The Upper Thames Major
Resource Development

Stage 2 Preferred Scheme and Design Options Report

Volume 1

6 January 2007

The Upper Thames Major
Resource Development

Working in Partnership

Foreword by External Affairs and Environment Director Thames Water

In the aftermath of the 2005 and 2006 drought the issues we face in ensuring adequate water supplies for our customers remain as challenging as ever. The possibility of a third dry winter, and of future droughts, means that we all need to use water wisely if we are to minimise the prospect of water restrictions in the future.

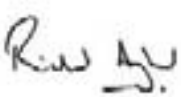
Managing demand and developing new water resources to meet the needs of our customers remains at the core of our obligations as a water company. In our Stage 1 consultation in the autumn of 2006 we set out the results of our studies into the need for water and the best way of supplying it in the future for Swindon and Oxfordshire, and London. These studies concluded that a large reservoir near Abingdon was likely to be part of a programme of supply and demand measures to secure our customers' supply in the longer term.

The Stage 1 consultation generated considerable interest from the general public as well as our regulators and other organisations. We are taking the responses that we received into account in developing the proposal for a reservoir near Abingdon. The need for a new reservoir is an important element of our Water Resources Plan, which is updated regularly in agreement with our regulators, OFWAT and the Environment Agency.

We recognise that some of the issues raised during Stage 1 cannot be dealt with immediately but require further discussions with the Environment Agency and others, and that process will continue.

The purpose of the Stage 2 consultation is to provide details of the proposed reservoir and enable the local community and other stakeholders to identify issues and influence the proposals for conservation, landscape, buildings and the provision of recreational facilities. We believe it is sensible to proceed with this next stage of our consultation, as we need to be able to incorporate the responses as early as possible into the development of the design. In advance of any application to build a reservoir we will set out how we have taken the responses to both Stage 1 and 2 consultations into account in the proposal we submit.

I trust that you will find this report and the exhibitions useful in understanding the proposals for a reservoir and will take the opportunity to contribute your views to the consultation.



Richard Aylard
External Affairs and Environment Director

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VOLUME 2

The report has been written in as nontechnical language as possible. There are, however, some words that are not in everyday use and a glossary has therefore been provided. The first use of a word covered in the glossary is marked in blue in the text.

Introduction

1 Current stage: what is this stage about?

1.1 WHAT HAS BEEN DONE SO FAR?

1.1.1 This report marks the second stage of a major study being undertaken by Thames Water so that it can meet its obligation for the long-term provision of water in its supply area. The stages of public involvement being undertaken are shown in Figure 1.1.

1.1.2 The first stage of the work, completed in Autumn 2006, identified future needs for water in the Thames Water supply area and a preferred programme of schemes (including demand management and leakage control) was identified to ensure future security of supply for Thames Water customers (see Appendix A).

1.1.3 One essential element of this programme, the subject of this ongoing study, is a large reservoir near Abingdon supplying water to:

- the Swindon and Oxfordshire area - by direct supply to the local delivery network; and
- London - by storing water and releasing it back into the River Thames when needed.

1.1.4 Consultation was carried out with the local community and other stakeholders as part of Stage 1 to explain the studies undertaken and provide an opportunity to comment on the findings and raise specific issues. Section 2 sets out the local community feedback received from the Stage 1 feedback forms and a summary of Thames Water's responses to the issues raised.

The aims of the current Stage 2

1.1.5 Following detailed work on the reservoir design, the current stage provides the information to assist the local community and stakeholders:

A. To understand the scale and technical requirements of a reservoir, the associated pipelines and treatment works, including their construction and related issues.

This is the main stage for the local community and other stakeholders to identify priority issues and potential impacts to be addressed in the design process.

