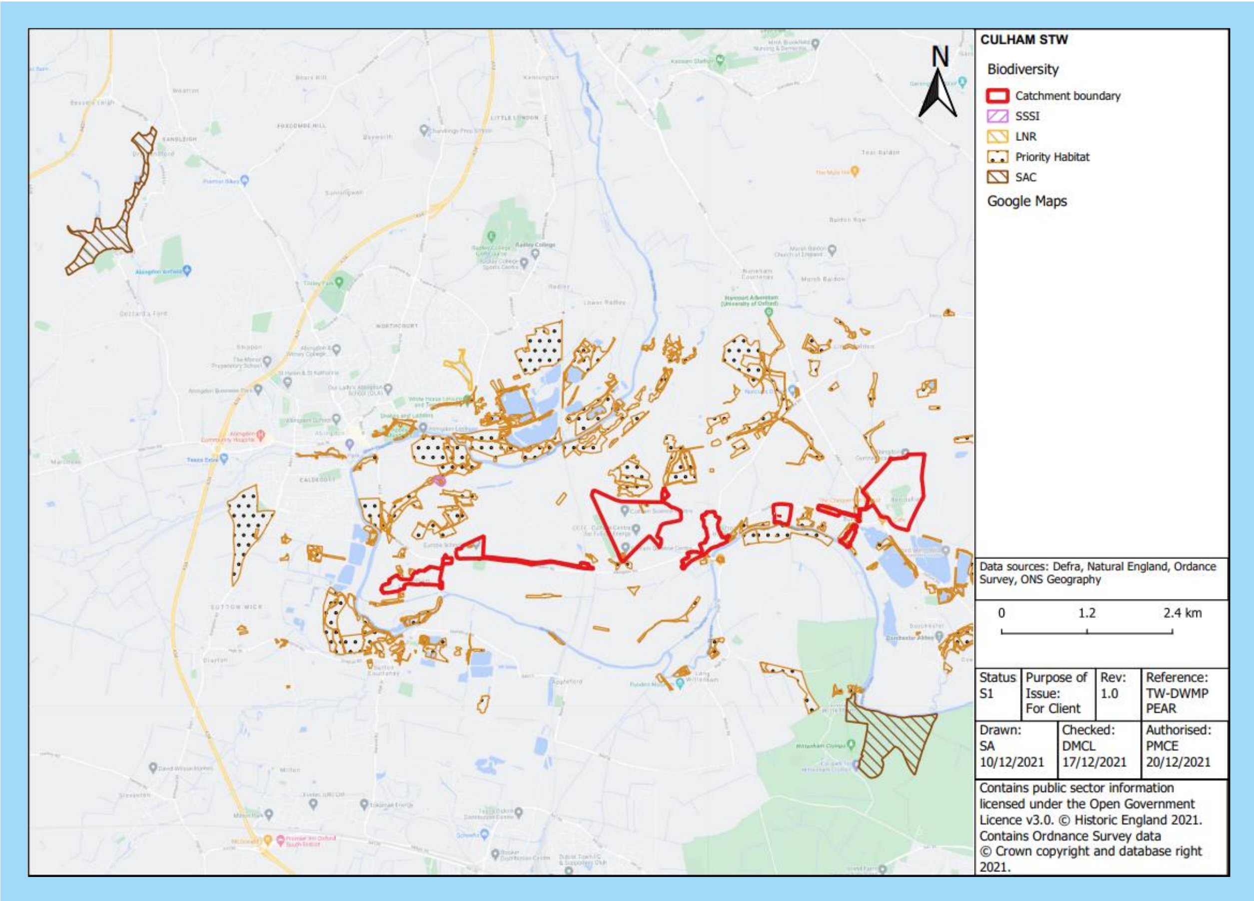


Figure 6-3 Example of GIS model output for biodiversity

Catchment	Biodiversity	Community Health and Wellbeing	Population and human health	Material assets	Water quality and resources		Flood risk	Soil	Air and climate	Infrastructure	Cultural heritage	Landscape
A	Med	High	Low	Med	Med		Med	Med	Med	Low	Low	High
B	Med	Med	Low	Med	Med		Med	Med	High	Low	Low	Low

Table 6-4 Example of the identified sensitivity of environmental and social indicators

6.21 The magnitude of positive benefit and negative adverse impacts that may arise from each option were considered, including typical construction impact and mitigations considered at design, construction and during operation. Five levels of magnitude (high, medium, low, negligible and neutral) were used to assess each option type.

Valuation

6.22 Scores were derived to represent the likely significance of impact of each option by combining the location sensitivity for each environmental indicator and the option impact as shown in Table 6-5 and Table 6-6. This provides a relative scoring of both benefit and adverse impacts respectively: the two elements should not be added together.

Location sensitivity	Option significance of impact									
	High		Medium		Low		Negligible		Neutral	
	Beneficial	Adverse	Beneficial	Adverse	Beneficial	Adverse	Beneficial	Adverse	Beneficial	Adverse
High	+3	-3	+2	-2	+2	-2	+1 / 0	-1 / 0	0	0
Medium	+2	-2	+1	-1	+1	-1	0	0	0	0
Low	+1	-1	+1	-1	0	0	0	0	0	0
Note 1. Where the same type of option is proposed in different locations, differences in the sensitivity of the location result in different impact scores. Note 2. When different option types are being compared at the same location, differences in the impact of the option result in different significance of impact scores.										

Table 6-5 Relationship between the sensitivity of the location and the significance of the impact

	Significance of effect						
	Major beneficial	Moderate beneficial	Slight beneficial	Neutral / negligible	Slight adverse	Moderate adverse	Strong adverse
Score[1]	+3	+2	+1	0	-1	-2	-3
1. Utilised for embedding environmental performance in ODA and programme appraisal stages							

Table 6-6 Overall significance of the environmental and/or social impact

6.23 We then applied this significance of impact score to each environmental and social indicator for each option type utilised across every catchment. Each individual beneficial score (per environmental indicator) was then summated, giving an overall beneficial score per option. Similarly, each individual adverse score (per environmental indicator) was also summated, giving an overall adverse score per option.

Natural capital assessment

6.24 A natural capital indicator highlights the potential ecosystem services and benefits that could be provided by an option (or benefits that might be lost). Natural capital refers to the elements of the natural environment that have value to society by generating “ecosystem services” which benefit people, such as by purifying water, storing carbon and regulating air quality.

6.25 The natural capital impact of each option has been assessed with a benefit (positive) score and a dis-benefit (adverse) score determined for each option.

6.26 The natural capital assessment has been determined using Natural England's Natural Capital Atlas[14] to qualitatively score the benefits/disbenefits for seven key ecosystem services in relation to each option:

- natural hazard regulation (flooding)
- water regulation (provisioning, relevant to drought)
- water purification
- climate regulation (carbon storage and sequestration)
- biodiversity and habitat
- air quality regulation
- recreation and amenity

6.27 The Natural England Natural Capital Atlas valuation was used to determine a baseline indicator score for each catchment.

6.28 Each generic sub-option type was then assessed for benefit (positive) and disbenefit (adverse) natural capital impacts such as flooding, water quality, carbon storage and sequestration, biodiversity and habitat and air quality.

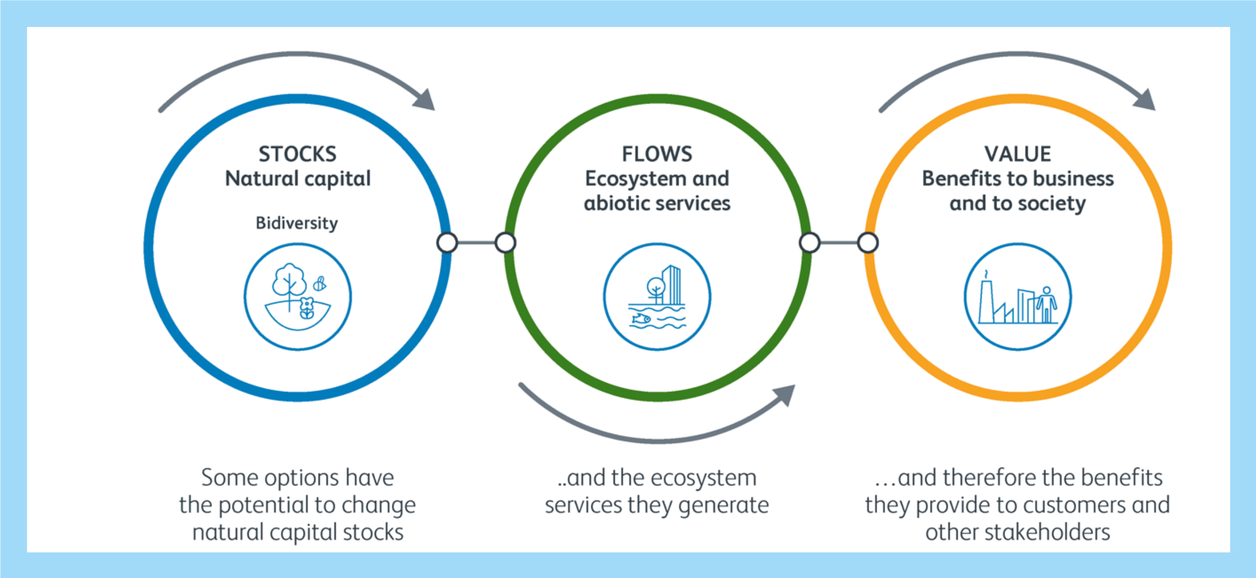


Figure 6-4 Natural capital benefits through ecosystem services

[14] https://publications.naturalengland.org.uk/publication/6672365834731520

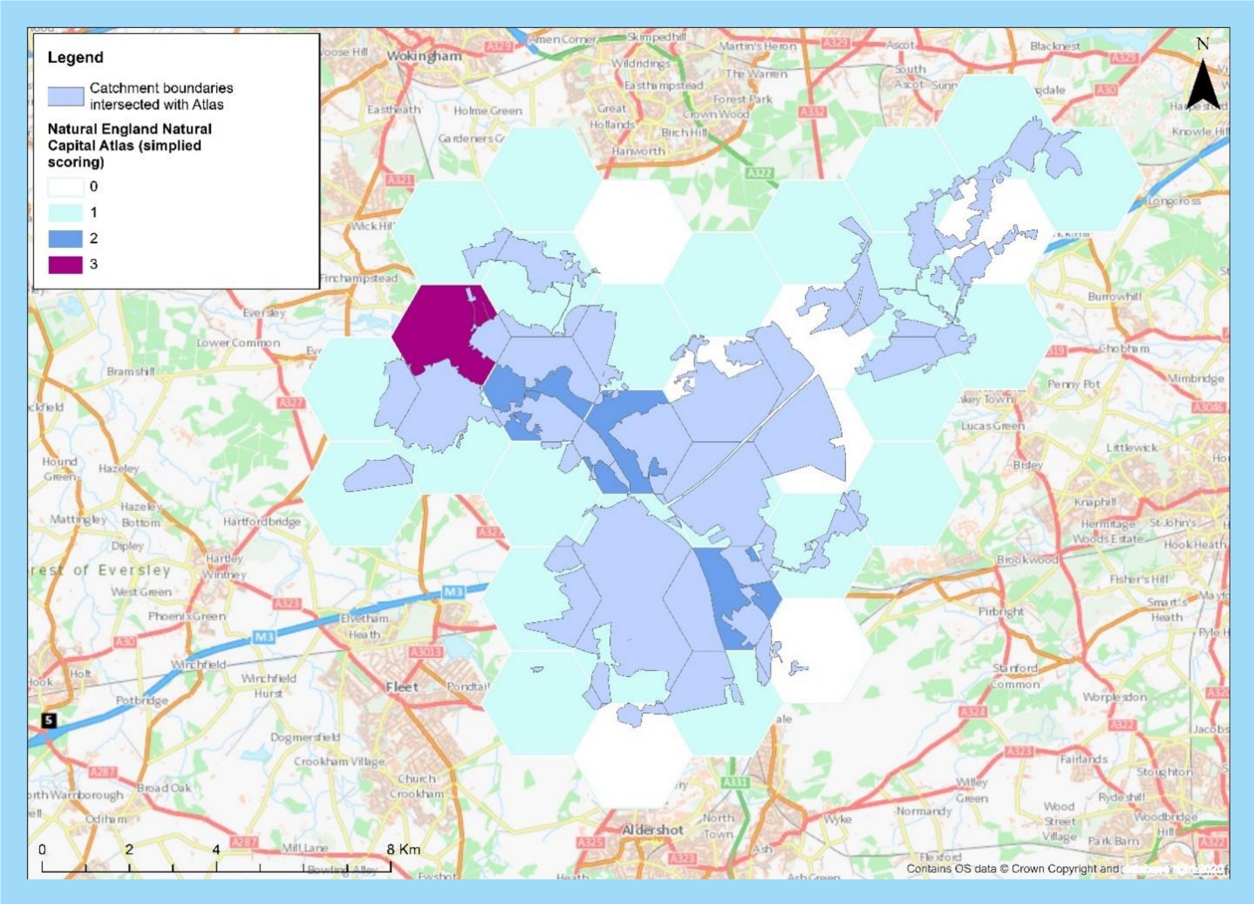


Figure 6-5 Example of natural capital mapping within a catchment

6.29 The natural capital indicator score for an option is the product of the baseline indicator and option impact.

6.30 Where an option has the potential to enhance natural capital through the creation of green infrastructure, the effective 'green area' created has been estimated. This has been used to scale the overall metric score as a simple multiplier. This formally recognises and prioritises green infrastructure options or options that provide green infrastructure benefits.

Wellbeing

6.31 A specific wellbeing score was developed, to represent the option impact on population and human health. This indicator follows the same principles of the environmental performance indicator and considered factors such as improving human health and well-being of the area, improving access to recreation and the environment, and reducing inequalities. Datasets used in the assessment included: the locations of urban areas, country parks, opens access land, hospitals, schools, sports facilities and noise important areas (Figure 6-6).

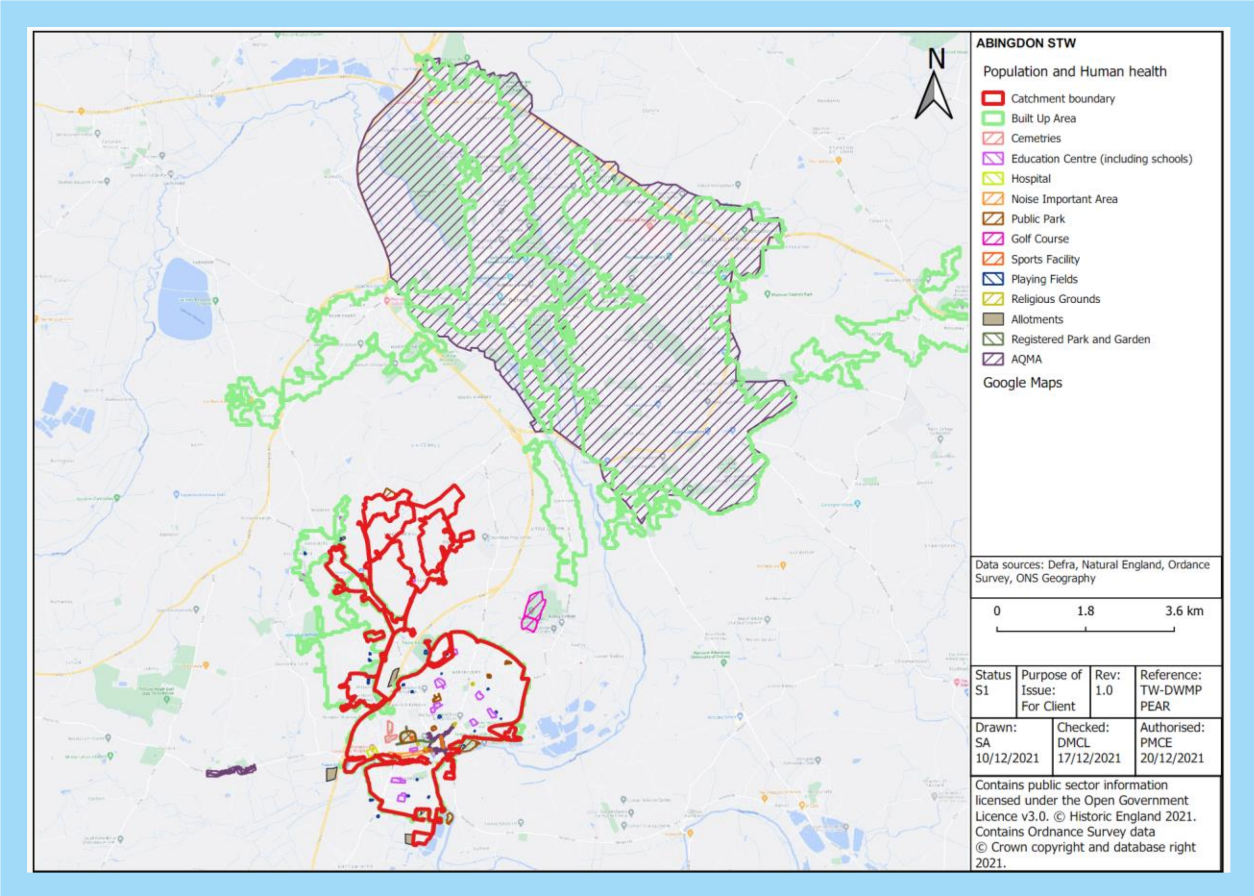


Figure 6-6 Example of GIS model output for wellbeing

6.32 As with other environmental indicators, a significance of impact score was derived from the associated location sensitivity and the option magnitude for each option type utilised across each catchment. The maximum individual score was then used as the wellbeing indicator.

6.33 For example, an option that creates additional green space through retrofitting SuDS has the potential to provide physical and mental health benefits by creating attractive and accessible areas for recreation and physical activity. In contrast, an option such as increasing sewer capacity by installing larger sewers would provide limited benefits to health and wellbeing, other than serving its primary purpose to safely remove wastewater.

Collaboration

6.34 Table 6-7 summarises how we measured option performance in terms of the potential of the option to generate opportunities to collaborate with other stakeholders.

Collaboration score	Description
0	Negligible/limited potential for option to be developed or delivered in collaboration with others.
1	Option could potentially be developed and/or delivered in collaboration with others:

Collaboration score	Description
	• When considering the potential to address multiple benefits across a number of stakeholders (due to the nature of the problems addressed and/or the option being developed) • And/or option cannot be delivered solely using our existing powers
2	Option could potentially be developed and/or delivered in collaboration with others - stakeholders have been identified and/or previous engagement has established collaborative practices that can be repeated / built upon.
3	Stakeholders are actively engaging to progress a collaborative approach to developing and/or delivering the option.
4	Stakeholders have committed to working collaboratively to develop and/or deliver the option.

Table 6-7 Approach to measuring potential for collaboration opportunities

6.35 Each of our options was assigned a score based on the descriptions shown in Table 6-7, considering:

- Our evidence base of stakeholder issues as identified during the BRAVA stage
- Our identification of potential partnership opportunities established through our engagement during the DWMP process
- The type of option being considered. For example, nature-based solutions provide opportunities for collaboration, while some of our network interventions do not.

Reduce surface water runoff

6.36 For network options, the conceptual design provided the basis for an assessment of the proposed number of hectares of surface area:

- Disconnected from the combined and/or surface water sewer system, and/or
- From which flows are attenuated by installing SuDS

6.37 This was modelled in detail across all of our London catchments, using our computational hydraulic models.

6.38 For catchments outside London, we undertook an assessment of the potential for surface water management techniques such as SuDS to contribute to our long-term targets. We modelled options in detail across our eight London catchments and extrapolated the findings from this analysis to other catchments.

6.39 Our analysis concluded that by 2035, on average, surface water management techniques such as SuDS could comprise 10% of all investment to address future pressures. We estimate that this could increase to 30% by 2050. This assessment was, in turn, used to estimate the value for the 'reducing surface water' metric.

Reduce misconnections

6.40 This metric covers both reducing the number of misconnections of surface water entering our foul sewer network and misconnections of foul water entering surface water networks.

6.41 Where option proposed to remove/attenuate surface water flows entering our foul sewer network, our measurement of this option is as described for reducing surface water runoff (as detailed in the previous section).

6.42 Options have been assessed to consider whether they will offer benefit or not to reducing foul misconnections to surface water networks.

Asset health

6.43 As outlined in Table 6-1, options have been assessed to consider whether they will offer benefit or not to overall asset health, which would, for example, reduce sewer collapse risk. Table 6-8 summarises how we measured option performance in terms of the potential of options to prolonging asset life (i.e., contributing to 'asset health').

Asset health score	Description
0	Negligible/limited potential for option contribute to asset health. For example: • Property level protection to stop flooding – no benefit to existing assets • New permits at STWs • Additional storage that does not impact on the performance of existing assets And/or: option is likely to contribute to asset health, but option scope is of a scale to only impact a negligible/small proportion of the assets within the catchment / at the STW: For example, SuDS options applied to less than 10% of the impermeable area within a catchment.
1	Option is likely to contribute to asset health, but option scope is of a scale to only impact a relatively minor proportion of the assets within the catchment / at the STW. For example: • SuDS options applied up to 30% of the impermeable area within a catchment (SuDS reduces the demand placed on existing assets as flowrates are reduced) • Replace or expand existing process units at the STW
2	Option is likely to contribute to asset health, and option scope is of a sufficient scale to have an impact on a significant proportion of the assets within the catchment / at the STW. For example: SuDS options applied to over 30% of the impermeable area within a catchment.
3	Option directly contributes to asset health (for example, through replacement of existing assets), but option scope is of a scale to only impact a relatively minor proportion of the assets within the catchment / at the STW.
4	Option directly contributes to asset health, and option scope is of a sufficient scale to have an impact on a significant proportion of the assets within the catchment / at the STW. For example: • Sewer lining (improving the structural integrity of sewers) to all sewers at risk of significant infiltration rates • New STW replacing existing assets

Table 6-8 Approach to measuring potential for improving asset health

6.44 Each of our options was assigned a score based on the descriptions shown in Table 6-8, considering the scope of the conceptual design, as completed following option development.

Costing options and assessing carbon impact

6.45 The conceptual design provided the basis for a cost assessment where we used a combination of our Engineering Estimation System (EES) and bottom-up costing (using market rates for new technologies) where costs were not present in EES. Costs have been developed for construction, operation and replacement / capital maintenance over the plan period reflecting asset life.

6.46 Options have been costed using our EES and reflecting a cost base at 2020/21 (consistent with regularity guidance from Ofwat). EES costs include assessment of option uncertainties based on the level of design maturity / confidence we have at this stage. We have explored this further in the Risk & Uncertainty Technical Appendix.

6.47 Costs within our EES are subject to routine review and updating to reflect current outturn cost data, and ongoing data and process quality assurance.

6.48 Table 6-9 provides an overview of the costing approach for the main option types developed during the ODA stage.

Option type	Costing approach[1]
Sewer lining to target infiltration hotspots	EES cost models available and utilised
Increase storage capacity at our STW to address storm overflow risks	
Increase network capacity by installing larger sewers	
Increase treatment intensity at existing STWs	
Expand existing STWs	
Source control SuDS	Cost models not currently included in EES – requiring bottom-up costing using market rates
Property-level protection to stop buildings from flooding	Unit cost approach per property based on the level of protection to be provided and cost information from previous implementation examples
1. The conceptual design (from feasible option development) provided the basis for an assessment of cost	

Table 6-9 Costing approach for the main option types developed during the ODA stage

6.49 The carbon impact of each option has also been quantified (identifying carbon dioxide equivalents (tC02e)), again using carbon models present within EES and bottom-up assessments where carbon models were not available in EES.

7 Setting ambitious targets for our planning objectives

Progress

7.1 Our outputs from the BRAVA stage of the DWMP identify our current "baseline" performance and how that performance would deteriorate in the long-term, due to climate change, development and population growth. The next step in the process was to define the performance our customers and stakeholders expect us to achieve in the long-term (our 'targets'), so that we could develop options to address the gap between forecast and target future performance.

7.2 For those planning objectives amenable to long-term forecasting and modelling (when considering the future pressures considered within the scope of the DWMP), a range of planning objective targets were set during the ODA stage, to understand the range of costs and benefits of options required to achieve them.

7.3 Reflecting the very different historical conditions and the nature of the systems that have been developed over the last century, we have different challenges and therefore different targets for our London catchments, compared to those outside London. Our London networks are comprised of a mixture of combined and separate networks, while our catchments outside London are predominantly separate. The highly developed London catchments present numerous option deliverability challenges, such as congested utilities and lack of free space, when considering ambitious targets.

7.4 For planning objectives relating to sewage treatment works compliance, only one target has been set: to achieve compliance across all permit conditions (dry weather flow, suspended solids, biochemical oxygen demand and ammonia) over the plan period to 2050. To ensure that future compliance risks are managed, we set more onerous performance targets than required by our permits. As specified in our internal standards, these targets are 80% for quality parameters, and 90% for Dry Weather Flow (DWF) permit values, which provides performance headroom based on industry best practice. For example, for an ammonia permit value of 2 mg/l in the final effluent, we would aim to achieve 1.6 mg/l (80%) which provides better water quality than required by the permit.

7.5 Ambitious targets for our DWMP have been set following engagement with stakeholders. We presented the planning objectives targets to our stakeholders during the workshops held in May 2021 (see section 4 for more details of the workshops).

7.6 During the consultation on our draft DWMP, new legislation - the Environment Act - came into force and Government published the Storm Overflows Discharge Reduction Plan[2] imposing new obligations on water companies relating to performance targets for storm overflow discharges. We have reflected these in revised targets for our final plan (Table 7-1 and Table 7-2).

Planning objective	Maintain current performance target			ODA target		
	2030	2035	2050	2030	2035	2050
Internal sewer flooding risk	Maintain baseline (2025) level of performance			Glidepath baseline (2025) level of performance to 2035 target	No greater than 1.5% of properties at risk per zone	
External sewer flooding risk					No greater than 3% of properties at risk per zone	
Risk of flooding in a 1 in 50 storm					No greater than 7.6% of properties at risk per zone	
Storm overflow performance	Compliance with our obligations under the Environment Act and the Storm Overflows Discharge Reduction Plan[2] Specifically, <=10 discharges in a typical year (as a proxy for no environmental harm[3]), with <=3 discharges in a typical year for discharges to designated bathing water sites.					
Sewage treatment works quality compliance	Not applicable			100%	100%	100%
Sewage treatment works flow compliance				100%	100%	100%
Note 1. For our large London catchments, we assessed options and targets across smaller areas (risk zones) to ensure assessment was undertaken at an appropriate spatial extent, recognising hydraulically discrete areas and variations in performance. Note 2. Our 2035 and 2050 flooding targets (percentage of properties at risk) ensure that current performance is at least maintained in all risk areas. Areas where there is currently the greatest predicted sewer property flooding risk benefit from improved performance in the future. Note 3. Our plan is based on achieving the 'backstop' target of no more than10 discharges, and in parallel there is also a programme of investigations and monitoring to confirm whether or not 10 discharges per year will be sufficient to demonstrate that there is no local adverse ecological impact. If this is not the case, then further improvements will be made to avoid discharges causing ecological harm.						

Table 7-1 London catchments – ODA planning objective targets

Planning objective	Maintain current performance target			ODA target		
	2030	2035	2050	2030	2035	2050
Internal sewer flooding risk	Maintain baseline (2025) level of performance			50% reduction[1]	75% reduction[1]	100% reduction[1,2]
External sewer flooding risk				25% reduction[1]	50% reduction[1]	100% reduction[1,2]
Risk of flooding in a 1 in 50 storm				50% reduction[1]	75% reduction[1]	100% reduction[1,3]

Planning objective	Maintain current performance target			ODA target		
	2030	2035	2050	2030	2035	2050
Storm overflow performance	Compliance with our obligations under the Environment Act and the Storm Overflows Discharge Reduction Plan[2].. Specifically, <=10 discharges in a typical year (as a proxy for no environmental harm[4]), with <=3 discharges in a typical year for discharges to designated bathing water sites.					
Sewage treatment works quality compliance	Not applicable			100%	100%	100%
Sewage treatment works flow compliance				100%	100%	100%

Note 1. Reduction from baseline (2025 level of performance).

Note 2. Achieving the target for 'risk of flooding in a 1 in 50 storm' will also achieve internal and external flooding targets.

Note 3. Stop property flooding up to a one in 50-year storm event where possible.

Note 4. Our plan is based on achieving the 'backstop' target of no more than 10 discharges, and in parallel there is also a programme of investigations and monitoring to confirm whether or not 10 discharges per year will be sufficient to demonstrate that there is no local adverse ecological impact. If this is not the case, then further improvements will be made to avoid discharges causing ecological harm.

Table 7-2 Catchments outside London – ODA planning objective targets

7.7 During our public consultation we asked respondents which planning objective targets they would like to see in our fDWMP and in our next DWMP (cycle 2). The level of response is summarised in Figure 7-1. Specific feedback included:

- More scope for granularity in how targets have been applied inside and outside of London
- Inclusion of groundwater quality as a risk/planning objective
- Consideration of more extreme 1 in 100-year storm events

Figure 7-1 Number of stakeholders who provided suggestions for planning objective targets

7.8 This has provided us with a number of new ideas for how we could set out planning objectives, ranging from changing thresholds and targets we have set ourselves, through to recommendations of new targets. We have begun to review potential changes to planning objectives for the next cycle of our DWMP. We have done this by collating the suggestions for planning objectives and, subject to the regulator's requirements, will be working with our stakeholders throughout cycle 2 to further develop these.

7.9 It is highlighted that Water UK defined six common planning objectives for all water companies in cycle 1 of their DWMPs, against which catchment constraints are to be assessed and options developed[15]. The risk of sewer flooding in a 1 in 50-year storm is one of these objectives. However, acknowledging the feedback to the consultation but also that extending protection from a 1 in 50-year to a 1 in 100-year event is not simple, we will explore the impact on options and costs of planning for more extreme events, such as a 1 in 100-year flood event, as part of our cycle 2 planning (refer to Response to July 2021 Floods Technical Appendix).

7.10 Further details of our approach to groundwater quality is provided in Groundwater Quality Technical Appendix.

[15] BRAVA planning objectives for the first cycle of DWMPs, Water UK, 29 July 2020

8 Unconstrained/constrained option development and screening

Progress

8.1 The next step in the process was to assess the unconstrained and constrained list of generic sub-options, to further screen out those that would perform poorly when addressing our long-term objectives. This step resulted in the creation of a catchment specific set of sub-options to take forward for detailed assessment during the feasible option development stage.

8.2 This task was a qualitative assessment undertaken by our experienced system planners, who have an in-depth knowledge of the challenges faced and risks within individual catchments. Together with consideration of the views and priorities expressed by our stakeholders and customers, this enabled informed decisions to be made as to which options to progress to the feasible option development stage.

Reconciling catchments from completion of BRAVA to commencement of ODA

8.3 On completion of the BRAVA process in 2020, we identified 293 catchments at risk. These were reviewed prior to commencing the optioneering phase which resulted in the removal of 21 catchments (outside London) where the review of the BRAVA and problem characterisation assessments provided confidence that the scale and complexity of the risks identified were sufficiently low such that no interventions were warranted at this point and as with all other catchments would be subject to ongoing 'monitor and review'. Three of the six risk areas within our Beckton catchment were similarly reassigned as subject to ongoing 'monitor and review', the three remaining risk areas progressing to ODA.

8.4 BRAVA is an iterative process and as we learnt more, our risk assessments changed in some of our catchments. This resulted in some catchments being removed and new ones included, resulting in a total of 273 catchments being progressed through ODA, through the main phase in 2021.

8.5 Of the 273 catchments assessed at the ODA main phase:

- 16 had BRAVA risks associated with sewage treatment works performance
- 134 had BRAVA risks associated with the performance of our networks
- 123 had BRAVA risks associated with both networks and sewage treatment works performance

8.6 Additional catchments and associated solutions were subsequently added in response to feedback to our public consultation, regulator feedback and legislative changes on the draft DWMP as discussed in section 5.

Screening to a feasible option list

Unconstrained option development and screening

8.7 Initially, the unconstrained list of options was reviewed against the planning objective risks identified from the BRAVA stage, to screen out options that would not offer any benefit to the risks in the catchment, considering the following questions:

- What level of benefit could the option be expected to offer to the planning objective risks that need to be addressed?
  > For example, where no flooding risks had been identified, then property level protection measures can be discounted
- Will other options be required to fully meet the need presented by the planning objective?

8.8 The output of this process was the identification of a wide range of options appropriate to address all identified material risks in the catchment including compliance at the sewage treatment works.

8.9 The identified options were taken forward for further consideration/development with information based on catchment specific constraints. This information was subsequently used to inform the unconstrained to constrained screening process. Typical catchment specific considerations and constraints are listed below:

- The type of network present which might preclude selection of some option types
  > For example, where the network comprises of a separate system, with foul sewers conveying wastewater to STWs and surface water draining to soakaways, options that relate to separation of combined systems can be discounted
- Other characteristics of the catchment which may preclude selection of some option types
  > For example, the re-creation of historical rivers to convey surface water is an option type that could be considered for London (historically, many London rivers have been culverted or have become part of the wastewater network)

Constrained option development and screening

8.10 We then considered the options in more detail, to screen out those options deemed undeliverable due to the identification of a 'showstopper' constraint, following a more developed and detailed understanding of the local impacts and further option development work providing, where applicable:

- A greater understanding of the catchment characteristics to determine potential implementation constraints
- An initial view of the scope required to implement an option
- A more catchment-relevant understanding of the scale at which an option can be implemented

8.11 Options were assessed against their ability to meet the needs against each planning objective (value criteria). Providing there were sufficient alternative options to meet the identified planning objective needs, options were screened out where they were assessed as high cost compared to direct benefits and/or, in comparison to other options, or where the environmental/social impact were significant compared to marginal changes in cost.

8.12 The remaining options were reviewed considering the following key screening themes:

- Deliverability - does the option remain technically feasible and implementable noting any location specific constraints (e.g., land availability, infrastructure suitability, ground conditions)?
- Environment - are the potential/likely effects of the option on the environment considered mitigatable and/or acceptable noting any location specific constraints
- Resilience - is there an acceptable likelihood of the option providing sufficient future resilience e.g., climate change, growth, black-sky events, given location specific constraints?
- Promotability - does the option comply with policy requirements local to the area over which it will be implemented, e.g., does the option give rise to an acceptable risk of it obtaining planning approval? Are customers, regulators and stakeholders likely to accept the option when considering the area over which it will be implemented?
- Social - are potential effects of the option on our customers and their communities considered acceptable, when considering the area over which it will be implemented?

8.13 For our London catchments, the screening decisions and supporting rationale were recorded in detailed technical documentation that formed the basis for progression to feasible option development.

8.14 Table 8-1 provides examples of our screening frameworks applied to our London catchments.

8.15 For our catchments outside London, a more streamlined approach was taken that moved from the unconstrained to feasible options list in a one-pass assessment. This approach complies with the DWMP Framework (appendix D, section D.3.1.3)[16], which allows for a proportional approach to screening, by-passing steps in screening where the scale of the planning problem does not warrant more detailed assessment.

8.16 Table 8-2 provides an example of a screening framework applied to catchments outside London.

8.17 For catchments outside London, when considering options that impact on the performance of our network, we have grouped the majority of interventions for our first DWMP as one 'reference option' (in accordance with the DWMP Framework)[16]. This represents the broad type of work we may need to undertake to maintain and/or improve the network.

8.18 The reference option captures a blend of investment in nature-based options such as SuDS and more traditional options (for example, providing additional capacity through upsized

[16] https://www.water.org.uk/wp-content/uploads/2020/01/Water_UK_DWMP_Framework_Appendices_September-2019-D.pdf

sewers or storage tanks), as required, for example, to increase resilience and address storm overflow pollution risks.

8.19 Where groundwater ingress has been identified as impacting on our network performance, we have also selected options to manage infiltration into the network (for example, sewer lining and manhole sealing).

Option type	Screening rationale	Selected?
Source control SuDS	It is necessary to slow flows to the network in order to increase capacity. Opportunities are in and around industrial areas including Ealing Hospital and large business centres. This risk zone is urbanised with pockets of high industry e.g., Great Western Industrial Park/ Greenford Green Business Park. Areas of Alperton are undergoing redevelopment and so there should be a realised betterment of source control SuDS measures.	Yes
Increase network capacity by installing larger sewers	Lack of capacity is a significant problem in this risk zone. This option should also consider upsizing pumping stations; this will assist with achieving a reduction in storm overflow spills. Although this area is urbanised there are large pockets of open space that can be utilised. The Brent Valley Trunk Sewer runs through this risk zone and presents an opportunity for creating larger scale capacity in the network.	Yes
Use parks and urban spaces to store excess surface water during rainfall events	Modelled flood risk is dispersed across the zone. A number of public and private parks and open spaces are distributed across the risk zone such as Horsenden Hill Rec, Perivale Park, Warren Farm, Ealing Common, and Osterley Park, as well as numerous golf courses representing potential opportunities to implement this option via partnership working. There are multiple smaller parks creating dispersed opportunities to address the dispersed nature of the modelled flood risk. Partnership working and community engagement will be essential as parks and open spaces may be designated, protected and/or highly valued spaces by the community and would require full investigation into the practicality and viability of this option.	Yes
"Intelligent" sewer network to control flows	There are already existing underground attenuation tanks in this risk zone where capacity issues are known to exist. Converting these tanks to become “intelligent” would enable better utilisation of their existing capacity without the need to carry out disruptive and costly capital works to increase their capacity.	Yes
1. For clarity, not all option types considered are presented in the table.		

Table 8-1 Example of a screening framework (London catchment), constrained to feasible option selection

Option type	Screening rationale			
		Catchment A		Catchment B
Sewer lining to target infiltration hotspots		Catchment is a high-priority area to reduce infiltration - groundwater infiltration has been identified as impacting on our network performance		Potential to assist with DWF compliance - medium risk infiltration system
Reference option - source control SuDS and network enhancements		Selected as it is likely that infiltration reduction alone will not address planning objective needs		Option selected - represents the broad type of work we may need to undertake to maintain and/or improve the network
Combined sewer separation. Construct new surface water sewers.		Not applicable as catchment is served by a separate network (foul sewers and surface water to soakaways)		Not applicable as catchment is served by a separate network (foul sewers and surface water to soakaways)
Deep tunnel(s) to connect surface water to major reuse or discharge location(s)		No surface water system in general – discharge is to soakaways		No surface water system in general – discharge is to soakaways
Property-level protection to stop buildings from flooding		There are clusters of one or two properties at risk of internal flooding		Properties at risk of internal flooding are present in clusters greater than two - no peripheral (isolated) properties
"Intelligent" sewer network to control flows		No available capacity present to mobilise effectively (small network)		No available capacity present to mobilise effectively (small network)
Transfer flow between catchments via existing or new connections		No existing connections, creation of new transfers not suitable due to distance to next catchment		No existing connections, creation of new transfers not suitable due to distance to next catchment and lack of available capacity
Increase storage capacity at our STW to address storm overflow risks		Selected to address storm overflow performance risk identified from BRAVA		No storm overflow present at STW.
Increase treatment intensity at existing STWs		From site assessment, space is available to extend current capacity on site. Option selected to enable this. Infiltration reduction in the network will help.		DWF exceedance at Baseline (2025) - use this as intervention date. Modelled Capacity (process)(MCAP) and Ammonia (AmmN) achieve 75% of permit in 2025 - use this as intervention date. Exceedance in 2030.

Option type	Screening rationale	
	Catchment A	Catchment B
		Additional land available on site for expansion: Option D3.0 selected
Buy land and expand STW (effluent and sludge treatment)	Not applicable - sufficient land available	Not applicable - sufficient land available
General comment – screening rationale	Requirement for the site to be odour neutral with respect to additional assets. Groundwater infiltration issues in the catchment so there may be opportunities to reline sewer network that will provide benefit to the flows arriving at the STW. Currently applying to increase DWF limits and issue a new permit. There would also potentially be a tightening of quality limits as part of any change to DWF.	Go to Green scheme output for AMP7 has a design horizon of 2026 therefore BRAVA risks will not be impacted beyond 2026. Requirement for the site to be odour neutral with respect to additional assets. Two surface aerators utilised during peak in transient visitors to catchment – existing process cannot deal with demand.

1 For clarity, not all option types considered are presented in the table.

Key	
(very light blue)	Option selected for progression to feasible option development
(light blue)	Option to be progressed to feasible option development, if other options do not achieve planning objective targets
(dark blue)	Option not selected for progression to feasible option development

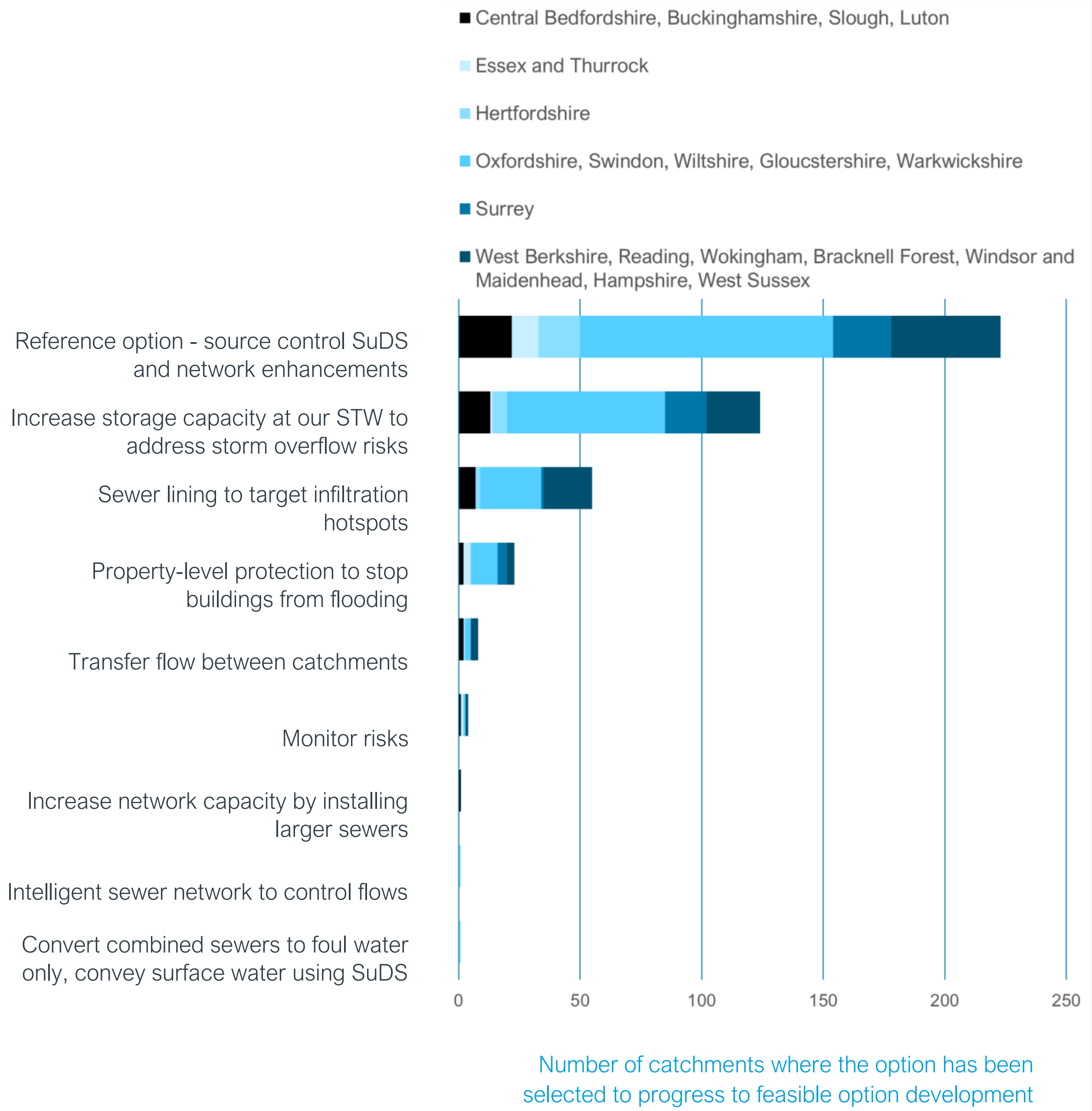
Table 8-2 Example of a screening framework (catchments outside London), unconstrained to feasible option selection

Options selected for feasible option development

8.20 The following tables provide a summary of the output of the screening steps, showing the options selected for progression to feasible option development.

8.21 As described in section 4, the views expressed by our stakeholders and the outcomes of our customer engagement, were considered when developing options and deciding which options to take forward and incorporate into our DWMP.

L2 Thames Regional Flood and Coastal Committee sub-committee[1]



1. Our ODA is built up at three geographical levels: catchments that are served by our STWs (L3), Thames Regional Flood and Coastal Committee (TFRCC) sub-committee (L2) and overall region wide (L1).

Figure 8-1 Network options selected for feasible option development (catchments outside London)

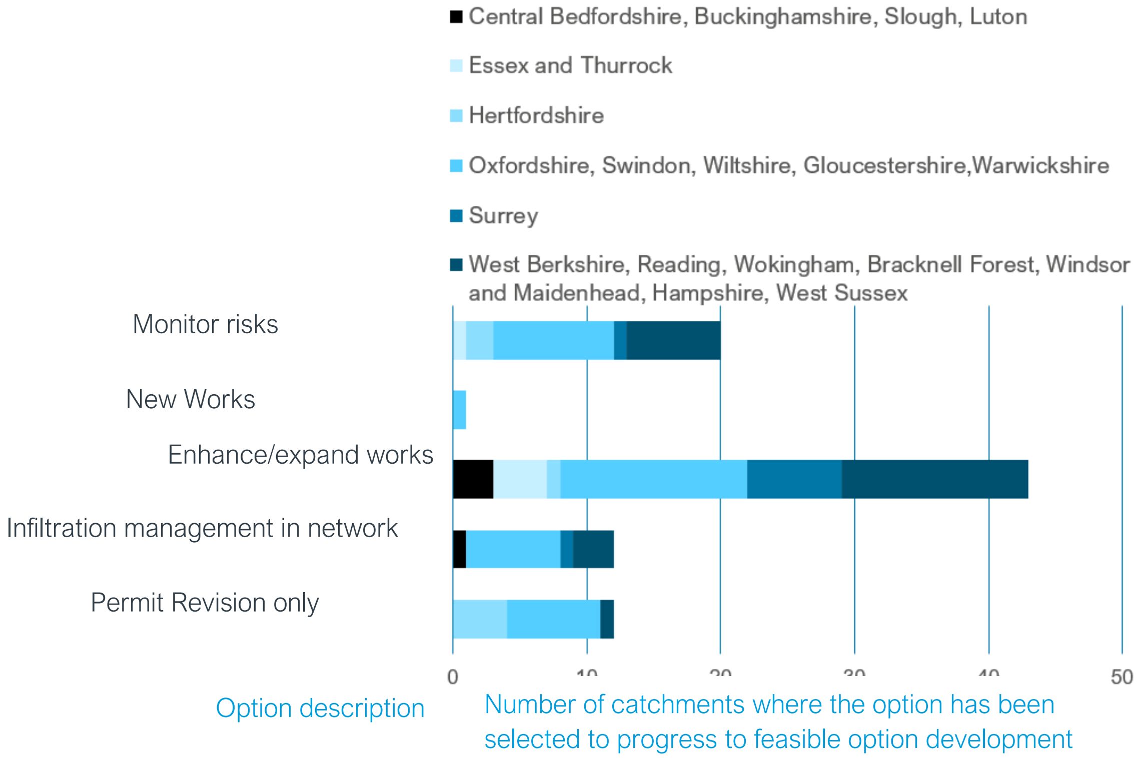


Figure 8-2 Sewage treatment works options selected for feasible option development (catchments outside London)

Beckton	Beddington	Crossness	Deephams	Hogsmill	Long Reach	Mogden	Riverside
STW enhancement/ expansion	STW enhancement/ expansion	STW enhancement/ expansion	No options required	STW enhancement/ expansion	STW enhancement/ expansion	STW enhancement/ expansion	STW enhancement/ expansion
					Construct new/additional STWs	Construct new advanced WwTW- Hydes Field	
						Wild card option - Iver South STW mixed liquors alternative discharge location	

Table 8-3 Treatment options selected (in priority order) for feasible option development (London catchments)

8.22 As described in section 4, feasible network options for our eight London catchments were prioritised based on feedback gathered during stakeholder workshops. In general, stakeholders prioritised source control SuDS measures over options that sought to enhance network capacity.