B. To influence landscape design, provision for nature conservation, recreation facilities and building design.

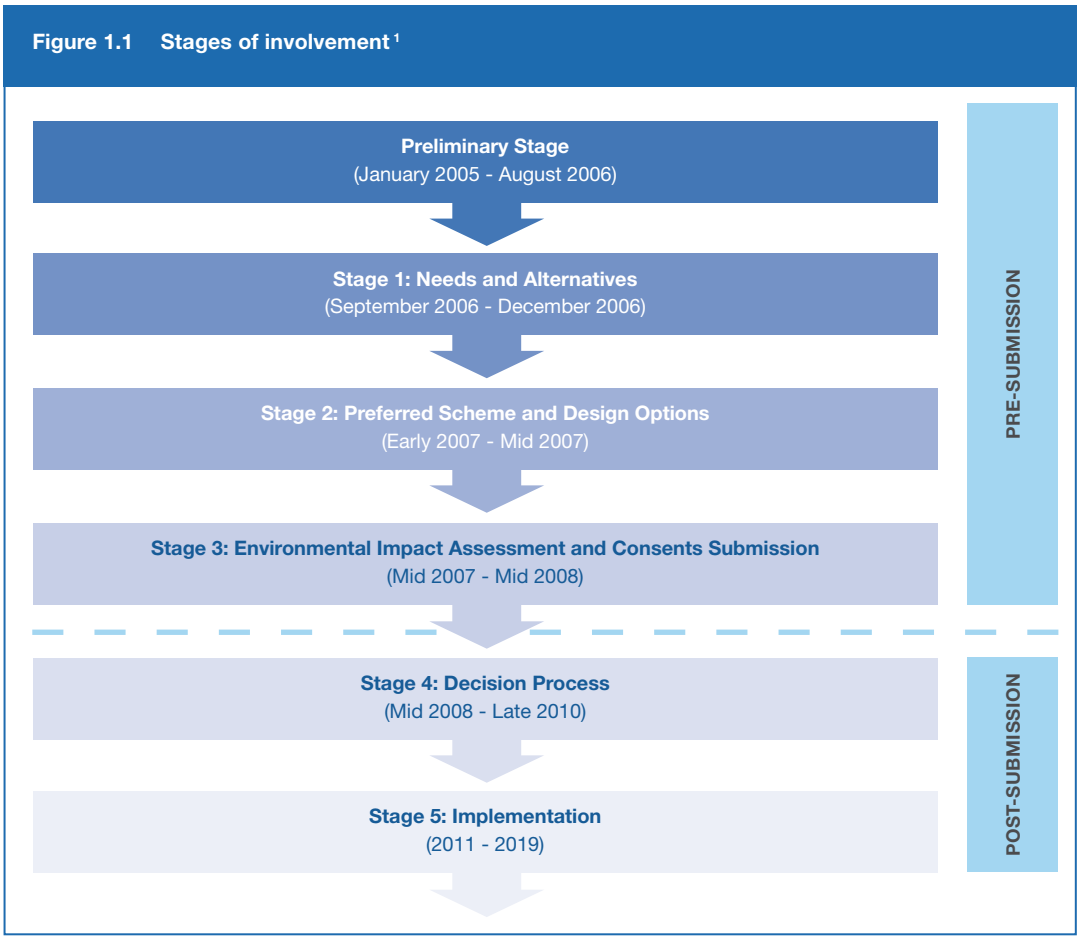
This is also the main stage for the local community and other stakeholders to express likes and dislikes amongst these opportunities, and to put forward ideas and suggestions.

The next stages

1.1.6 In the light of the output from Stage 1 and the current stage, the reservoir design will be developed in Stage 3 in conjunction with an Environmental Impact Assessment (EIA), and other assessments (e.g. economics and transport). The EIA will address environmental and social impacts, and put forward mitigation and compensation measures to reduce the effect of any adverse impacts. The reservoir design will include environmental and social benefits that could be generated through the reservoir development. It will, in addition, be subject to a Sustainability Appraisal to help optimise its performance against a wide range of sustainability objectives.

1.1.7 Following the EIA and Sustainability Appraisal, the reservoir proposals will be submitted for approval (involving formal consultation). Construction of a reservoir at this site will be subject to an application to the Secretary of State by Thames Water for a Compulsory Works Order (CWO) under Section 167 of the Water Industry Act 1991.