Priority	Beckton	Beddington	Crossness	Deephams	Hogsmill	Long Reach	Mogden	Riverside
1	Source control SuDS	Source control SuDS	Source control SuDS	Convert combined sewers to foul water only, convey surface water using SuDS	Source control SuDS	Source control SuDS	Source control SuDS	Source control SuDS
2	Increase network capacity by installing larger sewers	Sewer lining to target infiltration hotspots	Combined sewer separation. Construct new surface water sewers	Source control SuDS	Increase network capacity by installing larger sewers	Sewer lining to target infiltration hotspots	Increase network capacity by installing larger sewers	Sewer lining to target infiltration hotspots
3	Wild card option New STW at Luxborough Lane Barking town centre surface water disconnection	Deep tank(s) and tunnel(s) to store wastewater	Convert combined sewers to surface water, construct foul water sewers	Transfer flow between catchments	Deep tank(s) and tunnel(s) to store wastewater	Construct new/additional STWs	Deep tunnel(s) to connect surface water to major reuse or discharge location(s)	Wild card option - trunk sewer realignment to improve gradients
4	Disconnect surface water systems from combined sewers & discharge to watercourse	Increase network capacity by installing larger sewers	Increase network capacity by installing larger sewers	Property-level protection to stop buildings from flooding	Intelligent sewer network to control flows	Increase network capacity by installing larger sewers	Use parks and urban spaces to store excess surface water during rainfall events	Property-level protection to stop buildings from flooding
5	Combined sewer separation, construct surface water sewers	Transfer flow between catchments	Property-level protection to stop buildings from flooding		Property-level protection to stop buildings from flooding	Transfer flow between catchments	Wild card option - Iver South STW mixed liquors alternative discharge location	
6	Re-create historical rivers to convey surface water	Intelligent sewer network to control flows			Wild card option - major upgrade to inlet pumping station at Hogsmill STW	Property-level protection to prevent buildings from flooding	Intelligent sewer network to control flows	
7	Convert combined sewers to surface water, construct foul water sewers	Wild card option - Surrey County Council schemes (Caterham Bourne & Caterham on the Hill)					Combined sewer separation, construct surface water sewers	
8	Property-level protection to stop buildings from flooding	Property-level protection to stop buildings from flooding					Convert combined sewers to surface water, construct foul water sewers	
9							Transfer flow between catchments	
10							Property-level protection to stop buildings from flooding	

1 Options are aggregated priorities per catchment based on stakeholder views expressed at a lower level of granularity

Table 8-4 Network options selected for feasible option development (London catchments)

8.23 The DWMP options set the overall required 'direction of travel' for the catchment if long-term objectives are to be achieved. While some options have not been selected for assessment for inclusion in the DWMP strategic plan, this does not preclude selection to address localised issues at a later date (if, for example, risks are considered at a more granular level than required for our strategic plan, and/or more information is available to assess the risks).

Preparing for feasible option development

8.24 Prior to commencement of feasible option development, an evaluation exercise was undertaken to confirm the scope of option development to be undertaken within each catchment, following inspection of the inputs to the ODA process. In parallel, we reviewed and updated data and modelling tools, where required, to reflect the ODA baseline conditions for the DWMP.

8.25 For example, where improvements to the capacity of our network or sewage treatment works were planned for implementation before 2025 (the start year for our DWMP), and they were assessed to have a significant benefit to risks identified at the BRAVA stage of the DWMP, data and modelling tools were updated accordingly.

8.26 Listed below are the key activities undertaken prior to commencing feasible option development:

- Review of option scope definition arising from:
  - Previous steps in the DWMP process, or
  - Previous investigations undertaken prior to commencement of the DWMP process
- Review of BRAVA outputs and findings
- Review of existing asset capacity and performance
- Update of data and modelling tools where improvements to the capacity of our network or sewage treatment works were planned for implementation before 2025, and they were assessed to have a significant impact on risks identified at the BRAVA stage of the DWMP
- Determine the extent of feasible option development required, based on the reviews undertaken

9 Developing feasible options to achieve our planning objective targets

Progress

9.1 The previous sections describe the process whereby the generic options were screened, progressing through unconstrained/constrained option listings, to arrive at a feasible option list for each catchment progressed during the ODA stage.

9.2 We presented the results of the screening exercises to our stakeholders over the course of four workshops held in May 2021 (see section 4), from which there was a consensus on the options to be taken forward. The workshop outputs were used to inform the scope of the detailed feasible option development stage we undertook between May and September 2021.

9.3 Options from the feasible list have been taken through the ODA process to assess key metrics (costs and benefits) as described in section 6. We developed a conceptual design which provided a consistent, high-level option definition to ensure a basis for comparable assessment of option performance metrics.

9.4 When developing options to achieve planning objective targets that relate to the performance of our networks, various combinations of the planning objective targets were considered. This provided flexibility during the programme appraisal stage to consider multiple alternative plans, covering a wide and varied range of performance across our catchments.

9.5 The conceptual design of options was developed to a level at which the broad elements of each option could be defined for performance metrics to be assessed (Table 6-1 and Table 6-2). The output from this stage is used in programme appraisal to identify the preferred programme of options to meet DWMP outcomes (in accordance with section D.3.5. of the DWMP Framework)[17].

9.6 Option development was undertaken at a much higher, concept level of design compared to outline and detailed design stages; these stages will be progressed as potential delivery schemes are confirmed. The concept design and associated impacts (positive and negative) will be enhanced as more detail becomes available through future iterations of the DWMP.

9.7 When comparing catchments inside and outside of London, there are differences in the:

- Targets set at ODA stage
- Blend of options selected for feasible option development

[17] https://www.water.org.uk/wp-content/uploads/2020/01/Water_UK_DWMP_Framework_Appendices_September-2019-D.pdf

- Extent and complexity of the risks arising from BRAVA (as described in section 9.36)

9.8 Approaches to option development progressed in recognition of these differences.

9.9 As options were developed and metrics defined during the feasible option development step, this highlighted that some options would not provide the best means of achieving the planning objectives. These options were not progressed further (i.e., they were not included in the ODA outputs progressing to programme appraisal) on the grounds of some or all of the following:

- Excessive cost
- Adverse environmental impact that cannot be mitigated
- Detailed assessment identifying that the option will not address planning objective targets

9.10 This resulted in a feasible set of options taken forward to programme appraisal (in accordance with Figure 2-3).

9.11 In some catchments, options that were originally selected for feasible option development were subsequently found not to be required as other options and/or committed improvements before 2025 achieve the planning objective targets.

9.12 The above issues are further detailed in Table 9-1 and Table 9-4.

Use of hydraulic models when developing feasible options

9.13 We used our suite of network hydraulic models to develop network options to achieve our planning objective targets. Over many years we have developed and maintained an extensive portfolio of hydraulic models, covering all of our major towns and cities.

9.14 Our models are built and calibrated in accordance with the Code of Practice for the Hydraulic Modelling of Urban Drainage Systems[18], as published by the Chartered Institution of Water and Environmental Management (CIWEM) Urban Drainage Group (UDG). Models of our major towns and cities are built to a standard (defined as Type II within the Code of Practice) that is appropriate for planning purposes such as DWMP assessments. There are areas within our models that are built and verified to a more detailed level (Type III), being suitable for detailed design purposes.

9.15 Our models are built using asset data gathered from surveys (such as manhole, CCTV and impermeable area surveys) or captured within our historical records (for example, within our corporate geographical information system). We calibrate our models by matching their performance to recorded observations taken from our networks (for example, from permanent or short-term flow monitors and rain gauges). We also take into consideration other factors that influence our network performance, such as soil saturation and river levels.

[18] Ciwem udg code of practice for the hydraulic modelling of urban drainage SYSTEMS 2017

9.16 Our use of hydraulic models accords with the expectations set in the DWMP Framework ('…hydraulic models will be the primary tools required to understand the impacts on the network and its associated components')[19].

9.17 To further support the DWMP and to gain a wider understanding of our asset base for other planning purposes, we extended our model coverage to include all catchments we serve, no matter how small. We completed a model build exercise in these catchments, enabling BRAVA to be fully based on model assessments. We also utilised these models when developing our ODA outputs, ensuring our analysis included a representative sample of all catchments, in terms of size, location and problems to be addressed (see section 9.39). For the second cycle of our DWMP we will enhance these models so that they are built and calibrated to a standard similar to that of our major towns and cities.

9.18 We constantly improve our models, focusing on areas where performance risks have been identified. Increasing computational power enables us to further increase the complexity of our modelled representations of our systems. In addition to enhancing our 'small' catchment models, to support the second cycle of our DWMP we have identified some specific areas where we will enhance our models, to consolidate our knowledge of network performance:

- Improve the modelled representation of predicted flooding, by incorporating 2D overland flow routing into our models
- Extend our modelled coverage of surface water networks – to increase confidence in our plans for surface water management

Developing network options for our catchments in London

9.19 Within our strategic London networks an integrated, hierarchical approach was taken when assessing the options required to achieve the targets as defined in Table 7-1. This recognised that, at a strategic scale, flooding targets cannot be considered in isolation from storm overflow performance:

- Firstly, options were developed to achieve storm overflow performance targets
- Secondly, where required, the scope of the option was increased to achieve internal sewer flooding targets
- Thirdly, where required, the scope of the option was increased to achieve external sewer flooding targets
- Lastly, where required, the scope of the option was increased to achieve targets associated with the 'risk of flooding in a 1 in 50 storm' planning objective

9.20 We used our hydraulic models of each of our London catchments to develop a conceptual design.

9.21 Options to address the targets were developed using a systematic, prioritised approach as detailed in Table 8-4. For example, if after assessing that the maximum feasible extent of SuDS implementation (our highest priority option type) would not achieve storm overflow performance targets, we increased the scope of the option to include the next priority option type. This continued until the targets were achieved for all planning objectives. Therefore,

[19] Water_UK_DWMP_Framework_Appendices_September-2019-C.pdf

numerous types of options, with varying degrees of extent/scope, were developed and combined to address the planning objective(s) as listed above.

9.22 Targets to ‘maintain current performance’ were applied to two risk zones (Greenwich and Merton) within our Crossness catchment. In these areas, future performance was forecast to be better than the targets defined in Table 7-1. Therefore, we developed options to maintain current performance to 2050, to ensure that the effects of population growth, climate change and urban creep, which will all increase flood risk without intervention, is at least mitigated.

9.23 Table 9-1 highlights the options that required feasible option development, to meet planning objective targets.

Priority	Beckton	Beddington	Crossness	Deephams	Hogsmill	Long Reach	Mogden	Riverside
1	Source control SuDS	Source control SuDS	Source control SuDS	Convert combined sewers to foul water only, convey surface water using SuDS	Source control SuDS	Source control SuDS	Source control SuDS	Source control SuDS
2	Increase network capacity by installing larger sewers	Sewer lining to target infiltration hotspots	Combined sewer separation. Construct new surface water sewers	Source control SuDS	Increase network capacity by installing larger sewers	Sewer lining to target infiltration hotspots	Increase network capacity by installing larger sewers	Sewer lining to target infiltration hotspots
3	Wild card option New STW at Luxborough Lane [1] Barking town centre surface water disconnection [2]	Deep tank(s) and tunnel(s) to store wastewater	Convert combined sewers to surface water, construct foul water sewers	Transfer flow between catchments	Deep tank(s) and tunnel(s) to store wastewater	Construct new/additional STWs	Deep tunnel(s) to connect surface water to major reuse or discharge location(s)	Wild card option - trunk sewer realignment to improve gradients
4	Disconnect surface water systems from combined sewers & discharge to watercourse	Increase network capacity by installing larger sewers	Increase network capacity by installing larger sewers	Property-level protection to stop buildings from flooding	Intelligent sewer network to control flows	Increase network capacity by installing larger sewers	Use parks and urban spaces to store excess surface water during rainfall events	Property-level protection to stop buildings from flooding
5	Combined sewer separation, construct surface water sewers	Transfer flow between catchments	Property-level protection to stop buildings from flooding		Property-level protection to stop buildings from flooding	Transfer flow between catchments	Wild card option - Iver South STW mixed liquors alternative discharge location [2]	
6	Re-create historical rivers to convey surface water	Intelligent sewer network to control flows			Wild card option - major upgrade to inlet pumping station at Hogsmill STW	Property-level protection to prevent buildings from flooding	Intelligent sewer network to control flows	
7	Convert combined sewers to surface water, construct foul water sewers	Wild card option - Surrey County Council schemes (Caterham Bourne & Caterham on the Hill) [2]				Deep tank(s) and tunnel(s) to store wastewater[2]	Combined sewer separation, construct surface water sewers	
8	Property-level protection to stop buildings from flooding	Property-level protection to stop buildings from flooding					Convert combined sewers to surface water, construct foul water sewers	
9							Transfer flow between catchments	
10							Property-level protection to stop buildings from flooding	

Note: Options are aggregated priorities per catchment based on stakeholder views expressed at a lower level of granularity

1 Wild card option offers localised improvements, but not of a sufficient scale to address DWMP long-term objectives

2 Option not originally selected for feasible option development; utilised to achieve planning objective targets

Key

Light blue	Option assessed during feasible development option stage to address planning objective targets
Dark blue	Option deemed not to offer best value (not viable due to excessive cost / inability to address planning objectives), next viable prioritised option used to address targets
Mid blue	Option not required as higher priority options address planning objective targets

Table 9-1 Feasible option development and appraisal summary for London catchments

Deephams catchment case study

9.24 Feedback to our consultation on the draft DWMP included some challenge for our justification of our option selection hierarchy, specifically our selection of nature-based surface water management options (such as SuDS) over more traditional network infrastructure (such as sewers) in our London catchments. As noted above, our option hierarchy was developed based in consultation with stakeholders.

9.25 To provide further evidence to support our approach, we undertook a comparative assessment of nature-based surface water management options (Option B1.2, targeted source control SuDS) with traditional network options (Option C3.1, increasing network capacity by installing larger sewers) for our Deephams catchment in London.

9.26 Our approach considered the same targets as met by the hierarchy of options set out in Table 9-1 above.

9.27 The intent for both the original options and reassessment was to achieve the internal and external flooding targets by modelling an overall option scope that results in the lowest construction cost. The approach therefore focused on options in areas with an overall greater number of internal and external properties at risk of flooding. However, due to the differing hydraulic performance associated with each option, the outcomes varied slightly, as summarised in Table 9-2.

Planning metric	Source control SuDS (B1.2)	installing larger sewers (C3.1)
Internal flooding	5,249	5,251
External flooding	10,285	9,486

Table 9-2 Deephams catchment case study – number of properties protected from flooding for different option types

9.28 A high-level comparison of the two options generated is given in Table 9-3. This shows that the construction costs of nature-based surface water management options are typically 70% of the equivalent traditional network infrastructure option. The environmental, natural capital and wellbeing benefits are also greater.

Option type	Construction cost £m	Quantity	Quantity unit
B1.2 surface water management	760.7	619	ha
C3.1 sewer upsize	1,100.0	163	km

Table 9-3 Deephams catchment case study – number of properties protected from flooding for different option types

9.29 Our case study therefore provides additional evidence to support our 'SuDS first' option selection and development approach for our fDWMP in London. Deephams is representative of large urban separately drained catchments in our area with challenges not as large as observed in central London.

Developing network options for our catchments outside of London

9.30 For catchments outside London, the reference option approach (see section 8) considered a blend of different types of options. The reference option captures a blend of investment in nature-based options such as SuDS and more traditional options, representing the broad type of work we may need to undertake to maintain and/or improve the network.

9.31 Therefore, prioritisation of different types of options was not required, except for catchments where groundwater infiltration has been identified as impacting on our network performance.

9.32 For these catchments, we have committed to implement Groundwater Impacted System Management Plans[20]. In line with these plans, options to manage infiltration into the network (for example, sewer lining and manhole sealing) were prioritised.

9.33 The reference option was then developed to achieve targets as defined in Table 7-2.

9.34 Compared to London, a greater number of combinations of targets were assessed. These included infiltration reduction only, storm overflow discharge reduction only, flooding only, and then permutations of these. This reflects the potential for greater flexibility in the order in which targets are addressed outside of London, due to the de-centralised nature of the networks.

9.35 Table 9-4 provides a summary that highlights catchments (outside London) where the original selected options were revised during the feasible option development and appraisal step. This table provides further data on why some options were discounted, as specifically requested by our regulators during the public consultation.

[20] Drainage Plans | Regulation | About us | Thames Water

Catchment	Convert combined sewers to foul water only, convey surface water using SuDS	Property-level protection to stop buildings from flooding	Increase network capacity by installing larger sewers	Reference option Source control SuDS and network enhancements	Transfer flow between catchments	Increase storage capacity at our STW to address storm overflow risks
ALTON						Blue
ASHAMPSTE				Light blue		
BANBURY						Blue
BERKHAMST						Blue
BICESTER						Blue
BRACKNELL						Blue
CAMBERLEY					Dark blue	
CHALGROVE					Dark blue	Blue
CULHAM					Dark blue	
ELSTEAD		Dark blue				
FLEET						Blue
GERRARDS					Dark blue	
HEADLEY		Dark blue				
HORLEY		Light blue				Blue
HORTON-		Dark blue				
IRONSBOTT				Light blue		
IVER					Dark blue	
MANUDEN				Light blue		
MAPLE	Dark blue			Light blue	Dark blue	
MARKYATE		Light blue				
NAUNTON				Light blue		
NEWBURY				Light blue		
SANDHURST					Dark blue	
SELBORNE		Dark blue				
SLOUGH			Light blue			Blue
STANTON ST		Dark blue		Light blue		
STONE		Dark blue		Light blue		
SULHAMSTE				Light blue		
THORNWOO		Dark blue				
TYLERS				Light blue		
WILLINGALE		Dark blue				
WISLEY		Dark blue				
WOKING						Blue
WOOLHAMP					Dark blue	

Key

Light blue	Option not originally selected for feasible option development; utilised to achieve planning objective targets (originally briefed options assessed as not fully meeting planning objective targets, additional option required)
Dark blue	Option originally selected for feasible option development but deemed not to offer best value (not viable due to excessive cost / adverse environmental impacts that cannot be mitigated / inability to address planning objectives)
Blue	Option originally selected for feasible option development but not required to achieve planning objective targets - other options and/or planned improvements before 2025 achieve storm overflow planning objective targets

Table 9-4 Feasible option development and appraisal - summary of revisions (catchments outside London)

9.36 For our catchments outside London, we undertook a review of the modelled forecast of property flood risk (as the reduced population density compared to London gave rise to greater uncertainty in modelled forecasts). We undertook a 'ground truthing' exercise by comparing existing modelled property flood risk against our historically recorded flooding incidents. Subsequently, we revised the existing modelled risk where there were differences.

9.37 The trend in forecast flood risk, as identified at BRAVA, was used to predict property flood risk for our planning horizons (2030, 2035 and 2050).

Proportionate option development

9.38 We focussed our efforts on catchments that have the highest risks and matter the most to our customers and stakeholders. Our proportionate approach is in accordance with the DWMP Framework[21]. For example, section D.3.1. of the Framework states that the '*level of detail/complexity associated with the ODA process adopted should be proportionate to the levels of risk identified…*'

9.39 Of the 249 catchments outside London assessed at ODA stage and having BRAVA risks associated with the performance of the network:

- 55 were investigated in detail, using our computerised hydraulic models of the network to develop a conceptual design
  > This included all of the large towns and cities that we serve, covering two thirds of our customers that reside in catchments outside London
  > Our selection ensured that there was a representative sample of catchments modelled (for example, in terms of size, location, problems to be addressed)
- 177 were assessed using a statistical approach (regression analysis)
  > This used the data obtained from the 55 catchments modelled in detail to derive functional relationships between BRAVA risks / planning objective targets to be achieved and the cost / option definition required to address them. These relationships were then used to determine option costs for the 177 catchments. Other option metrics were assessed based on a concept design definition as derived from the data
- Two catchments had BRAVA risks that were considered of insufficient significance to warrant development of detailed options to address them during this first DWMP
  > Pragmatically, the forecast risks will be monitored to assess whether they remain of low concern, or if this changes, when future action is required
- The remaining 15 catchments had planning objective targets to address relatively small numbers of property flooding risk; these were assessed on an individual basis, assigning unit costs for property level protection measures

9.40 Figure 9-1 summarises the option development approach undertaken across the 257 catchments assessed at ODA stage and having BRAVA risks associated with the performance of the network:

[21] https://www.water.org.uk/wp-content/uploads/2020/01/Water_UK_DWMP_Framework_Appendices_September-2019-D.pdf

Total Nr of catchments	Feasible option development approach
8	London catchments: investigated in detail, using our computerised hydraulic models of the network to develop a conceptual design
55	Catchments outside London: investigated in detail, again using our computerised hydraulic models of the network to develop a conceptual design[1]
177	Catchments outside London: assessed using a statistical approach (regression analysis)[2]
15	Catchments where planning objective targets addressed relatively small numbers of property flooding risk[3]
2	Catchments where BRAVA risks were considered of insufficient significance to warrant development of detailed options to address them during this first DWMP[4]

1 This included all of the large towns and cities that we serve, covering two thirds of our customers that reside in catchments outside London

2 This used the data obtained from the 55 catchments modelled in detail to derive functional relationships between BRAVA risks / planning objective targets to be achieved and the cost / option definition required to address them. These relationships were then used to determine option costs for the catchments. Other option metrics were assessed based on a concept design definition as derived from the data

3 These were assessed on an individual basis, assigning unit costs for property level protection measures

4 Pragmatically, the forecast risks will be monitored to assess whether they remain of low concern, or if this changes, when future action is required

Table 9-5 Feasible option development approach for network options (key to accompany Figure 8-1)

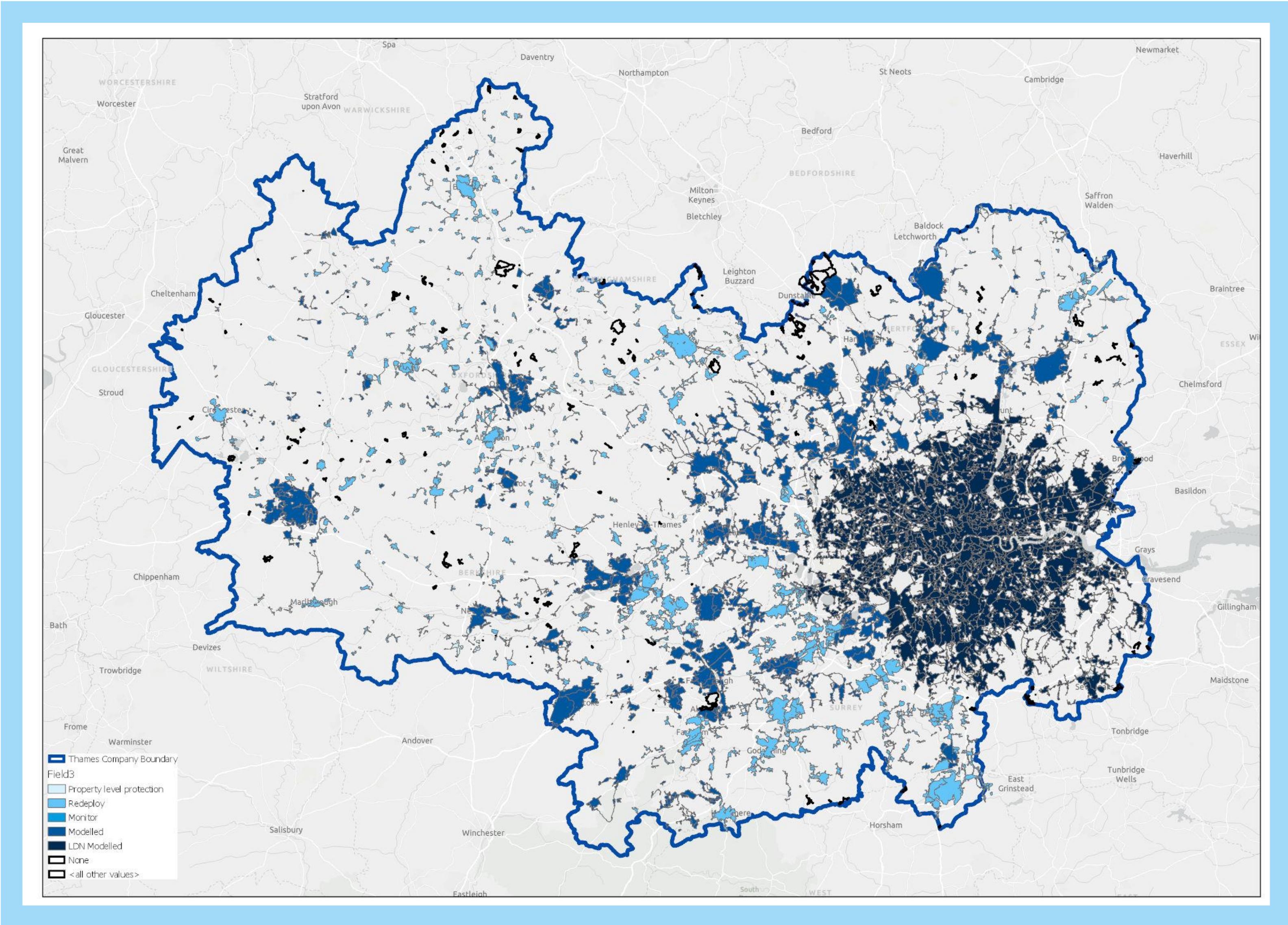


Figure 9-1 Feasible option development approach for network options

Aligning with our WINEP obligations

9.41 Aligning our DWMP with our WINEP storm overflow obligations has introduced additional solutions, such as managed wetlands/reedbeds within our plan. In some cases, this has resulted in a change in option type selection from the DWMP unconstrained/constrained option development to focus on the solutions generated from the WINEP programme. For example, to meet the legislative timescales for storm overflow discharge reduction an 'end-of-pipe' storage option has been selected rather than a catchment wide surface water management scheme.

9.42 Our DWMP incorporates the WINEP storm overflow derived solutions for our short-term plan (up to 2030).

9.43 Options to address the SODRP obligations in the medium and longer term have been based on the industry algorithm derived as part of the Storm Overflows Evidence Project (SOEP)[22] to estimate attenuation storage volumes[23]. We have derived options scopes and generated our option specific cost curves for all overflows in our region that had not previously been considered during ODA.

9.44 Aligning our plan with regulatory guidelines has meant implementing an increased pace of delivery and investment. This has an impact on the options that we will be using to deliver our plan; our project programmes will be delivering an increased number of 'end of pipe' solutions such as storm tanks rather than nature-based surface water management solutions. The benefit of this is that we will be implementing proven solutions which will enable us to meet the challenging targets set out in the WINEP guidance. We will still have the opportunity to further develop these solutions as our designs develop during cycle 2, informed by the investigations and monitoring that we will undertake in the next planning period.

9.45 Further details of our storm overflows discharge reduction plan can be found in the Storm Overflows Technical Appendix.

Developing sewage treatment works options

9.46 We undertook detailed modelling of sewage treatment works during the feasible optioneering stage to determine whether the catchment needed to progress further in the DWMP.

9.47 For our non-infrastructure assets, some catchments were not progressed further due to one of the following reasons:

- Detailed process modelling showed that the site has sufficient capacity to meet the treatment requirements of the planning horizon.
- Sites which had a DWF exceedance only were assessed to determine whether pending DWF permit revisions would resolve the issue. Calculations were made on the impact of this DWF permit revision (i.e., the works taking more flow) on the

[22] Storm overflows evidence project - GOV.UK (www.gov.uk)
[23] Storm Overflows Taskforce - GOV.UK (www.gov.uk)

site's ability to meet the final effluent quality. These calculations were made based on a worst-case scenario to provide confidence in treatment capacity.

- Where the catchment has a known infiltration management scheme in its network, the flow and load forecast for the STW was updated with new loads due to infiltration. In turn, capacity of the site was re-assessed and if found to be sufficient, then the site would not need to be progressed further in DWMP.
- STW improvement schemes currently underway were assessed to determine the impact on treatment capacity over the planning horizon. Where the current scheme provides the required treatment capacity, the site has not been progressed further in DWMP.

9.48 For STWs that required further development in the DWMP, the following approach was taken:

- If there was a functional and up to date existing Thames Water model for the site:
  > This was updated with latest flows and loads data and was used to assess compliance across the key water quality and loading metrics: AmmN, Biochemical Oxygen Demand (BOD), Suspended Solids (SS) and DWF.
  > Compliance was assessed over a 25-year period (2025-2050) in 5-year increments to identify implementation dates of options to coincide with AMP cycles.
  > Assets were added of the same type as existing (in accordance with our asset standards) until compliance was met.
  > Note that the order of priority for process modelling was to ensure assets were compliant with the asset standards first, then include any options that would be required to address any outstanding forecast permit exceedances (if any).
  > If thresholds in the asset standards were met, for example works over a certain size would require a process type change (from biofiltration to activated sludge), then the site would be remodelled using the bespoke DWMP process model (see below).
- If there wasn't a functional and up to date existing Thames Water model for the site:
  > A bespoke DWMP model was created from the latest available Thames Water model by updating with the latest flows and loads data and was used to assess compliance across the key water quality and loading metrics: AmmN, BOD, SS and DWF.
  > The same procedure as above was then followed.
- Discharge permit targets for all final effluent quality parameters on all option development was 80% of the permit (90% for DWF) to provide headroom in the process as per our TWUL design standards. Some allowance was provided for the uncertainty in process modelling of flows and loads a significant time step in the future and so some tolerance of the 80% design target was allowed for in this.

Managing uncertainty

9.49 Through the conceptual design we also identified option risks. These were captured and then monetised following established practice from Treasury Green Book.

9.50 Confidence grades were calculated for each option, to reflect uncertainty in the:

- Deliverability of the option - considering risks related to factors such as:
  - Planning approval
  - Land ownership
  - Regulatory and legal permissions/consents
- Effectiveness of the option to achieve required benefits - considers risk related to factors such as:
  - Dependability of chosen technology
  - Reliability of data used to inform the concept design

9.51 Confidence grades were calculated following the approach established for the WRMP.

Description	Rationale	Factor Weighting	High Confidence	Medium Confidence	Low Confidence	Comments / Notes
Capability Limitations	Does Thames Water as a company have experience in delivering equivalent solutions (i.e., is the technology new to Thames project delivery teams?)	1	X			Delivery of nature-based and traditional solutions demonstrated through recent asset management planning cycles. Recent delivery of surface water management focusing on partnership scheme funding. Infrastructure solutions such as tanks: traditional approach. Experience in implementing Infiltration reduction schemes.
Dependence on other assets or activities	Do the benefits rely on the performance of other assets or success of other activities? For example, is a pumping station upgrade dependent on associated network improvements?	1	X			Implementation of surface water management approaches at a strategic level across a catchment, no interdependence. Similarly for infiltration reduction. Note that some treatment works option benefits will rely on the success of infiltration reduction.
Inherent construction uncertainty	For example, tunnelling = low confidence. Contaminated land with unknown pollution impact would similarly pose an uncertainty over the construction phase	1		X		Specific location of implementation subject to inherent uncertainty at the first round of this DWMP due to the need to improve knowledge of surface water flow sources. However, inherent option uncertainty considered medium.
Planning	Confidence that there are no significant planning issues associated with the project that could change or totally jeopardize successful delivery of project.	2		X		Public realm improvements subject to planning approvals to allow successful delivery. Traditional infrastructure solutions primarily below ground so limited planning constraint.
Property & Land Owners	Confidence that construction of the solution will not have	1		X		Public realm changes incorporating surface water management may

Description	Rationale	Factor Weighting	High Confidence	Medium Confidence	Low Confidence	Comments / Notes
	any significant customer impact or land issues that could change or totally jeopardize successful delivery of project					impact customers and could influence the successful delivery of the project
Environmental	Is the solution likely to be subject to an environmental challenge. For example, solutions that require significant additional energy would be more difficult to justify.	1		X		Solution focuses on maximising the impact of surface water management and nature-based solutions where possible. No high-risk aspects considered applicable. Ambition is for 30% SuDS by 2050.
Regulators & Legal Framework	Any permissions or consents from outside/statutory bodies, which if not granted could significantly change or totally jeopardise successful delivery of project. If solution is based on a new consent, how confident are we that the new consent will become statutory in the period?	2	X			No significant permissions of consent anticipated.
Other representative Groups	Are there likely to be any interested parties who could influence the final outcome and thus invalidate the solution?	1		X		Stakeholder engagement indicates general support for surface water management and nature-based solutions. Ambition is for 30% SuDS by 2050

Table 9-6 Example extract from a confidence grade assessment

9.52 Further details of our consideration of risk and uncertainty can be found in the Risk and Uncertainty Technical Appendix.

10 Main outputs

Progress ✚

10.1 Our DWMP is built up at three geographical levels: catchments that are served by our STWs (L3), Thames Regional Flood and Coastal Committee (TFRCC) sub-committee areas (L2) and Thames Water's wastewater operating region (L1). Figure 10-1 shows our L1 operating region boundary and the L2 TRFCC sub-committee areas.

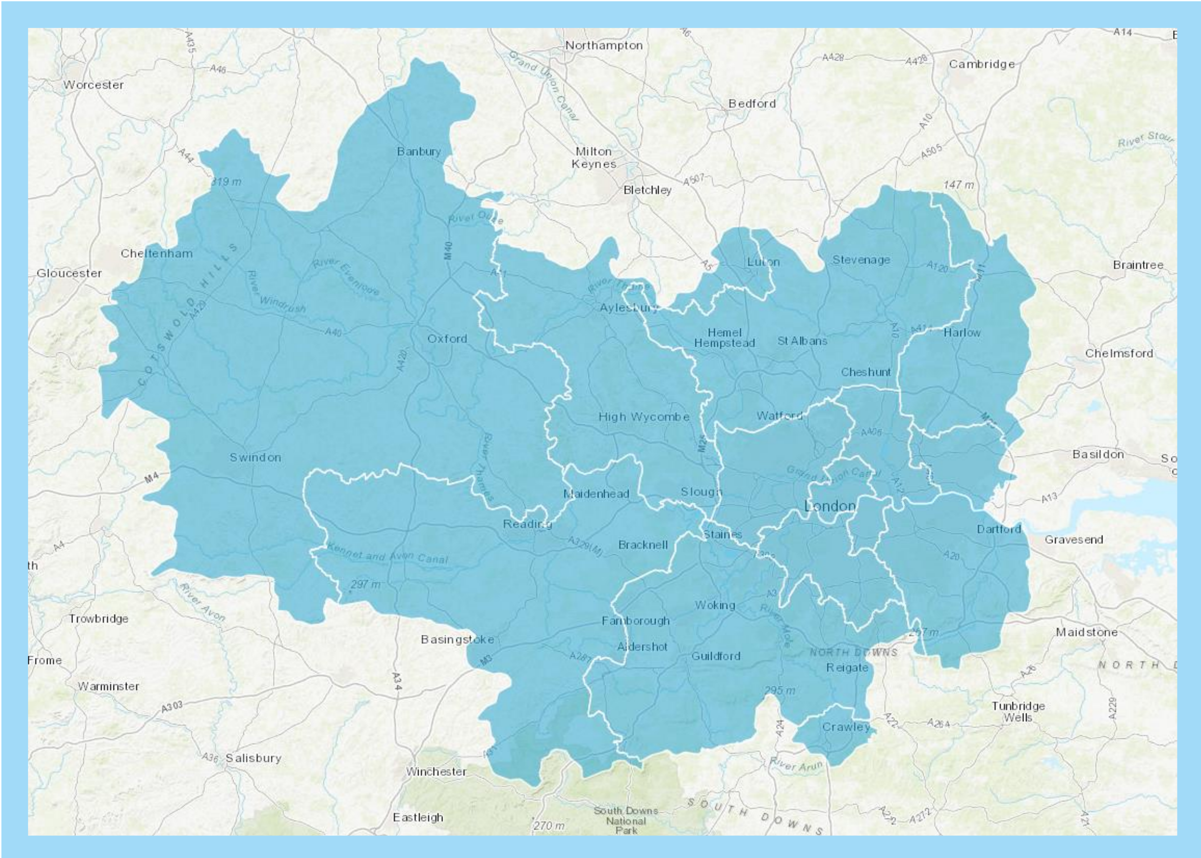


Figure 10-1 Level 2 Thames Regional Flood and Coastal Committee (TRFCC) sub-committee areas[24]

10.2 Options have been developed through the ODA stage to achieve a range of targets which can then support the programme appraisal to determine an optimised plan, balancing competing priorities.

10.3 The following sections show the overall costs and activities for options developed to address our planning objective targets. The data presented shows the maximum construction costs for the options generated in the ODA stage. It does not represent the options that have been selected for our preferred and alternative plans – this is discussed in our Programme Appraisal Technical Appendix.

[24] Extract from our DWMP Portal: Drainage and Wastewater Management Plan (arcgis.com)

10.4 All stated costs comprise construction costs only. Costs are presented at a 2020-21 price base, which aligns with costs submitted in the Ofwat data tables. Costs are subject to rounding; however, totals are correct.

Overview - London

10.5 The following figures show the overall construction costs for options developed to address our planning objective targets, for all of our eight London catchments.

10.6 Figure 10-2 shows the overall network option costs and Figure 10-3 shows the overall treatment option costs.

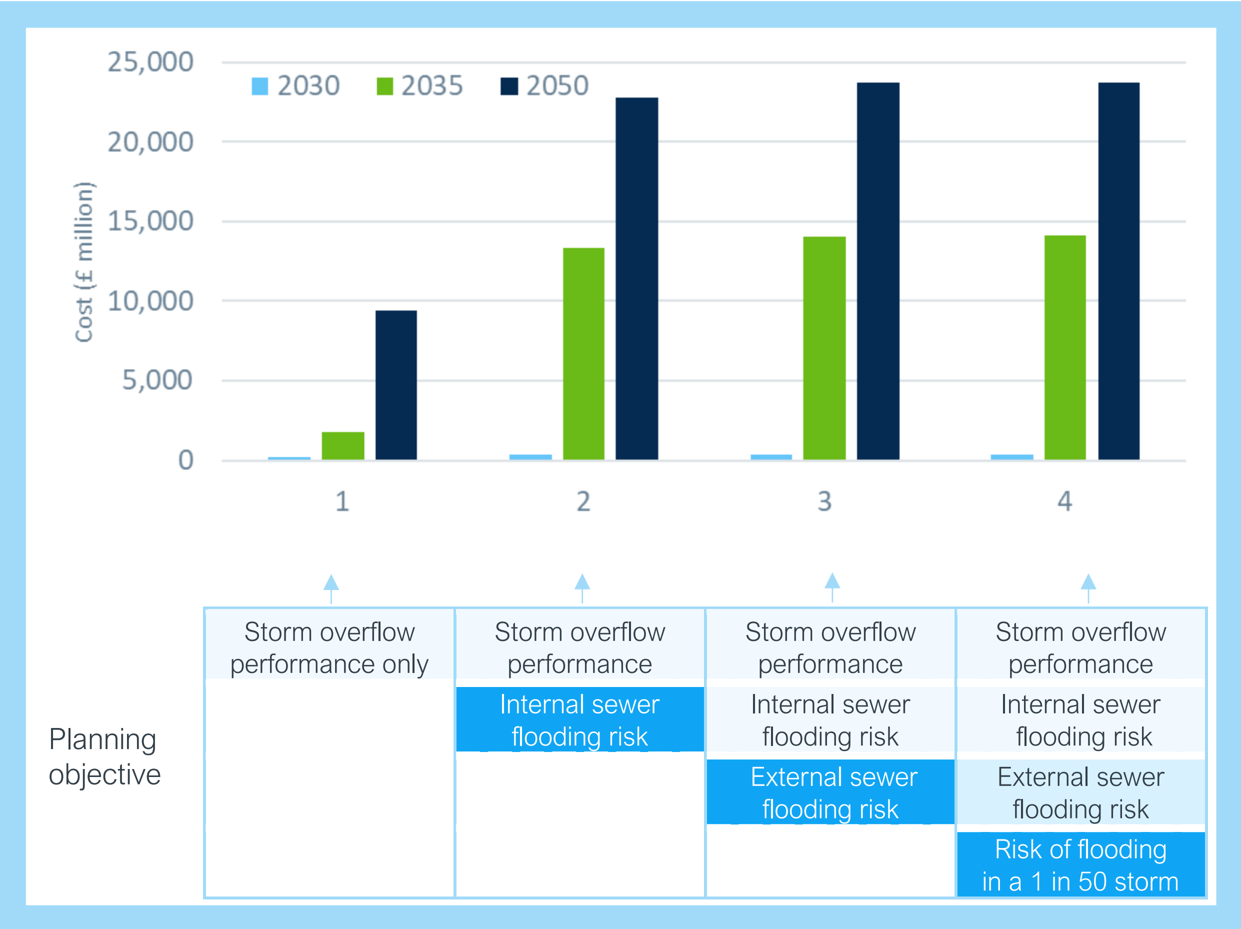


Figure 10-2 Overall network option construction costs (London catchments summated)

10.7 Figure 10-2 shows that the overall cost of options to achieve both our sewer property flooding and storm overflow performance targets (target hierarchies 2, 3 and 4), is significantly higher than costs solely to achieve storm overflow performance targets (target hierarchy 1). This is due to climate change having a larger impact on our network performance and property flooding risk.

10.8 The overall cost of options to achieve internal, external flooding and storm overflow performance targets at 2050 (hierarchy 3) is approximately £0.9 billion higher than that required to achieve internal flooding and storm overflow performance targets (hierarchy 2). This is because for the majority of areas, options to achieve internal flooding targets also achieved external flooding targets.

10.9 The overall cost of options to achieve all performance targets at 2050 (hierarchy 4) is the same as that required to achieve internal, external flooding and storm overflow performance targets (hierarchy 3). The tighter targets set for internal and external flooding (in terms of the percentage of properties to remain at risk of flooding, see Table 7-1) also achieve the targets relating to the risk of flooding in a 1 in 50 year storm event (which has a higher threshold for the number of properties to remain at risk of flooding).

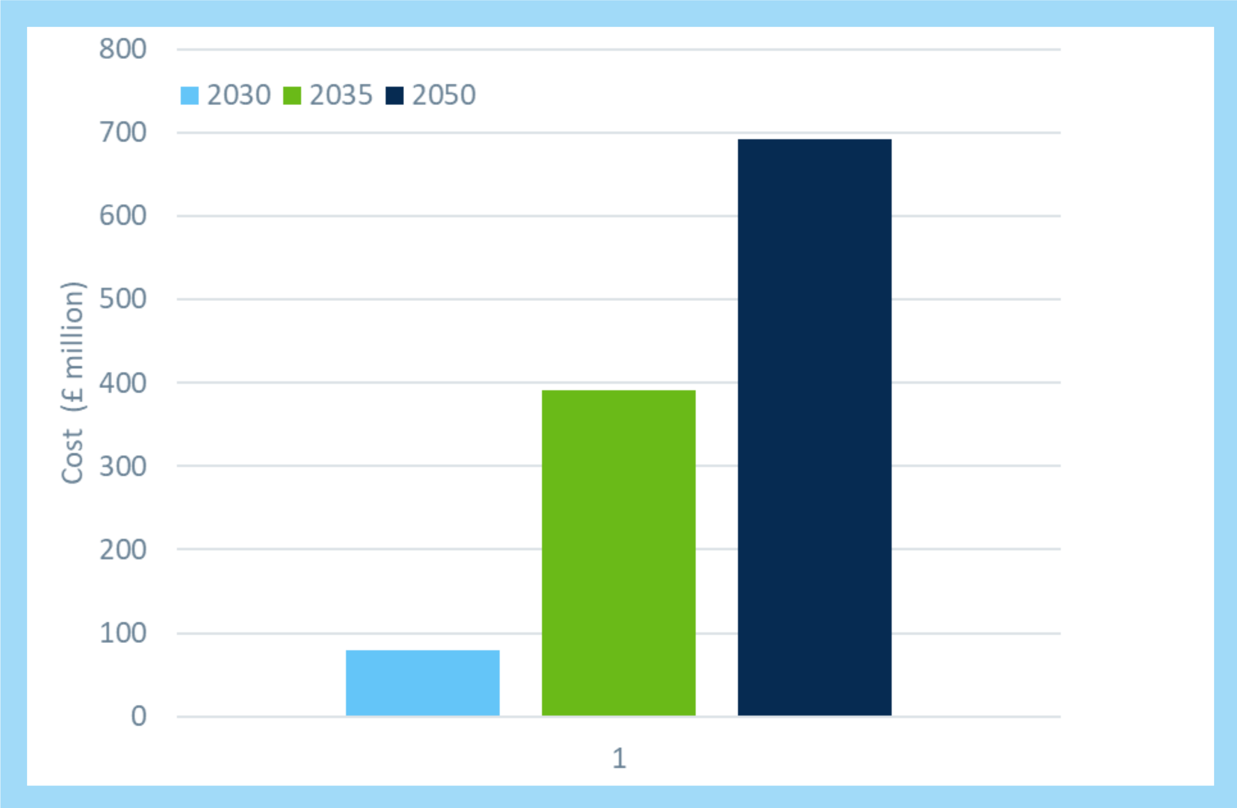
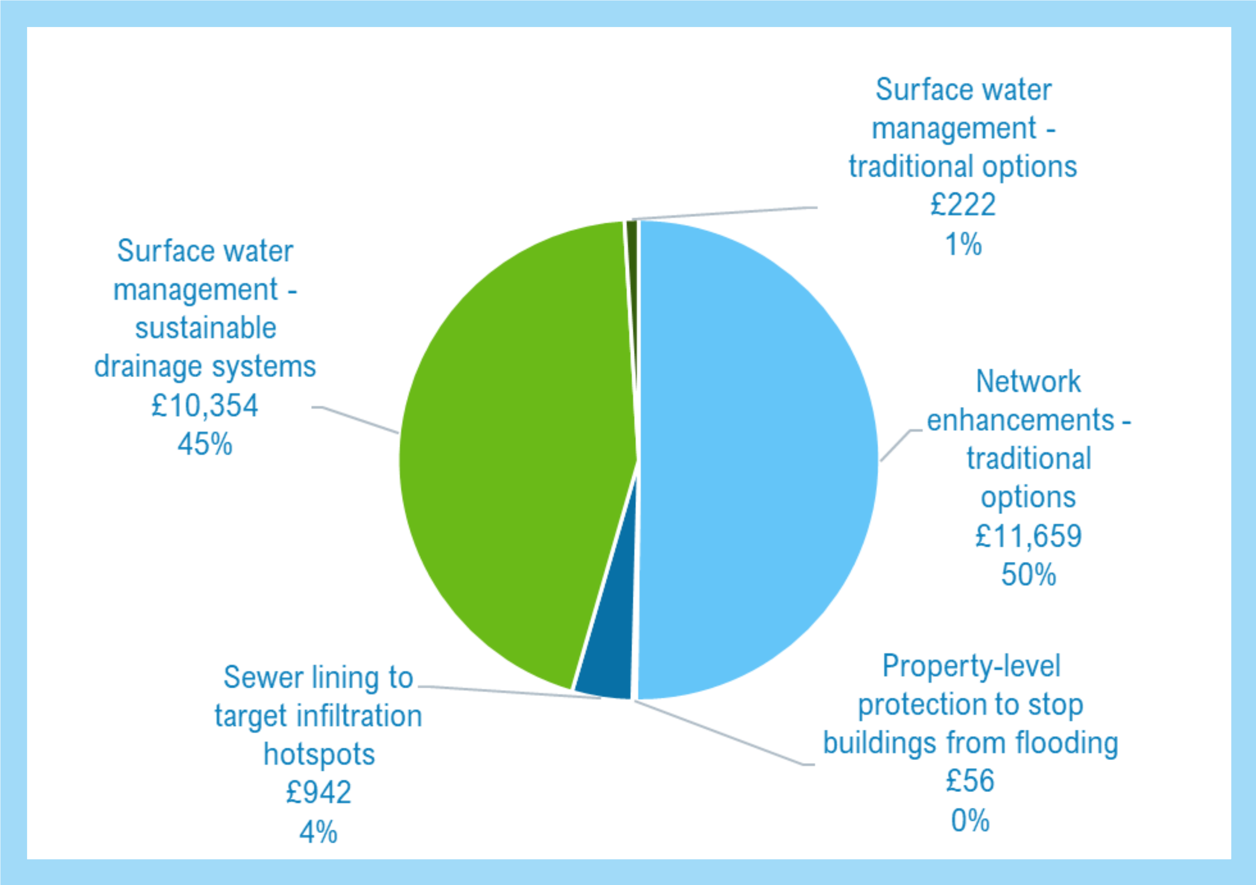


Figure 10-3 Overall sewage treatment works option construction costs (London catchments summated)

10.10 Figure 10-3 shows the cumulative construction costs required in London catchments to ensure sewage treatment works compliance to 2050. This is less than 5% of the network option costs due to the impact of climate change being far less significant on the STW performance.

10.11 For the network, the option types developed for London are shown in Figure 10-4. Aligning our plan with regulatory guidelines and legislation introduced between our draft and final DWMP has a significant impact on the timing and technology that we will be using to deliver the storm overflow discharge reduction part of our plan; hence an increased number of end of pipeline solutions such as storm tanks.



Costs are £ million

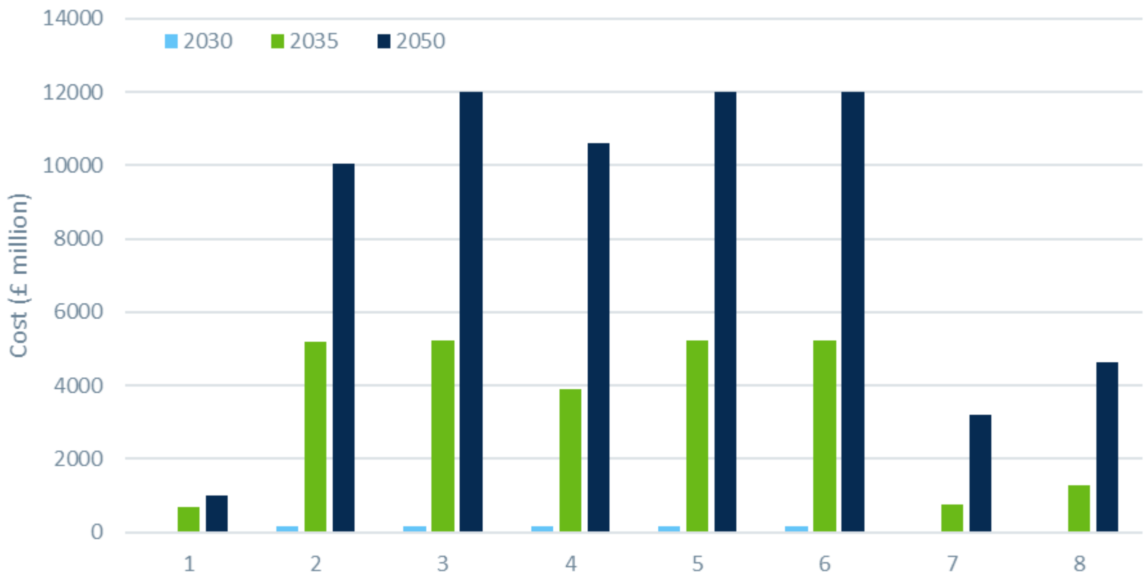
1. Surface water management - traditional options: examples include disconnecting surface water systems from combined sewers and constructing deep tunnels that convey surface water flows to discharge to watercourses

Figure 10-4 Network option types developed for London as a proportion of total construction cost (to address network planning objective targets by 2050)

10.12 Aligning our plan with regulatory guidelines has meant implementing an increased pace of delivery and investment. This also has an impact on the technology that we will be using to deliver our plan; our project programmes will be delivering an increased number of ‘end of pipe’ solutions such as storm tanks. The benefit of this is that we will be implementing proven solutions which will enable us to meet the challenging targets set out in the WINEP guidance. We will still have the opportunity to further develop these solutions as our designs develop during cycle 2, informed by the investigations and monitoring that we will undertake in the next planning period.

Overview - catchments outside London

10.13 The following figures show the overall construction costs for options developed to address our planning objective targets, for our catchments outside London. Figure 10-5 shows the overall network option costs and Figure 10-6 shows the overall treatment option costs.



	1	2	3	4	5	6	7	8
Planning objective(s) addressed	Manage infiltration[2]	Manage infiltration[2]	Manage infiltration[2]	Manage infiltration[2]	Manage infiltration[2]	Manage infiltration[2]	Manage infiltration[2]	Manage infiltration[2]
			Storm overflow performance	Storm overflow performance	Storm overflow performance	Storm overflow performance	Storm overflow performance[3]	Storm overflow performance
		Internal sewer flooding risk		Internal sewer flooding risk		Internal sewer flooding risk		Internal sewer flooding risk
		External sewer flooding risk		External sewer flooding risk		External sewer flooding risk		External sewer flooding risk
			Risk of flooding in a 1in50 storm		Risk of flooding in a 1in50 storm	Risk of flooding in a 1in50 storm		Risk of flooding in a 1in50 storm

ODA targets

Maintain current performance

1 Targets are defined in Table 7-2
2 Assess impact of sewer and manhole lining to reduce sewer infiltration, where selected for feasible option development
3 This is a lower cost than target 1, as not all catchments with an option developed to manage infiltration also have a storm overflow performance target to be addressed

Figure 10-5 Overall network option construction costs (catchments outside London, summated)

10.14 Where we have identified that current sewer infiltration rates have a significant impact on our planning objectives, we have assessed the impact of reducing infiltration levels across every planning objective target combination.

10.15 Figure 10-5 shows that options with a total cost of approximately £18.1 billion are required to address flooding and storm overflow performance targets (at 2050). The overall cost of options to achieve sewer property flooding targets is significantly higher than that required to achieve storm overflows performance targets.

10.16 The overall cost of options to maintain performance at current levels (planning objective target combination 8) is approximately a quarter of that required to achieve our more stretching targets. This reflects two key drivers:

- The more stretching targets deliver our ambition to protect our environment, look after the health of our rivers (aiming for zero harm from spills), be resilient to the risks of flooding and generate wider benefits to the communities we serve
- The 'maintain' options maintains current performance given forecast impacts of growth and climate change. So, one quarter of the overall cost to achieve the more stretching targets is required to offset the impact of growth and climate change.

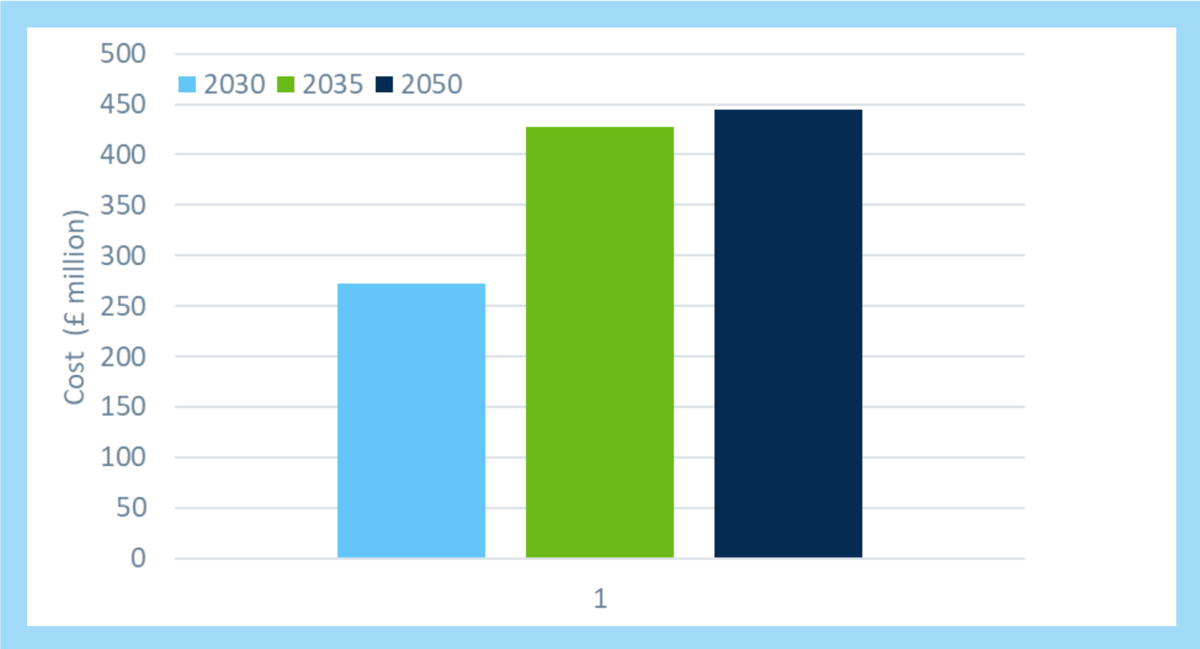


Figure 10-6 Overall sewage treatment works option construction costs (catchments outside London)

10.17 Figure 10-6 shows the summation of construction costs required in catchments outside of London for the single planning objective of achieving treatment works compliance up until 2050.

10.18 For the network option please refer to Figure 10-7.

10.19 Compared to London, the proportion of nature-based options currently proposed to address our planning objective targets is lower for catchments outside London. This is due to a number of factors, including the differences in system type – our London catchments are predominantly combined (surface water and foul water conveyed in the same sewer), while our catchments outside London have separate networks. Most of our surface water systems are not covered by verified hydraulic models; our plan is to map and model our surface water systems within the second cycle of our DWMP, to consolidate our knowledge of areas of the network where investment is needed the most and to increase confidence in our plans for surface water management solutions.

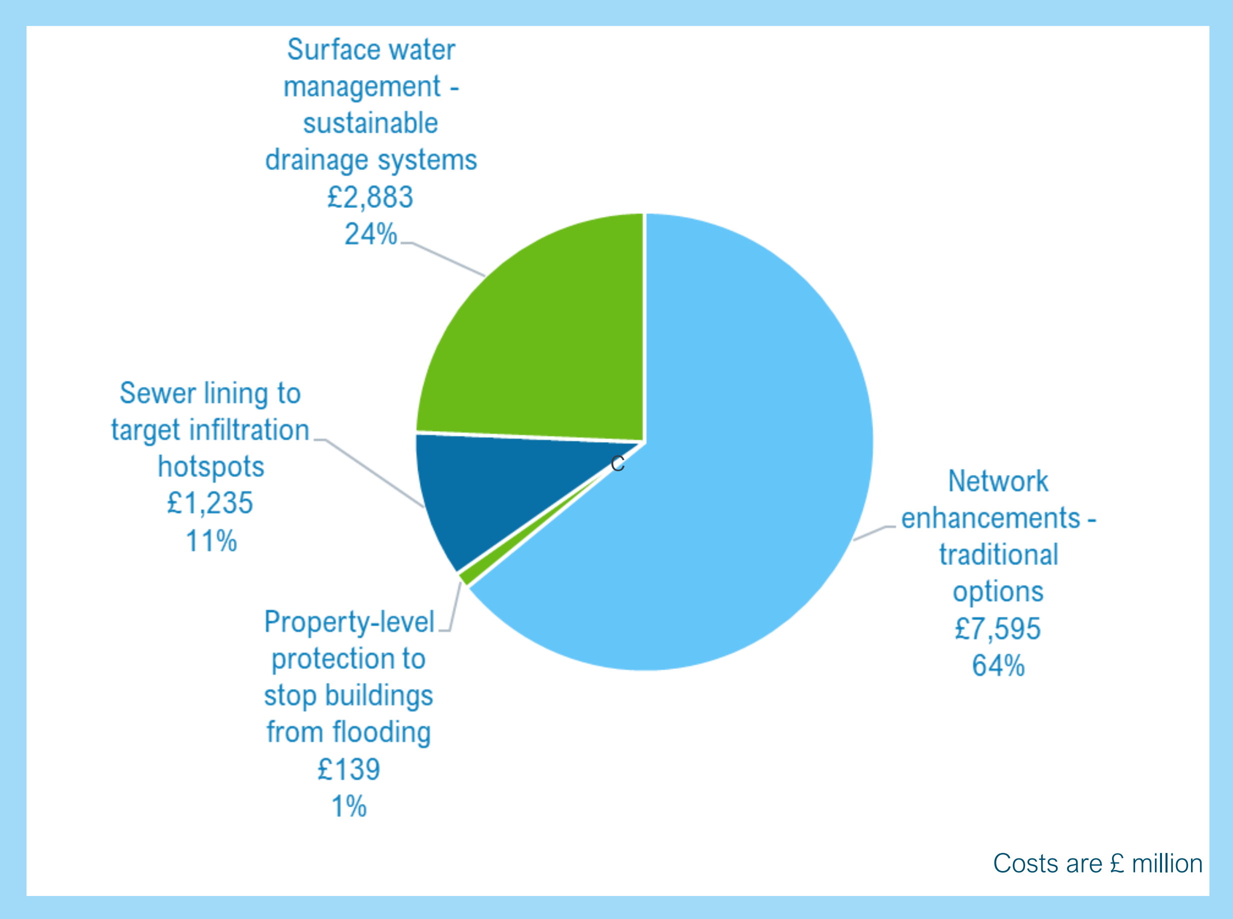
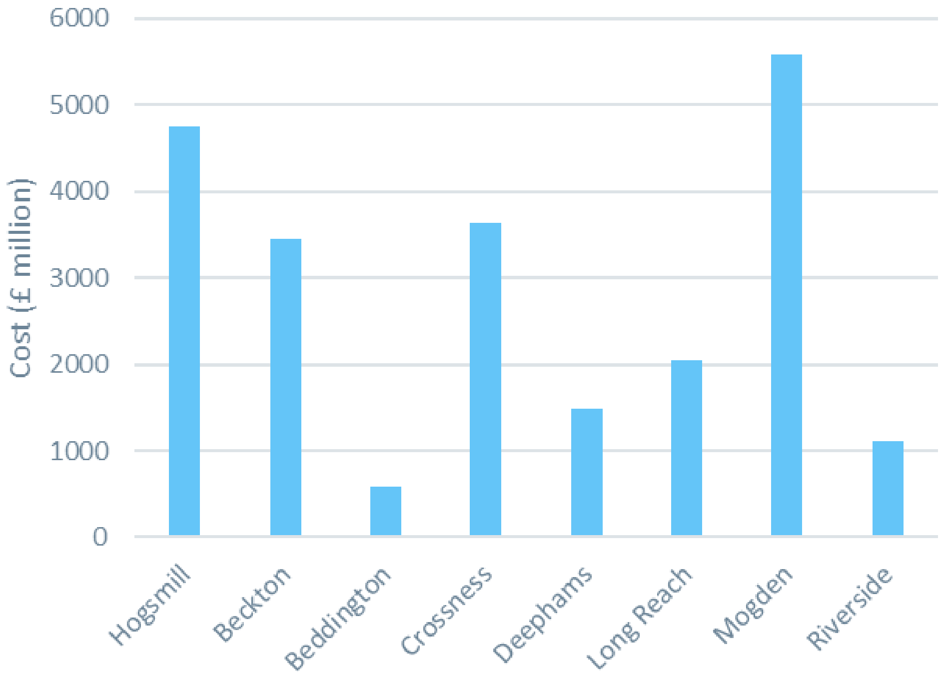


Figure 10-7 Network option types developed for catchments outside of London as a proportion of total construction cost (to address network planning objective targets by 2050)

10.20 As with our London catchments, aligning our plan with regulatory guidelines has meant our project programmes will be delivering an increased number of 'end of pipe' solutions such as storm tanks.

Main outputs – London catchments

10.21 The following figures and tables show the overall construction costs for options developed to address our planning objectives for each of our London catchments: Costs have increased for our fDWMP as it recognises the need to meet the legislative timescales for storm overflow discharge reduction, and as such an 'end-of-pipe' storage option may be required rather than a catchment wide surface water management scheme.



1 The option costs presented per catchment address the following planning objective targets: storm overflow performance, internal sewer flooding risk, external sewer flooding risk, risk of flooding in a 1 in 50-year storm event.

Figure 10-8 Network option construction costs (London catchments, to address network planning objective targets by 2050)

10.22 Figure 10-8 shows that the highest overall option costs has been assessed for the Mogden catchment with Hogsmill catchment second.

10.23 The BRAVA showed an exceptionally high baseline flood risk for these catchments, especially on the surface water network (there is extensive surface water network modelled coverage in the catchment). We suspect that the original design of the network was to provide a level of protection from flooding significantly less than for a storm event with a 1 in 30-year return period. Our planning objective targets (requiring protection up to a storm event with a 1 in 50-year return period) far exceed current network capacity. Therefore, options to address our targets have very high costs.

10.24 Within the Mogden catchment, with the exception of SuDS implementation, the modelling assessments indicate that benefit reduces significantly as the scope (and hence cost) of selected option types is increased, to achieve all planning objective targets.

10.25 In this catchment there is known to be hydraulic interaction between watercourses, surface water sewers and foul sewers. We have evidence of this from a scheme Harrow Council, the Lead Local Flood Authority, are currently progressing to create capacity in the Wealdstone Brook. The scheme is predicted to provide significant hydraulic benefit to the surface water and foul sewer networks. We have accounted for the predicted benefits of the scheme when developing our DWMP proposals.

10.26 We have therefore developed a “no regrets, SuDS only” option for Mogden, recognising that more work is required in subsequent DWMP cycles to fully address our 25-year planning objective targets. We plan to undertake further bespoke and detailed modelling assessments in the second cycle of DWMPs, to increase our understanding of the performance of the integrated drainage and wastewater network and identify further integrated options. This will be informed by the actual performance improvements that arise as a result of completion of the Wealdstone Brook scheme.

10.27 Despite the model coverage of the surface water network, further work is still required within the Mogden and Hogsmill catchments to increase our knowledge of the performance of surface water drainage and wastewater networks, to increase confidence in our plans for surface water management solutions. We plan to undertake this work within the second cycle of our DWMP.

10.28 In Crossness, the of scale options developed to achieve flooding targets was also extensive, and therefore high cost. However, when compared to other catchments on a pro-rata basis (i.e., taking into account relative sizes), the costs per head of catchment population are similar to the average costs for all catchments.

10.29 The Beckton catchment serves the largest number of our customers. Costs to achieve our planning objective targets were the lowest for this catchment, on a pro-rata basis, evidence of the catchment's greater capacity to manage future pressures compared to other catchments.

10.30 Long Reach is similar to Crossness; when compared to other catchments on a pro-rata basis (i.e., taking into account relative sizes), the costs to address flooding are similar to the average costs for all catchments.

10.31 Deephams, Riverside and Beddington have the lowest overall costs to address planning objectives, reflective of the lower scale of exceedances identified during the BRAVA stage, and the available capacity in existing networks.

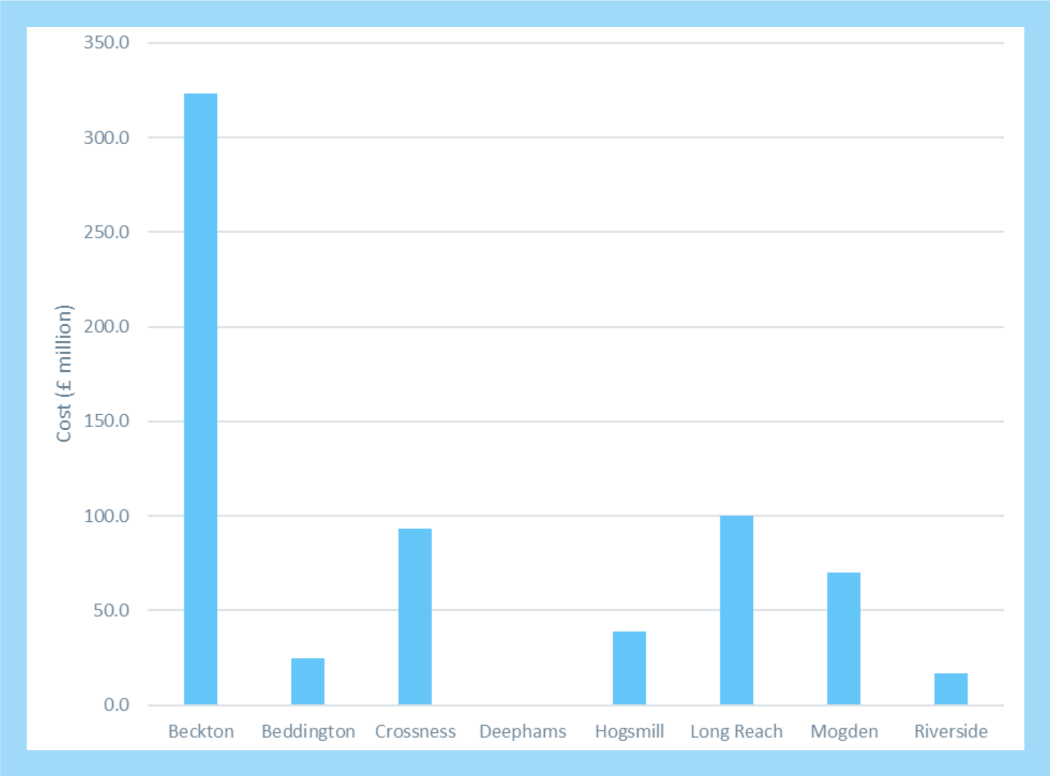


Figure 10-9 Sewage treatment works option construction costs (London catchments, to address treatment planning objective targets by 2050)

10.32 Figure 10-9 shows that construction costs required to meet sewage treatment works requirements up to 2050 for Crossness, Mogden and Long Reach are similar. Whilst Mogden is the larger works, it has a significant capacity enhancement scheme planned for completion before the DWMP commences in 2025, meaning less investment is required over the planning horizon.

10.33 Beckton requires the largest investment due to a significant asset on site requiring replacement (as it is near the end of its expected asset life), and a large amount of population growth expected within the catchment. The timing of this has been adjusted between our draft and final DWMP to reflect our latest delivery planning.

10.34 Beddington and Hogsmill require some investment in line with moderate population growth in the catchment driving a need to expand the existing works.

10.35 Riverside requires little to no investment due to significant AMP7 schemes providing substantial treatment capacity that is forecast to meet demands over the entire planning horizon.

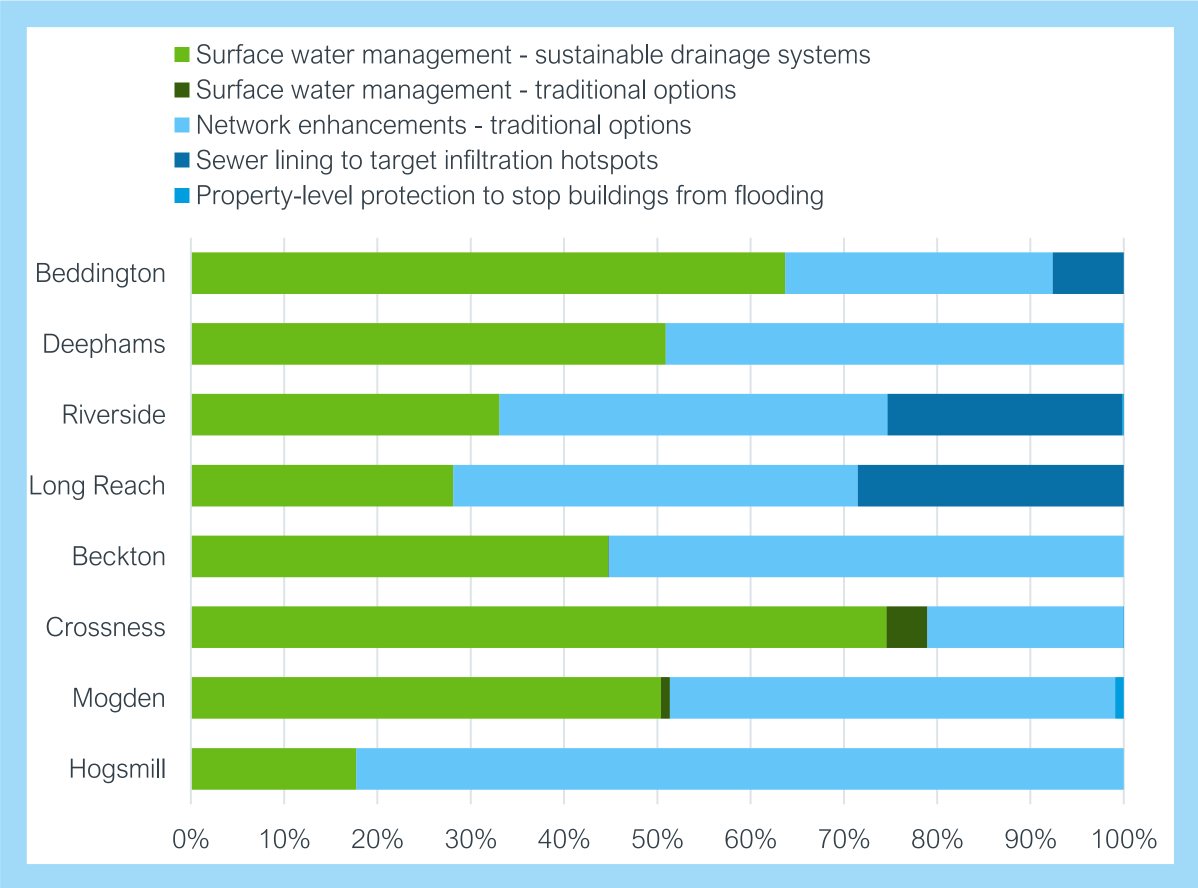


Figure 10-10 Network option types developed for London catchments as a proportion of total construction costs (to achieve planning objective targets by 2050)

10.36 Figure 10-10 shows that nature-based, SuDS options to manage surface water can address a significant proportion of the planning objective targets to 2050 for the majority of the catchments in London. The inclusion of traditional network enhancement options to address storm overflow discharges in the short-term has increased the proportion of this option type. This is most obvious in the Deephams catchments where SuDS can achieve the flooding target, but storage solutions have been introduced to align with our WINEP SODRP submission. Hogsmill has the lowest percentage of nature-based options because our modelling assessments indicate that significant capacity enhancements in surface water networks are required to achieve the targets.

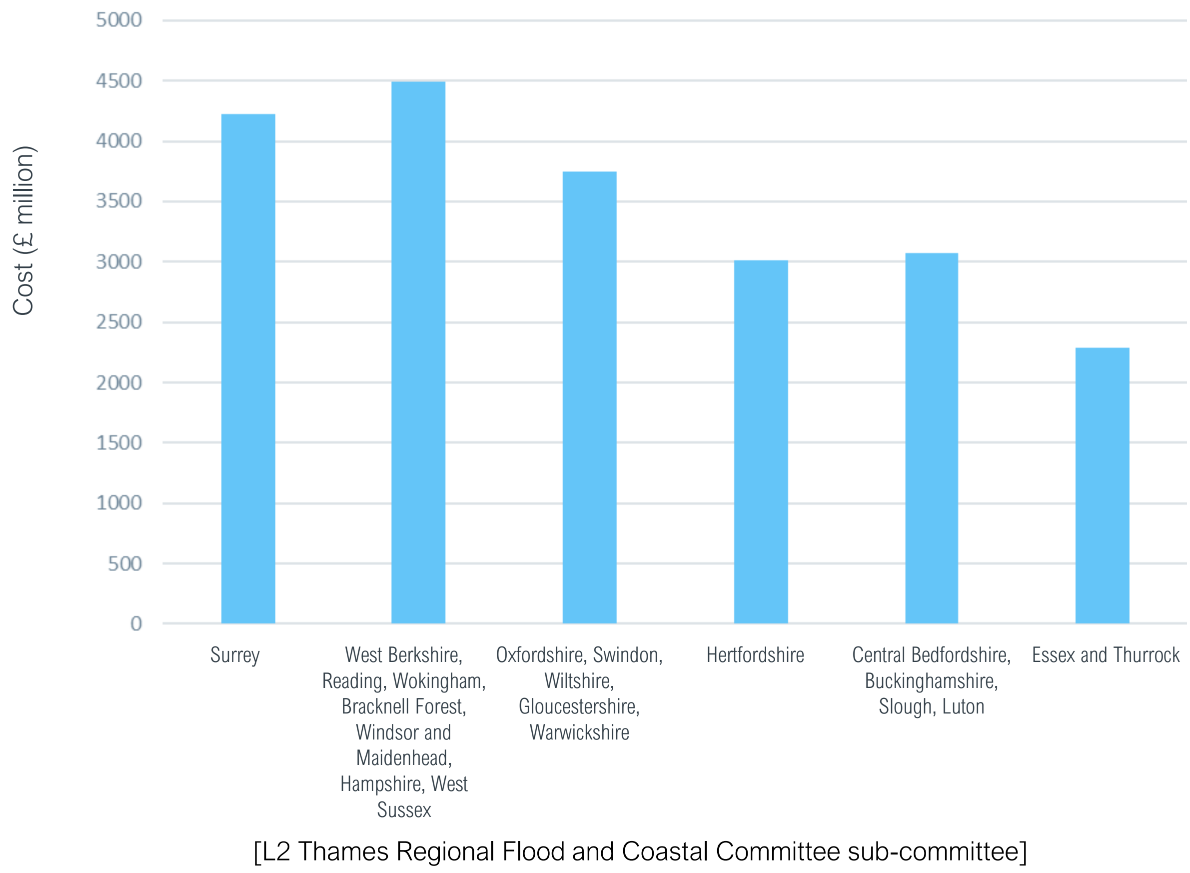
10.37 A significant extent of sewer lining to target infiltration hotspots has been identified in the Riverside and Long Reach catchments.

10.38 Sewer lining has been scoped within the Long Reach and Riverside catchments, and to a lesser extent within Beddington reflecting the less urban elements of these catchments. The models for both catchments incorporate significant levels of infiltration.

10.39 The large proportion of SuDS in Mogden and Crossness required to address our flooding targets (see Figure 10-10) reflects the large area draining surface water to our sewers from which flows will be removed or attenuated by SuDS. This also results in high rates of sequestered carbon.

Main outputs – L2 areas outside London

10.40 The following figures and tables show the overall costs for options developed to address our planning objectives for each of our L2 areas outside London. Costs have significantly increased to reflect our revised storm overflow discharge reduction targets in our fDWMP. In addition, some costs and timing of STW investment has been updated to reflect alignment with our business planning for AMP8.



1. The option costs presented per L2 address the following planning objective targets: storm overflow performance, internal sewer flooding risk, external sewer flooding risk, risk of flooding in a 1 in 50-year storm event.

Figure 10-11 Network option construction costs (L2 areas outside London, to address network planning objective targets by 2050)

10.41 The West Berkshire, Reading, Wokingham, Bracknell Forest, Windsor and Maidenhead, Hampshire and West Sussex L2 has highest option costs were associated with networks serving major cities and towns (highest being Bordon, Crawley, Reading and Aldershot).

10.42 In the Surrey L2 a significant proportion of the overall L2 cost associated with the Esher catchment. Our modelling showed that network capacity constraints in this catchment needed more and larger options to achieve the planning targets. Significant option costs were also identified for Chertsey, Guildford, Ripley, Lightwater and Woking.

10.43 The Oxfordshire, Swindon, Wiltshire, Gloucestershire and Warwickshire L2 has the greatest number of catchments considered during the ODA stage (114). Whilst costs were distributed throughout the significant number of small rural villages and towns in the area, over a third of the total cost was driven by Swindon and Oxford. Sewer lining to address infiltration hotspot comprised of 29% of the overall costs and, as with other catchments outside London where sewer lining has been identified, we have committed to implement Groundwater Impacted System Management Plans[25].

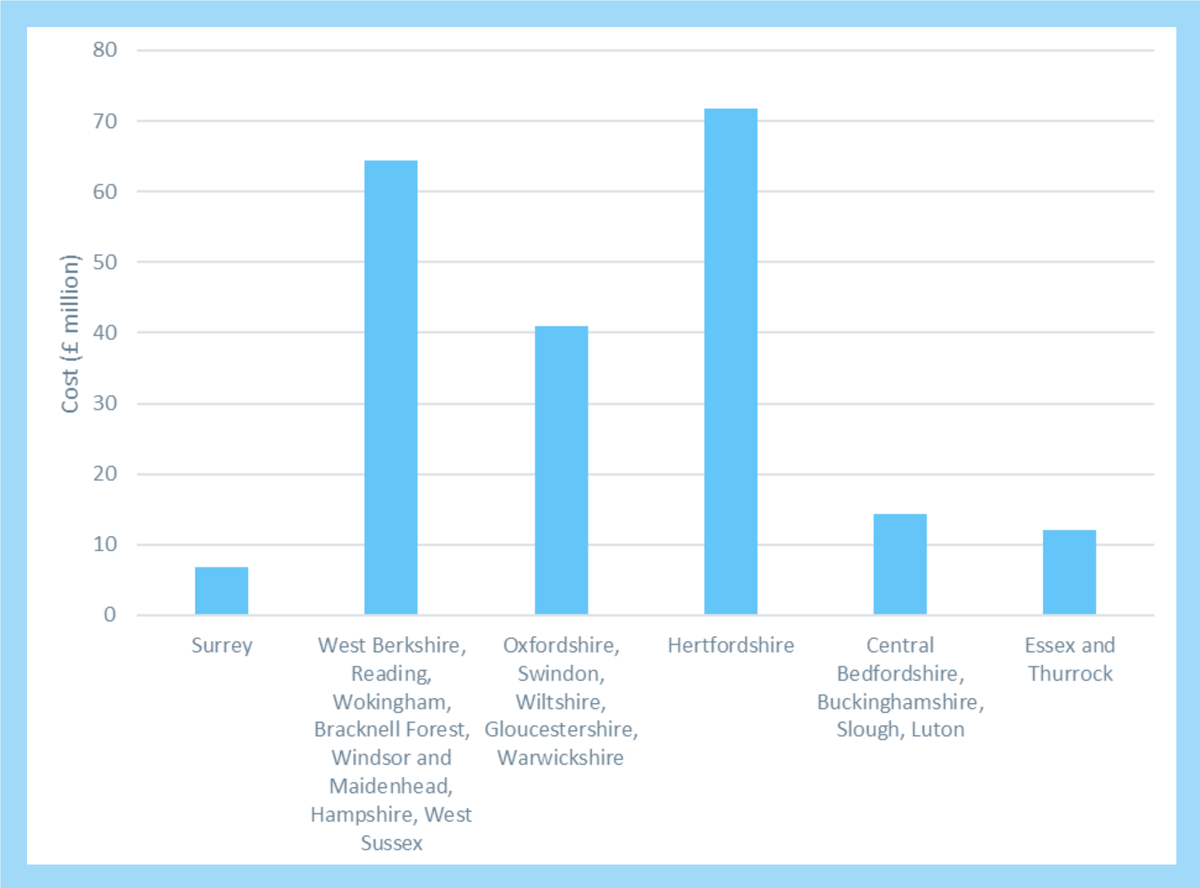


Figure 10-12 Sewage treatment works option construction costs (L2 areas outside London, to address treatment planning objective targets by 2050)

10.44 The Hertfordshire L2 area has the highest investment primarily due to works required at our Maple Lodge site.

10.45 West Berkshire, Reading, Wokingham, Bracknell Forest, Windsor and Maidenhead, Hampshire, West Sussex is the second largest L2 area, with 18 treatment works requiring approximately £66 million investment over the next 30 years.

10.46 The Oxfordshire, Swindon, Wiltshire, Gloucestershire and Warwickshire L2 area also has the greatest number of sewage treatment works considered during the ODA stage (26) and the highest investment requirement at approximately £42 million by 2050.

10.47 Other L2 areas have relatively fewer catchments considered during the ODA stage and therefore require much less investment over the planning horizon.

[25] Drainage Plans | Regulation | About us | Thames Water

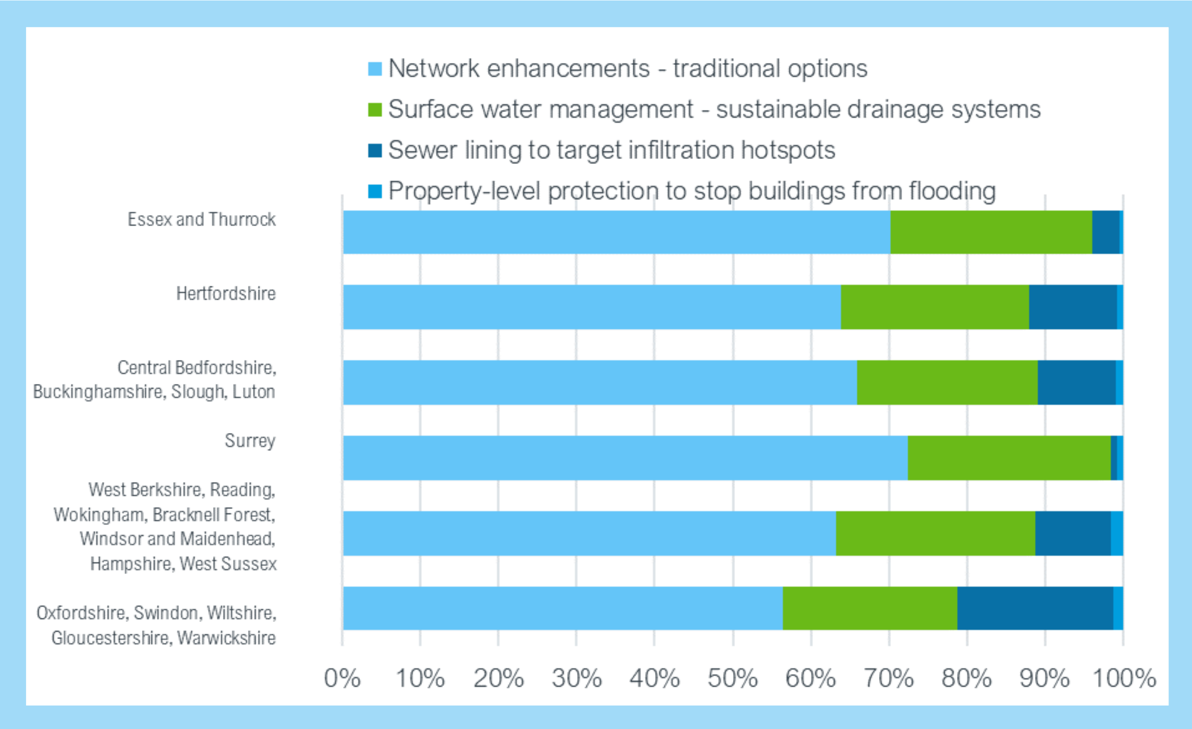


Figure 10-13 Network option types developed for L2 areas outside of London as a proportion of total construction costs (to address planning objective targets by 2050)

10.48 Figure 10-13 shows that, for the majority of the catchments outside of London, the 2050 planning objective targets are achieved by a significant proportion of network enhancement (e.g., upsizing sewers and providing additional storage). The inclusion of our short-term targets to address storm overflow discharges has increased the proportion of these option types for our fDWMP.

10.49 This is a function of the use of a 'reference option' approach (see section 8), which considers a blend of different types of options, including nature-based options such as SuDS and more traditional options, reflecting our existing knowledge of network performance and the broad type of work we may need to undertake to maintain and/or improve the network.

10.50 Through further mapping and modelling of our surface water systems, we will enhance our knowledge of these areas of the network. This will help us to develop strategic surface water management and network reinforcement solutions, with continual refinement of our plans as our knowledge increases.

10.51 Sewer lining to address infiltration hotspots comprises 27% of option costs for Oxfordshire, Swindon, Wiltshire, Gloucestershire and Warwickshire L2, where most of our catchments impacted by groundwater infiltration are located.

10.52 The highest number of properties forecast to be protected from flooding is in the following two L2s:

- West Berkshire, Reading, Wokingham, Bracknell Forest, Windsor and Maidenhead, Hampshire, West Sussex
- Oxfordshire, Swindon, Wiltshire, Gloucestershire, Warwickshire

Main outputs – L3 areas outside London

10.53 The option data created at this level during the ODA stage was collated and used as an input dataset for undertaking the next stage in the DWMP process (programme appraisal).

Appendix A Generic Options

A1 Generic Options

Table A1-1 and Table A1-2 lists our generic options and sub-options, including descriptions for each. The key used in the tables is provided below.

Key

(light blue)	Options considered when devising the **feasible option list**
(light green)	Options that are not currently considered viable for inclusion in our first DWMP (following screening of generic options) and have been allocated for **further investigation**
(light orange)	Options that are not currently considered viable for inclusion in our first DWMP (following screening of generic options) and have **not been progressed further during the ODA process**
(grey)	Property and community level water management options, or indirect measures that have been **considered at an L1 and L2 scale and have not been developed across L3 catchments**. Options have been considered when devising the overall DWMP and have not been further detailed in this ODA technical appendix, which considers options developed at an L3 scale and lower.

DWMP generic option reference	DWMP generic option title	Description
A1	Water efficiency measures (property, community or industrial level)	Water efficiency measures can be installed within buildings with the purpose of reducing water consumption. This could include metering or supplying customers with household appliances designed to reduce consumption. Reduced consumption can also benefit the wastewater system by reducing the dry weather flow to be conveyed through the sewer network and through the STWs.
A2	Rainwater harvesting (property, community or industrial level)	Capture and treatment for re-use of rainwater from roofs and paved surfaces. Rainwater harvesting reduces the amount of flow that needs to be conveyed through the sewer network during a storm, thus reducing the likelihood of sewer flooding or spills to watercourse.
A3	Greywater treatment and re-use (property, community or industrial level)	Reduces both flow and load to the system either by offering some treatment and/or by reusing existing wastewater a second time before final treatment. The treatment levels considered vary from treatment for potable use to pre-treatment for discharge into the combined or foul sewer network.
A4	Blackwater treatment and re-use (property, community or industrial level)	Reduces both flow and load to the system either by offering some treatment and/or by reusing existing wastewater a second time before final treatment. Options vary from pre-treatment before the wastewater is conveyed through to a STW, to complete treatment of blackwater.
B1	Surface water source control measures	Managing surface water and maximising its potential for re-use. Opportunities for large-scale source control installation such as retrofitting in highways and around buildings (e.g., downpipe disconnection), as well as aligning with ongoing programmes like local authority highway upgrades or major opportunity area developments.
B2	Surface water pathway measures	Conveying surface water by means of above- or below-ground pathways such as open channels, swales, highways, and sewers. This includes options to attenuate or convey exceedance flows, options to separate the surface water from combined sewers and options to create new blue/green corridors.
B3	Surface water receptor measures	Keep floodwater (either surface water or foul / combined water) away from buildings and strategic infrastructure in the event of a storm. Includes property level resilience (PLR) measures such as flood gates etc.
C1	Intelligent automated sewer network operation	Allows the system to be operated proactively, maximising the use of existing assets. These options cover a range of different approaches e.g., modifying the start-stop levels at strategic pumping stations, creation of new network control points which allow for flow to be temporarily held back in the catchment, intelligent SuDS features such as smart water butts.
C2	Intelligent automated asset maintenance	Allows the system to be maintained proactively, maximising the use and longevity of existing assets (for example by repairing minor sewer damage before a collapse occurs).
C3	Increase sewer capacity (e.g., pipe replacement)	Replacement of existing sewers in most beneficial locations with larger sewers to increase network capacity.
C4	Stormwater storage tanks and tunnels	Construction of storm water storage tanks/tunnels in areas of high flood (or future flood) risk. Creates storage volume to reduce storm impact.

DWMP generic option reference	DWMP generic option title	Description
C5	Sewer lining	Sewer and manhole lining to improve asset condition and reduce infiltration type inflows. Also includes sewer rehabilitation more generally.
C6	Utilise & optimise existing inter-catchment connections	Optimising existing connections between catchments and those between some of the STWs. These connections could be used to transfer flows between catchments without capacity to those with short-term capacity.
C7	Create new inter-catchment connections	Creation of new connections between the STW catchments to optimise capacities balancing flow and load
C8	Create strategic connections between STWs (e.g., wastewater ring main)	Large infrastructure project that would allow most/all catchments to discharge into a single infrastructure pipe/tunnel and then allow any or all of the STWs to extract from this ring main and treat the flows.
C9	Transfer wastewater across company boundaries	Utilise available capacity elsewhere by transferring flows to nearby STW that are outside our boundary.
D1	Treat wastewater in the network	Treating the wastewater in the network either to relieve load transferred to existing treatment works or by removing contaminants that cause problems in the network and/or at the STW.
D2	Increase level of performance in existing STWs	These options are about measures that could increase the efficient use of the existing capacity of the works with the existing assets.
D3	Increase treatment intensity at existing STWs	These options are concerned with increasing the available treatment capacity on the existing footprint of the site.
D4	Expand existing sewage treatment works	These options cover purchasing land adjacent to an existing STW and expanding them. The expansion could be with conventional treatment or with a more intensive treatment option.
D5	Construct new/additional STWs	These options consider the construction of additional STWs e.g., in catchments where the existing STW capacity is constrained. This can include new STWs for the purpose of treating storm discharges.
D6	Increase treatment centralisation	This option considers the development of one or more ‘mega’ treatment works that would take flow and load from a number of existing STWs.
D7	River catchment-based discharge permitting	Catchment-based discharge permitting (optimising operational and environmental headroom, including nutrient balancing). Some deterioration or less stringent discharge permit criteria allowed in certain locations with conditions improved elsewhere (potentially more stringent permit criteria at certain sites) giving a net overall benefit.
D8	Dynamic Consenting	This option considers real-time effluent and receiving water quality monitoring to improve statistical confidence, reduce uncertainty and allow for dynamic consenting.
D9	Catchment management treatment initiatives	These options are concerned with treating either diffuse or point-source non-domestic elements of wastewater before they enter the sewer system, or by treating and controlling the other contributors to the environment.
D10	Indirect re-use of effluent	Utilising the effluent from the STW for reuse as a potable water supply.

DWMP generic option reference	DWMP generic option title	Description
D11	Wastewater treatment resource recovery	These options focus on maximising resource recovery (energy/nutrients/organics/metals etc.) while minimising its impact on the environment.
D12	Transfer sludge across boundaries	Reduce sludge bottlenecks at existing sites, reduce the impact of liquors on the effluent stream, provide space on existing sites for effluent expansion, maximise energy and resource recovery market opportunities.
E1	Customer education and awareness	Customer engagement and involvement in the provision of wastewater and drainage services. Over time, customers may become more active participants which could help to reduce the demand on existing wastewater assets by influencing customer behaviour.
E2	Customer incentivisation	These options look at developing a range of incentive programs designed to motivate customers to make smart choices in managing and/or utilizing water and wastewater services.
E3	New and amended wastewater and drainage regulations	This generic option covers the area of wastewater regulation such we can seek to influence, where possible, the existing regulatory framework to better align with the current pressures and challenges facing the industry.
E4	Alternative wastewater and drainage business models	Provide a platform to help create new wastewater and drainage business models that may deliver solutions more effectively than if they were delivered directly by us
E5	Integrate drainage and wastewater policy/management within local authorities or wider regional partnerships	Integrating wastewater policy, delivery and management into wider city planning in order to promote the delivery of such solutions. Embedding water and wastewater priorities at the city level may create the necessary top-down momentum for delivering collaborative solutions that provide multi-sectoral benefits
E6	Influence where growth can occur	Influence where growth can occur and hence mitigate impact on its assets.
M	Monitor risk	Risk monitoring. Approach is dependent on the risk type and will need to be specified prior to feasible option development.
WR	WRMP integrated scheme	Option that integrates with a particular option in the WRMP.
WC	Wild card options	Option that does not naturally fall under any of the other generic options.

Table A1-1 Generic options

Generic option reference	Generic sub-option reference	Generic sub-option title	Generic sub-option title description
A1	A1.1	Metering	Metering at houses, bulk flats and individual flats.
A1	A1.2	Water Efficiency Advice and Guidance	Domestic benchmarking to help drive water efficient behaviours, water efficiency goods advice to new customers, promotional campaigns including the development of water certificates, smart phone apps and distribution of self-audit packs.
A1	A1.3	Retrofit Water Efficient Devices	Water efficient homes and businesses. Retrofitted through Smarter Home Visits and Smarter Business Visits.
A1	A1.4	Super Water Efficient New Developments	New developments to incorporate properties with water efficiency devices delivering a net consumption of less than 105 l/h/d.
A1	A1.5	Water Efficiency Research and Regulation	Support ongoing research projects and campaigns in order to improve understanding and develop capability.
A2	A2.1	Rainwater harvesting – New developments (buildings and / or paved areas)	Rainwater harvesting systems in new individual buildings, new multi-building developments with provision for collection of runoff from driveways and paved areas.
A2	A2.2	Rainwater harvesting – Retrofit	Retrofitted rainwater harvesting systems to existing individual buildings, in regenerated areas such as council-owned flats and properties,
A2	A2.3	Rainwater harvesting with paved area collection – Retrofit	Retrofitted rainwater harvesting systems to existing individual buildings with provision for collection of runoff from property driveway and paved areas. Large rainwater harvesting systems at street level with small distribution network to properties.
A3	A3.1	Grey Water Treatment for potable use	Treatment of grey water (from baths, showers and washing machines) to an acceptable potable (drinking) water standard for individual properties and communities.
A3	A3.2	Grey Water Treatment for non-potable use	Treatment of grey water (from baths, showers and washing machines) to an acceptable standard for reuse for toilet flushing or other non-potable domestic requirements or local industrial reuse. This could be for manufacturing or other non-potable water uses (e.g., toilet flushing) for a community.
A3	A3.3	Grey Water Treatment and discharge to the environment	Treatment of grey water (from baths, showers and washing machines) to an acceptable standard for discharge to the local environment e.g., parks, gardens and local streams
A3	A3.4	Pre-treat effluent (greywater)	Provision of some level of treatment prior to the effluent entering the sewers system for final treatment at the STW
A4	A4.1	Black Water Treatment for potable use	Allocated for further investigation
A4	A4.2	Black Water Treatment for non-potable use	Allocated for further investigation
A4	A4.3	Black Water Treatment and discharge to the environment	Allocated for further investigation

Generic option reference	Generic sub-option reference	Generic sub-option title	Generic sub-option title description
A4	A4.4	Pre-treat effluent (blackwater)	Allocated for further investigation
B1	B1.1	Source control SuDS measures	Installation of surface water management devices to collect, store and infiltrate surface water from buildings and surrounding impermeable areas such as driveways and car parks. This option includes residential properties, schools and other public buildings, commercial and industrial buildings. Installation of surface water management devices to collect, store and infiltrate surface water from roads, pavements and pedestrianised areas.
B1	B1.2	Targeted source control SuDS measures at opportunity areas	Delivery of large-scale surface water management strategies across the catchment's opportunity areas to significantly reduce the total flow entering the sewer network at these locations. Retrofit surface water pathway measures (above or below ground) into area around a local sink point or intensive source control area. This could be a property development with available surface water storage/re-use capacity or a local river or stream. Retrofit surface water new surface water sewers into area around a local sink point or intensive source control area. This could be a property development with available surface water storage/re-use capacity or a local river or stream.
B2	B2.1	Combined sewer separation. Convert existing combined sewers to surface water only and construct new foul water sewers.	Progressively convert existing combined sewer networks into surface water networks by constructing a parallel foul sewer network (gravity, vacuum or pressurised).
B2	B2.2	Combined sewer separation. Construct new surface water sewers.	Fully below ground surface water sewer network collecting different types of run off and conveying to receptor which could be a local watercourse, a major watercourse or a water reuse point.
B2	B2.3	Disconnect existing surface water systems from combined sewers & discharge to watercourse	Progressively disconnect surface water sewers from existing combined sewer networks and direct discharge to suitable receptors such as watercourses. Likely to require resolution of property misconnections as well as pumping of flows to watercourse (depending on topography).
B2	B2.4	Deep tunnel(s) to connect surface water networks to major reuse or discharge location(s)	Deep tunnel network to capture surface water flows from major strategic sink points and convey it to a major reuse or discharge location. Assumed that this approach would only be used where natural surface level pathways are insufficient.
B2	B2.5	Combined sewer separation. Convert existing combined sewers to foul water	Fully above ground system (highways, swales, channels etc.) collecting highway and building flows and conveying to local watercourse or re-use point.

Generic option reference	Generic sub-option reference	Generic sub-option title	Generic sub-option title description
		only and convey surface water on the surface using SuDS measures.	
B2	B2.6	Re-create historical rivers to convey surface water	Create a watercourse along the route of a historical watercourse by diverting surface runoff from the surround area to the proposed route.
B2	B2.7	Use parks and urban spaces to store excess surface water during rainfall events	Daylight surface water systems through parks to create a water-based public amenity with a well-defined flood plain to be used for exceedance events and/or allow surface water systems running through/under urban social spaces to flood (during extreme events) into a well-defined sacrificial storage area within the urban space. Could involve daylighting some or all of the surface water flow path but keep buried if more appropriate.
B2	B2.8	Use highways to store and convey surface water during rainfall events	Highways designed to retain water when gullies and/or the sewer network are unable to accept any more flow. Highways to convey exceedance flows as a secondary function when sewer network capacity is reached. Further protective receptor measures to be taken at topographical low points.
B3	B3.0	Property-level protection measures to prevent buildings from flooding	Provide vulnerable homes with passive flood protection measures such as flood proof doors and/or provide vulnerable homes with active property flood resilience measures such as self-sealing bath/shower systems (non-return valves). Provision of individual property level pumps, particularly for basement connections Temporary raised barriers erected in response to flood predictors in order to create a flow retention storage volume to avoid damage to property. Increase thresholds of commercial properties to protect from more severe floods (future-proof). Develop and build partnerships with strategic asset owners and operators to provide resilient flood protection measures. Develop and build partnerships with property developers, product suppliers and the insurance industry to provide a framework for offering high quality affordable property flood protection measures.
C1	C1.0	Intelligent sewer network to control flows	Active system management at key points in the network to optimise available network capacity by balancing network flows. E.g., Automation of weir chambers on trunk sewers. Requires deployment of sewer monitors for live/predictive modelling. Requires deployment of sewer monitors for live/predictive modelling. Active system management at key pumping stations across the network to optimise available network capacity by balancing network flows. Requires deployment of sewer monitors for live/predictive modelling. Ability to monitor and control flow at pipe/chamber level.

Generic option reference	Generic sub-option reference	Generic sub-option title	Generic sub-option title description
			Integrate energy and cost monitoring from operational sites into active system management decision-making process.
C2	C2.0	Proactive maintenance	Condition based maintenance at all pumping stations; Use of intelligent autonomous vehicles to survey sewer network, highlight/prioritise repairs and carry out repair and maintenance work from within the sewer.
C3	C3.1	Increase network capacity by installing larger sewers	Replace existing sewers in most beneficial locations with larger sewers to increase network capacity.
C3	C3.2	Deep tunnel(s) to convey combined sewage	Deep tunnels to convey combined sewage to treatment location. Creates conveyance capacity for storm events.
C4	C4.0	Deep tank(s) and tunnel(s) to store combined sewage	Construction of storage tanks/tunnels in areas of high flood (or future flood) risk. Creates storage volume to reduce storm impact.
C5	C5.0	Sewer lining to target infiltration hotspots	Programme of sewer and manhole lining in areas of high infiltration and high potential benefit.
C6	C6.0	Transfer flow between catchments via existing connections	Connections exist between the catchments and also between some of the STWs. These connections could be used to transfer flows between catchments without capacity to those with short-term capacity.
C7	C7.0	Transfer flow between catchments via new connections	This option is about creating new connections between the STW catchments to optimise capacities and to find the best balance of flow and load i.e., removing catchment boundaries. It would allow utilisation of the short-term capacity in some STWs whilst other STWs are expanded or redeveloped.
C8	C8.0	Create strategic connections between STWs (e.g., wastewater ring main)	Similar to the London Water Ring Main this could be a large infrastructure project that would allow most/all catchments to discharge into a single infrastructure pipe/tunnel and then allow any or all of the STWs to extract from this ring main and treat the flows.
C9	C9.0	Intercompany wastewater transfers	Transfer sewage effluent from catchments within our region to STWs in neighbouring water and waste companies that had spare capacity.
D1	D1.1	Screening in the network	Removing screenings in the network would result in less blockages and optimal use of sewer capacity. Less screenings capacity would then be required on site and/or more screenings could be removed on site therefore reducing the risk of screens being overwhelmed and blockages on the site resulting in out of service plant thus increasing the sites resilience. Technology such as coarse or fine screens could be used. Skips and odour control would be required.

Generic option reference	Generic sub-option reference	Generic sub-option title	Generic sub-option title description
D1	D1.2	Remove fats, oils and grease in the network	Removing fats, oil and grease in the network would result in less blockages and optimal use of sewer capacity. For removal in the catchment then technology such as Dissolved Air Flotation could be used to remove grease. This would require additional storage tanks in the network.
D1	D1.3	Primary settlement in the network	Primary treatment in the network would reduce the requirement for similar capacity on site. This would only be possible where the volume of settled flow can subsequently diverted directly to secondary treatment. Compact technology with associated sludge holding tanks could be located near major pumping stations.
D1	D1.4	Chemical treatment within the network	Adding treatment chemicals into the network reduces septicity and enhances primary treatment at the site. This improves the treatability of the sewage and also improves the performance of existing processes
D1	D1.5	Biological treatment within the network	Use of return activated sludge nitrates, granular activated sludge or media treatment in the network to reduce treatment requirement on site. Periodically oxygen would have to be added to continue the biological treatment.
D1	D1.6	Other within-sewer treatment	Within-sewer treatment options (e.g., fatberg dissolving enzymes, peroxide) to begin treatment processes in advance of sewage treatment works. Eliminates or reduces risk of blockages and corrosive by-products).
D2	D2.1	Optimising maintenance performance	Asset digitisation, enhanced capital maintenance and increased operator training
D2	D2.2	Real Time Control Implementation (including supervisory control and data acquisition upgrades and automation)	Real Time Control is about managing and controlling the works based on the actual flows and loads arriving at the site rather than on a set profile.
D3	D3.0	Replace/retrofit/expand existing primary/secondary treatment processes using existing process types or more intensive processes	Chemically Assisted Primary Sedimentation, Dissolved Air Flotation, Lamellas, and sand ballasted primary treatment are some of the 5+ methods of getting more intensive Primary treatment from a smaller area of land than traditional processes. There are a range of different technologies that have been identified for increasing the intensity of secondary treatment processes at the STW either with retrofitting or new build, e.g., modular stacked treatment processes.
D4	D4.1	Buy land and expand STW (effluent and sludge treatment)	Buy land and expand STW (effluent and sludge treatment)
D4	D4.2	Buy land and move sludge treatment to new location. Expand effluent stream on remaining land.	Buy land, either locally or elsewhere and move sludge treatment to new location. Expand effluent stream on remaining land. Can also include removing return liquors.

Generic option reference	Generic sub-option reference	Generic sub-option title	Generic sub-option title description
D5	D5.0	Construct new/additional STWs	Provide one or more small new wastewater treatment facilities (1000 to 50,000 pe) and re-direct a sub-section of the existing wastewater catchment into these facilities. This reduces the demand for wastewater treatment at the main STWs.
D6	D6.0	Centralise STWs	One or more mega-works serving a large area (L2) of our region. This could be on the site of an existing STW or on an entirely new site. This option includes the closure and abandonment of other STWs.
D7	D7.1	River catchment-based discharge permitting	Catchment-based discharge permitting (optimising operational and environmental headroom). Some deterioration or less stringent discharge permit criteria allowed in certain locations with conditions improved elsewhere (potentially more stringent permit criteria at certain sites). Net overall benefit.
D7	D7.2	Environmental effects-based permitting	Discharge permitting based on bioavailability or ecological impact rather than water quality. Reflects the fact that the relationship between water quality and ecological quality is often non-linear and difficult to predict.
D7	D7.3	Treatment process-based permitting	Treatment process- based permitting where the permit requires specific treatment processes and conditions to be deployed at a site (rather than the discharge quality that should be achieved) - permit compliance determined through provision of evidence that influents have been subject to the agreed treatment processes (follows example of sludge treatment principles).
D8	D8.1	Real-time quality monitoring and dynamic consenting	Real-time effluent and receiving water quality monitoring to improve statistical confidence, reduce uncertainty and allow for dynamic consenting.
D8	D8.2	Real-time quality monitoring with automated process response	Real-time effluent and receiving water quality monitoring to improve statistical confidence, reduce uncertainty and allow for dynamic consenting.
D9	D9.1	Treatment of diffuse pollution sources (inputs to river)	Treat the chemical inputs to the river from sources other than STWs e.g., from agriculture, road and trading estate run-off, in lieu of STW-based treatment options to achieve the equivalent environmental outcome.
D9	D9.2	Treatment of diffuse pollution sources (inputs to sewer)	Treat chemical inputs from non-water sector sources to reduce ultimate wastewater process treatment requirement.
D9	D9.3	Treatment of point pollution sources (inputs to sewer)	Pre-treat trade/industrial effluent. In combination with active/continuous trade-effluent monitoring (to check and verify compliance). This would be treatment at source before it is input to the sewers.
D9	D9.4	Control of chemicals at source	Source control / supply chain management and engagement - setting procurement standards that preclude the use of (or limit) certain chemicals.
D10	D10.0	Indirect re-use of effluent	Allocated for further investigation

Generic option reference	Generic sub-option reference	Generic sub-option title	Generic sub-option title description
D11	D11.1	Increased use of technology for energy recovery and reuse	Not progressed further during the ODA process
D11	D11.2	Increased use of technology for organics recovery and reuse	Not progressed further during the ODA process
D11	D11.3	Increased use of technology for metals recovery and reuse	Not progressed further during the ODA process
D11	D11.4	Increased use of technology for bioplastics/biofibre recovery and reuse	Not progressed further during the ODA process
D11	D11.5	Bacteria and virus recovery and reuse	Not progressed further during the ODA process
D11	D11.6	Resource recovery permitting	Not progressed further during the ODA process
D12	D12.1	Sludge transfers (cross-company, internal, from centralised STW)	Transfer of sludge from our STWs to the STWs of another company, from areas/sites of under capacity to areas/site of overcapacity. This could be within an existing site or to alternative sites, from decentralized treatment works which could be smaller STWs, local and community level treatment works to existing or new sludge treatment centres.
E1	E1.1	Wastewater awareness campaigns	Campaign to improve public awareness of IUR wastewater system, its challenges and our aspiration to develop closer partnerships with customers in the future.
E1	E1.2	Educational programme for kids and schools	Engaging children now so they become future advocates of sustainable water use.
E1	E1.3	Build partnerships for wastewater education and awareness	Identify and engage with delivery partners to successfully implement campaign initiatives and educational programmes.
E1	E1.4	Increase visibility of wastewater operations	Increase public visibility of drainage and wastewater operations to increase awareness and influence behaviour.
E2	E2.1	Gamification in wastewater industry	Allocated for further investigation
E2	E2.2	Relax planning requirements	Allocated for further investigation
E2	E2.3	Fast track planning	Allocated for further investigation
E2	E2.4	Dynamic tariffs -storm water	Allocated for further investigation
E2	E2.5	Dynamic tariffs - wastewater reuse	Allocated for further investigation
E2	E2.6	Disincentivise unsustainable wastewater use	Allocated for further investigation
E3	E3.1	Enhance regulatory requirement for long-term wastewater and drainage investment	Water utility regulatory framework to encourage investment based on wider benefits (such as air quality, amenity value etc.) to better facilitate strategic long-term system interventions in addition to partnership working.

Generic option reference	Generic sub-option reference	Generic sub-option title	Generic sub-option title description
E3	E3.2	Building design planning requirements	Green infrastructure to delay run-off providing in catchment storage and pre-treatment capacity (e.g., distributed water butts, specific consideration for building design). Household / Building grey-water or water re-use systems in conjunction with on-site water treatment.
E4	E4.1	Entrepreneurial model for wastewater reuse	Allocated for further investigation
E4	E4.2	Thames Water Household Treatment Services	Allocated for further investigation
E4	E4.3	Digitisation and digital operation of our assets	Allocated for further investigation
E4	E4.4	Partnership led SuDS delivery	Allocated for further investigation
E4	E4.5	Rebrand Thames Water	Allocated for further investigation
E4	E4.6	Outsourcing & subsidiaries	Allocated for further investigation
E5	E5.1	Top-down incentivisation for public space partnership schemes	Allocated for further investigation
E5	E5.2	Common benefit framework for public-space upgrades	Allocated for further investigation
E5	E5.3	Centralised planning and management of all public spaces upgrades at city level	Allocated for further investigation
E5	E5.4	City wide integrated collaboration research	Allocated for further investigation
E5	E5.5	Local authority funding partnerships	Allocated for further investigation
E5	E5.6	Wastewater local community groups	Allocated for further investigation
E5	E5.7	Integrated community masterplans	Allocated for further investigation
E6	E6.0	Influence where growth can occur	Not progressed further during the ODA process
M	M	Monitor risk	Risk monitoring. Approach is dependent on the risk type and will need to be specified prior to feasible option development.
WC	WC	Wild card options	Option that does not naturally fall under any of the other generic options.
WR	WR	WRMP integrated scheme	Option that integrates with a particular option in the WRMP.

Table A1-2 Generic sub-options

Appendix B Summary of generic options for customer engagements

Having identified the types of options that can be used to address long-term challenges, we undertook research to understand our customers preferences, to find out, for example, if any options were unacceptable to them and why. The ‘generic’ options were summarised into 16 categories and presented to six customer focus groups, during May 2021. This provided qualitative insights to understand the level of customer support for the main types of options.

The following pages present the generic option descriptions that were used during our customer engagement.

Rainwater collection and use in buildings

What is it?

Rainwater is collected and stored so that it can be treated to a good enough standard for re-use e.g. to flush toilets or as part of industrial or cooling processes

Already used?

Limited use, typically in industrial and commercial properties

Pros

- ✓ Rainwater is stopped from entering the sewers, and so reduces the risk of storm overflows or flooding during storm events
- ✓ Re-use of rainwater means less water needs to be taken from the environment and treated for water supply

Cons

- ❖ It requires storage, basic treatment and ongoing maintenance and so can only be used on certain types of buildings and locations
- ❖ Difficult to fit to existing buildings

Cost	LOW
Benefits it can deliver	LOW

Treatment and recycling of household wastewater (excluding toilets)

What is it?

Recycling systems are installed in houses, industrial and commercial properties so that 'grey water' from baths/showers/sinks/washing machines is collected and treated to a good enough standard for re-use e.g. to flush toilets

Already used?

Limited use, typically in commercial properties e.g. hotels

Pros

- ✓ Reduces the amount of wastewater put into the sewer network that needs treatment and can reduce the risk of sewer flooding or storm overflows during storms
- ✓ Re-use of greywater means less water needs to be taken from the environment and treated for water supply

Cons

- ❖ Requires storage, treatment and ongoing maintenance to ensure it is recycled correctly and treatment can use quite a lot of energy
- ❖ Space required can limit use and it is difficult to fit to existing buildings

Cost	LOW
Benefits it can deliver	LOW

Managing rainwater to prevent or slow the flow into sewers in local communities

What is it?

Uses 'green infrastructure' to divert rainwater and surface water away from wastewater drains, such as:

- Green roofs that absorb and store rainfall
- Channels that send rainfall run-off to gravel/grass areas along roads or by properties
- Surfaces that let rainwater drain into the underground water table

Already used?

Yes by all water companies

Pros

✓ Rainwater is stopped from entering the sewers, or the flow is slowed down, reducing the risk of wastewater flooding or overflows during storms

✓ Helps to filter and clean surface water run-off and can create some habitat areas for wildlife

Cons

❖ Requires enough space for areas that rainfall and run off can drain in to and absorb it

❖ Requires ongoing maintenance e.g. by the local authority

Cost	MEDIUM
Benefits it can deliver	MEDIUM

Separating the combined pipe systems to create one system for wastewater and a separate one for rainwater runoff

What is it?

New pipes are built underground and the existing combined sewer system is separated. This means that sewers would take only wastewater to the treatment works, and rainwater/run-off would go into separate pipes. The rainwater does not need treatment and so can go straight into the river. Drains from properties have to be re-laid and reconnected

Already used?

Yes by all water companies

Pros

- ✓ Prevents wastewater flooding and the release of wastewater from storm overflows during storms
- ✓ Significantly reduces the amount of wastewater requiring treatment

Cons

- ❖ Involves major widespread construction which may cause disruption and noise
- ❖ If rainwater and surface water drains are connected incorrectly to the wastewater system in future, may cause pollution or wastewater flooding

Cost	VERY HIGH
Benefits it can deliver	VERY HIGH

Using alternative pathways such as open channels or roads to take rainwater away

What is it?

Rainwater and runoff is moved away from wastewater drains to where it can drain to the environment or into a dedicated surface water pipe system using 'surface water corridors' such as

- Roads/highways would be allowed to "flood" to a depth of a few centimetres;
- Open surface water channels would be built through open spaces

Already used?

Not typically used in the UK

Pros

- ✓ Prevents wastewater flooding and the release of wastewater from storm overflows during storms
- ✓ Significantly reduces the amount of wastewater requiring treatment

Cons

- ❖ Allowing surface water to flow overland at very low depths may have an impact on how we use urban spaces or roads during storms e.g. impact on pedestrians or cyclists
- ❖ Difficult to implement and needs multiple organisations to be involved

Cost	HIGH
Benefits it can deliver	VERY HIGH

Use awareness and education campaigns to reduce the amount of wastewater and contaminants in the wastewater system

What is it?

Initiatives to encourage customers and businesses to use the wastewater system correctly. For example, encouraging people to use less water and not put the wrong things down the drain (Thames Water's 'Bin It - Don't Block It campaign'), and to make sure their wastewater and surface water pipes are connected to the correct drainage system

Already used?

Yes by all water companies

Cost	LOW
Benefits it can deliver	LOW

Pros

- ✓ Using less water reduces the amount of wastewater in the wastewater network and needing treatment
- ✓ Prevents blockages caused by fat and sewage litter (e.g. cotton buds, wet wipes) and prevents sewage litter being released into rivers during storms

Cons

- ❖ Requires customers to change behaviours and maintain these changes over time
- ❖ Requires a large number of customers to reduce their water use to make a significant difference

Vulnerable properties are supplied with flood prevention measures

What is it?

Properties that are at risk of sewer flooding during storms are provided with temporary measures such as flood gates that can be fitted during storms/heavy rainfall or valves that stop wastewater coming back into properties.

Already used?

Yes by all water companies

Pros

- ✓ Easy to install
- ✓ Can protect those properties most at risk of wastewater flooding

Cons

- ❖ Does not do anything to reduce outside wastewater flooding
- ❖ Relies on property owners being able to fit the measures at the right time and continues to restrict access to the property and stops the use of sinks and toilets during storm periods

Cost	LOW
Benefits it can deliver	VERY LOW

Use of monitors and real time data to control wastewater in the sewer network

What is it?

Use technology more to increase automation of the current system and actively control the wastewater flowing through the network e.g. temporarily hold back wastewater in one area if another part of the system is full

Already used?

Not typically used in the UK currently

Pros

- ✓ Offers the opportunity to maximise the use of the existing wastewater sewer network
- ✓ If flows of wastewater are managed, it can be better dealt with at the wastewater treatment works

Cons

- ❖ Holding back flows may increase the risk of flooding or storm overflows in a different area e.g. if technology fails
- ❖ Has not yet been proven on the larger scale required

Cost	LOW
Benefits it can deliver	LOW

Increasing the capacity of the existing wastewater sewer system

What is it?

The capacity of the existing sewer systems is increased by building storm water tanks/tunnels or replacing the existing sewers with larger pipes. This would allow the current system to hold and transport more wastewater and rainfall/runoff.

Already used?

Yes by all water companies

Pros

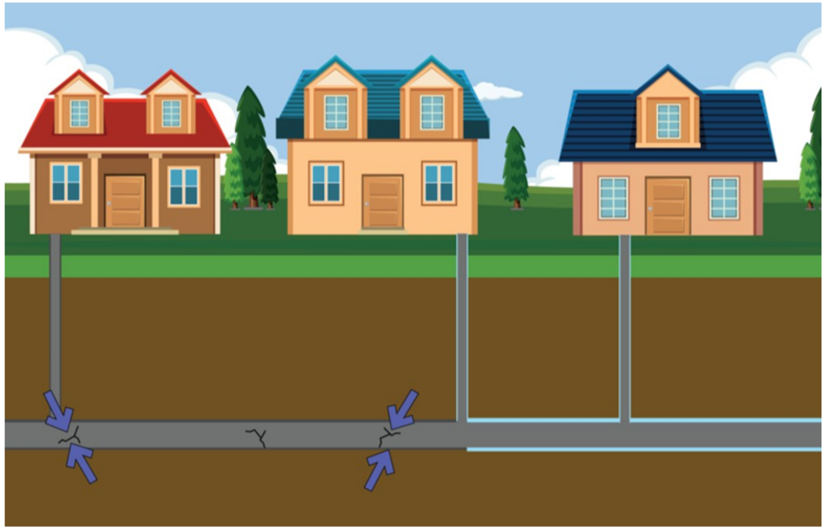
- ✓ Increased capacity reduces the risk of wastewater flooding and the amount of wastewater released from storm overflows
- ✓ Known solution which is well understood and benefits can be reliably predicted

Cons

- ❖ Involves major construction which may cause disruption and noise
- ❖ Limit on how much the capacity of the system can be increased by, e.g. due to limits on the space available underground

Cost	HIGH
Benefits it can deliver	HIGH

Re-lining existing sewers



What is it?

In some places where the underground water levels are high, the underground water can seep through any pipe joints or cracks in the pipes. The pipes are re-lined to stop this underground water getting into the wastewater pipe system.

Already used?

Yes by all water companies

Pros

- ✓ Reducing the amount of underground water getting into the pipes frees up capacity and reduces the risk of wastewater flooding and the amount of wastewater released from storm overflows
- ✓ Reduces the amount of wastewater requiring treatment

Cons

- ❖ Have to re-line long lengths of the pipe which may cause disruption and noise
- ❖ Benefits are limited as the amount of rainfall and runoff during storms is higher than the amount of groundwater getting into pipes

Cost	MEDIUM
Benefits it can deliver	MEDIUM

Building new wastewater sewers and tunnels to connect different areas

What is it?

Building large new sewers and tunnels that connect different wastewater pipe systems in to a closed system. These will allow wastewater to be moved between different areas during storms to balance the amount of wastewater and stop an area being overwhelmed.

Already used?

Not typically used in the UK currently

Pros

- ✓ Moving wastewater between different areas can reduce the risk of wastewater flooding and the the amount of wastewater released from storm overflows
- ✓ Known solution which is well understood and benefits can be reliably predicted

Cons

- ❖ Involves major widespread construction which may cause disruption and noise
- ❖ Limit on how much the different wastewater pipe systems can be connected, e.g. due to limits on the space available underground, or distance between different pipe systems

Cost	VERY HIGH
Benefits it can deliver	HIGH

Treat wastewater in the wastewater sewer pipes

What is it?

Treating the wastewater within the sewer network to reduce the amount of pollutants so that it only needs a small amount of treatment at a wastewater treatment works, or may go from the wastewater pipe system straight to the river.

Already used?

-Screening, which removes large objects such as wet wipes and cotton buds, is currently the only in-sewer treatment in widespread use.
- Other technologies are under development

Pros

- ✓ Reduces the impact of the wastewater released from storm overflows on the rivers
- ✓ May free up capacity in the wastewater treatment works

Cons

- ❖ Does not reduce the risk of wastewater flooding
- ❖ Apart from screening not typically used in the UK and the technology needs further investigations and trials

Cost	TBC after trials
Benefits it can deliver	TBC after trials

Using advanced technology to improve existing wastewater treatment works

What is it?

Using advanced technology at wastewater treatment works to increase automation and improve the treatment processes so that more wastewater can be treated

Already used?

Yes by all water companies

Pros

- ✓ Enables existing wastewater treatment works to treat the extra wastewater from population growth
- ✓ Opportunity to maximise the use of existing wastewater treatment works

Cons

- ❖ May impact on neighbouring communities due to increase in noise or bigger buildings/plant etc
- ❖ Limit on how much extra wastewater can be treated by using advanced technology

Cost	MEDIUM
Benefits it can deliver	MEDIUM

Expand existing wastewater treatment works

What is it?

Build additional or larger treatment processes on an existing wastewater treatment works to increase capacity so that additional wastewater from population growth can be treated.
This may require additional land to be purchased.

Already used?

Yes by all water companies

Pros

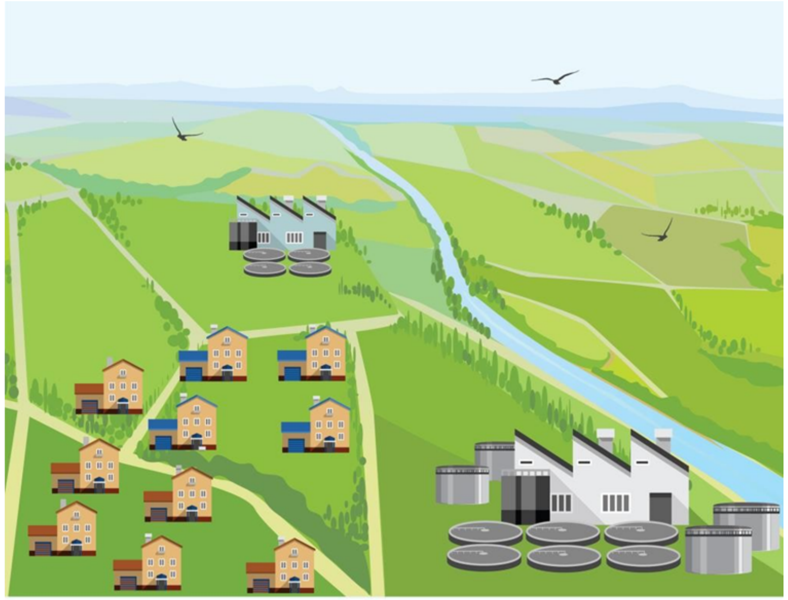
- ✓ Enables existing wastewater treatment works to treat the extra wastewater from population growth
- ✓ Opportunity to maximise the use of existing wastewater treatment works

Cons

- ❖ May impact on neighbouring communities as treatment processes move closer to them
- ❖ Building on new land may have detrimental impacts on the environment that need to be carefully considered during construction

Cost	HIGH
Benefits it can deliver	HIGH

Build new wastewater treatment works



What is it?

Build additional (potentially larger) wastewater treatment works on new sites and divert wastewater pipes to the new site. The new treatment works allow additional wastewater from population growth to be treated and may include tanks and treatment to deal with rainwater and runoff during storms.

Already used?

Yes by all water companies

Pros

- ✓ Enables the extra wastewater from population growth to be treated
- ✓ Can reduce the risk of wastewater flooding and the amount of wastewater released from storm overflows by providing additional capacity

Cons

- ❖ New sites may impact on neighbouring communities during construction and in the longer term e.g. traffic, noise, odour
- ❖ Difficult to find enough land in urban areas and building on new land may have detrimental impacts on the environment that need to be carefully considered

Cost	VERY HIGH
Benefits it can deliver	VERY HIGH

Catchment Management

What is it?

Thames Water work with other organisations and stakeholders to prevent and/or treat sources of pollution entering either rivers or the wastewater sewer network so that the overall impact on the environment is reduced. Sources of pollution may be from many different places e.g. run-off from agricultural land or contaminated surfaces, or individual sources e.g. waste from a factory that goes into the wastewater sewer system

Already used?

Not widely used by UK Water Companies for wastewater and drainage issues

Pros

- ✓ Reduces the impact on the rivers and environment from other sources of pollution
- ✓ May reduce the amount of wastewater in sewers during storms by slowing surface run-off e.g. by planting vegetation

Cons

- ❖ Difficult to implement and multiple organisations and individuals have to work together
- ❖ Sorting out how to pay for improvements could be complex eg. if Thames Water makes improvements to land/property it doesn't own, or the organisations have to pay for it themselves

Cost	LOW
Benefits it can deliver	LOW

Glossary

Term	Description
1 in 30-year storm	A storm that has a 1 in 30 chance (3.33% probability) of being equalled or exceeded in any given year. This does not mean that a 30-year flood will happen regularly every 30 years, or only once in 30 years.
1 in 50-year storm	A storm that has a 1 in 50 chance (2% probability) of being equalled or exceeded in any given year. This does not mean that a 50-year flood will happen regularly every 50 years, or only once in 50 years.
Asset Management Plan (AMP)	A five-year planning cycle used by English and Welsh water industry regulators to set allowable price increases for privately owned water companies and for the assessment of performance indicators such as water quality and customer service.
Baseline Risk and Vulnerability Assessment (BRAVA)	Following Risk Based Catchment Screening (RBCS), more detailed risk assessments on those catchments where we believed there was an adverse risk to performance over time. We modelled their performance to 2020 (baseline), 2030, 2035 and 2050.
Business Plan	Business Plans are produced by water companies every 5 years. They set out their investment programme to ensure delivery of water and wastewater services to customers. These plans are drawn up through consultation with the regulators, stakeholders and customers and submitted to Ofwat for detailed scrutiny and review.
Catchment Strategic Plans (CSPs)	Summary reports to promote system thinking across large wastewater catchments. These provide early sight of our final plans enabling co-authoring opportunities for our stakeholders. Each document outlines the challenges that the catchment will face in the future and the long-term plans to address these issues.
Combined sewer	A sewer designed to receive both wastewater and surface water from domestic and industrial sources to a treatment works in a single pipe.
Customer Challenge Group (CCG)	An independent body that challenges both our current performance and our engagement with customers on building our future plans.
Cycle 1 and Cycle 2 DWMP	Our current DWMP is referred to as Cycle 1, it covers a planning period of 2025-2050. Our next plan will be published in five years' time and is referred to as our Cycle 2 DWMP, it will cover a planning period of 2030-2055.
Department for Environment, Food and Rural Affairs (Defra)	UK government department responsible for safeguarding the natural environment, food and farming industry, and the rural economy.
Drainage and Wastewater Management Plan (DWMP)	A Drainage and Wastewater Management Plan (DWMP) is '*a long-term strategic plan that sets out how wastewater systems, and the drainage networks that impact them, are to be extended, improved and maintained to ensure they are robust and resilient to future pressures*'. The planning period is 25 years, from 2025 to 2050. DWMP is iterated every five years; the first known as 'Cycle 1', published as a final plan in May 2023.
dDWMP	The draft version of the Drainage and Wastewater Management Plan, published in June 2022.
fDWMP	The final version of the Drainage and Wastewater Management Plan, to be published in May 2023.
Dry Weather Flow (DWF)	Dry Weather Flow is the average daily flow to a Sewage Treatment Works (STW) during a period without rain.

Environment Agency (EA)	UK government agency whose principal aim is to protect and enhance the environment in England and Wales.
EA Pollution Categories 1 to 3	Category 1 incidents have a serious, extensive or persistent impact on the environment, people or property. Category 2 incidents have a lesser, yet significant, impact. Category 3 incidents have a minor or minimal impact on the environment, people or property with only a limited or localised effect on water quality. Further Ofwat guidance available here: WatCoPerfEPAmethodology_v3-Nov-2017-Final.pdf (ofwat.gov.uk)
Event Duration Monitoring (EDM)	Event duration monitoring (EDM) measures the frequency and duration of storm discharges to the environment from storm overflows.
External hydraulic sewer flooding	External flooding occurs within the curtilage of a property due to hydraulic sewer overload. Further Ofwat guidance available here: Reporting-guidance-sewer-flooding.pdf (ofwat.gov.uk)
Foul sewer	A foul sewer is designed to carry domestic or commercial wastewater to a sewage works for treatment. Typically, it takes wastewater from sources including toilets, baths, showers, kitchen sinks, washing machines and dishwashers from residential and commercial premises.
Grey infrastructure	New sewers, sewer upsizing and attenuation storage to provide additional capacity in the wastewater networks. Also covers new pumping stations, rising mains and/or civil structures at STWs.
Green infrastructure	Sustainable surface water management solutions, including sustainable drainage systems (SuDS), that are designed to mimic naturally draining surfaces. Typically applied to surface water or combined sewerage systems, but can also be applied to land, highway or other forms of surface drainage.
Historic England (HE)	A non-departmental public body of the government whose aim is to protect the historical environment of England by preserving and listing historic buildings, ancient monuments.
Hydraulic overload	Hydraulic overload occurs when a sewer or sewerage system is unable to cope with the receiving flow.
Internal hydraulic sewer flooding	Flooding which enters a building or passes below a suspended floor caused by flow from a sewer. Further Ofwat guidance available here: Reporting-guidance-sewer-flooding.pdf (ofwat.gov.uk)
L2 Area (Strategic Planning Area)	An aggregation of level 3 catchments (tactical planning units) into larger level 2 strategic planning areas. The level 2 strategic planning areas allow us to describe strategic drivers for change (relevant at the level 2 strategic planning area scale) as well as facilitating a more strategic level of planning above the detailed catchment assessments.
L3 Catchment (Tactical Planning Unit)	Geographical area in which a wastewater network drains to a single STW. Stakeholders may be specifically associated with this area. Includes for surface water sewerage that may exist which serves the wastewater geographical area but drains to a water course.
Lead Local Flood Authorities (LLFAs)	LLFAs are Risk Management Authorities as defined by the Flood and Water Management Act 2010. They have statutory duties with respect to flood risk management, investigating flooding and the compilation of surface water management plans.

Long-Term Delivery Strategy (LTDS)	A requirement by Ofwat on water companies, to ensure that short term expenditure meets long term objectives for customers, communities, and the environment. These will be submitted as part of the Price Review.
Misconnections	Misconnections are where either surface water drainage or foul water is connected to the wrong system e.g., surface water to foul only or foul to surface water systems.
Natural capital accounting	The process of calculating the total stocks and flows of natural resources in a given system, either in terms of monetary value or in physical terms.
Natural England (NE)	A non-departmental public body sponsored by the Department for Environment, Food and Rural Affairs to protect the natural environment in England, helping to protect England's nature and landscapes.
Non-governmental organisation (NGO)	An organisation that operates independently of any government, typically one whose purpose is to address a social or political issue.
Options Development and Appraisal (ODA)	A method to focus the level of planning effort, i.e., proportionate to the risks identified, with a view to providing a measure of consistency across the industry.
Ofwat	The regulatory body responsible for economic regulation of the privatised water and wastewater industry in England and Wales.
PR24	Every five years, water companies set out their plans for what they'll deliver and how much they'll charge customers[26]. Their plans over the next five years should include how they will: • Provide a safe and clean water supply • Provide efficient sewerage pumping and treatment services • Control leaks • Install meters • Maintain pipes and sewers • Maintain and improve environmental standards This process is known as the price review, and the next one will be in 2024, when Ofwat will make its final decisions. We call this PR24.
Risk-Based Catchments Screening (RBCS)	A first-pass screening exercise of catchment vulnerability against 17 different risk indicators. To understand which catchments are low risk catchments and those that are likely to be at risk in the future if not supported by our long-term plan.
Risk Management Authorities (RMAs)	Authorities responsible for Flood Risk as defined in the Flood and Water Management At 2010. These include, Lead Local Flood Authorities, Highway Authorities, Local Planning Authorities, Natural England and the Environment Agency.
Sewage Treatment Works (STW)	A sewage treatment works receives and treats wastewater to a standard legally agreed with the Environment Agency, before it is released back into the environment.
Specific, Measurable, Achievable, Relevant, and Time-Bound (SMART)	A framework for setting effective targets.
Storm overflow discharges	Storm overflows are used to manage excess flows, which typically occur as a result of heavy rainfall. Excess flow that may otherwise have caused flooding is released through a designated outfall to a water course, land area or alternative drainage system.

[26] https://www.ccwater.org.uk/priorities/price-review

Strategic Environmental Assessment (SEA)	A systematic decision support process to ensure that environmental and other sustainability aspects are considered effectively in policy, plan and programme making.
Surface water sewer	A surface water sewer collects rainwater from domestic and commercial roofs, driveways, patios etc to a local watercourse or suitable surface water drainage system.
Sustainable Drainage systems (SuDS)	Drainage solutions that provide an alternative to the direct channelling of surface water through networks of pipes and sewers to nearby watercourses. SuDS aim to reduce surface water flooding, improve water quality, and enhance the amenity and biodiversity value of the environment. SuDS achieve this by lowering flow rates, increasing water storage capacity and reducing the transport of pollution to the water environment.
Thames Regional Flood and Coastal Committee (TRFCC) area	The TRFCC area was established by the Environment Agency under the Flood and Water Management Act 2010 that brings together members representing the Constituent Authority. Featured TRFCCs are listed here on our DWMP portal: Drainage and Wastewater Management Plan (arcgis.com)
Water Industry National Environmental Programme (WINEP)	The framework under which Defra and the EA require environmental improvements to be delivered by water companies. Guidance is released by regulators, which water companies interpret for their geographical area, and resubmit the outputs back to regulators for endorsement.

Navigating our DWMP

We've developed a comprehensive document suite to share our final DWMP. This includes five summary documents that contain increasing levels of detail. To help you to navigate around our document suite and to find key DWMP content, we provide a Navigation index below and on our DWMP webpage. The orange cells refer to where key DWMP content can be found across our final document suite.

	Navigation index	Protecting the environment and providing a reliable, sustainable wastewater service							Best value and delivery					Working together		DWMP stages and data				
		Storm overflows	Sewer flooding	Level of ambition & pace of delivery	Growth & climate change	Resilience: flooding & power	Groundwater	Environmental assessments	Affordability & bill impact	Best Value	Base vs Enhancement	Solutions & deliverability	Programme alignment	Partnership working	Stakeholder & customer engagement	DWMP stages & process	Level 2 regional summaries	Level 3 regional summaries	Data tables	Risk & Assurance
Summary documents	Customer summary	●	●											●	●	●				
	Non-technical summary	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●				
	Technical summary	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●				
	The Plan	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●				
	Catchment Strategic Plans x13	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●		
Technical appendices x11	Appendix A - Strategic context												●			●				
	Appendix B - Risk-Based catchment screening															●				
	Appendix C - Baseline risk and Vulnerability assessment				●	●										●				
	Appendix D - Options development and appraisal	●										●				●				
	Appendix E - Programme appraisal	●		●		●			●	●	●	●	●			●				
	Appendix F - Stakeholder engagement														●	●				
	Appendix G - Adaptive pathway planning	●	●		●															
	Appendix H – Customer engagement Part A – Draft DWMP														●	●				
	Appendix I - Risk and uncertainty											●								●
	Appendix J - DWMP and WRMP alignment												●							
	Appendix M - Assurance																			●
New technical appendices x9	Appendix N - You Said, We Did (YSWD)	●	●	●	●	●	●	●	●	●	●	●	●	●	●					
	Appendix O - What base buys										●									
	Appendix P - Response to July 2021 Floods		●	●	●	●			●			●	●	●	●					
	Appendix Q - Storm overflows	●		●	●				●				●							
	Appendix R - Delivery of SuDS and nature-based solutions	●	●	●	●	●			●	●		●	●	●	●					
	Appendix S - Partnership opportunities and working			●								●		●	●					
	Appendix T - Groundwater quality						●													
	Appendix U - Resilience		●		●	●							●	●	●					
	Appendix V – Customer engagement Part B – Consultation Survey Report														●					
Environmental assessments	Appendix K - Strategic environmental assessment (SEA)							●												
	Appendix L - Habitats regulations assessment (HRA)							●												
Portals and data	Customer portal	●	●							●		●		●	●	●	●	●		
	Practitioner portal	●	●											●	●		●	●		
	Data tables			●							●									
	Data tables commentary																		●	

We welcome your views on our DWMP. Please share them with us by emailing: DWMP@thameswater.co.uk.

This document reflects our DWMP 2025-2050 as published in May 2023.