Figure 1.1 Stages of involvement [1]



1.2 STRUCTURE OF THE REPORT

1.2.1 The outline of the Stage 2 Report, illustrating the main opportunities for community and stakeholder involvement, is shown in Figure 1.2.

Introduction

1.2.2 Section 2 of the Introduction describes Stage 1 in more detail, including the feedback that was received and the responses to the issues raised.

1.2.3 Section 3 outlines Thames Water's strong commitment to environmental and social responsibility[2] as reflected in the study, and how this has influenced the assessment of options for the reservoir design.

[1] UTMRD Strategy for Community and Stakeholder Involvement, Thames Water, 14 September 2006.

[2] Corporate Responsibility Report 2005, Thames Water, August 2006.

1.2.4 Section 4 provides a brief summary of how the reservoir would work. This section is designed to give a useful overview before the more detailed sections that follow.

Part A: Reservoir design

1.2.5 Section 5 describes how the available technical options, enabling the reservoir to function, have been developed and selected.

1.2.6 Section 6 outlines construction tasks, their scale and likely timing, as a basis for identifying issues. Some of the means for reducing these potential construction impacts are given.

1.2.7 ***As the "Opportunities for involvement" column in Figure 1.2 indicates, Part A provides an opportunity for the local community and other stakeholders to identify priority issues and potential impacts that need to be addressed.*** Some questions are included at the end of Part A and there is a separate feedback form for making comments. A Reservoir Design Masterplan (available in Volume 2) shows the location of the main elements.

Part B: Landscape, conservation, recreation and building design

1.2.8 Section 7 describes the first suggestions for developing the landscape and improving the ecological value of the area, and introducing a range of recreation and other leisure facilities. It also outlines the development of the guiding principles for building design.

1.2.9 ***As the "Opportunities for involvement" column in Figure 1.2 indicates, Part B enables the local community and other stakeholders to be involved at a crucial stage in the development of these proposals, including the identification of likes and dislikes, ideas and suggestions.*** Some questions are included at the end of Part B. The feedback form enables comments to be recorded. The Scenario Plans included in Volume 2 are there to illustrate what could be achieved, but they are only intended to be starting points for the development of proposals.

Background documents

1.2.10 Certain information contained in this Report is based on the background technical documents as described in Subsections 5.1.3 and 5.1.4. These technical documents are work in progress and will be revised and updated over time in the light of any further developments in these areas. Copies of these technical documents are available for those who wish to read them on the Thames Water website (www.thameswater.co.uk/utmrd) and at local libraries.

Next steps

1.2.11 Section 8 describes the process to be followed in the next stages, including the Environmental Impact Assessment and Sustainability Appraisal, and the main opportunities to be involved during the current Stage 2 consultation and throughout the following stages.

Figure 1.2 Outline of the Stage 2 Report

Report structure	Opportunities for involvement
INTRODUCTION 1 Current stage: what is this stage about? 2 Stage 1: what came out of the earlier stage? 3 Sustainability: how has it influenced the proposals? 4 The reservoir: how would it work?	
PART A: RESERVOIR DESIGN 5 Reservoir design: what are the technical requirements? 6 Construction: what are the issues?	Identify • Priority issues • Impacts to be addressed
PART B: LANDSCAPE, CONSERVATION, RECREATION AND BUILDING DESIGN 7 Landscape, conservation, recreation and building design: what are the opportunities?	Identify • Likes and dislikes • Ideas and suggestions
NEXT STEPS 8 Next Steps: what involvement is possible?	

2 Stage 1: what came out of the earlier stage?

2.1 SUMMARY OF STAGE 1

2.1.1 Thames Water has undertaken an examination of future need for water and alternative measures available to meet the identified deficit. On the basis of this work the preferred long-term strategy was developed to meet the likely needs in London and in the Swindon and Oxfordshire water resource zones. This strategy included a reservoir among a range of other measures (including demand management and leakage control). A site selection process identified the site near Abingdon as the preferred site for a reservoir of the size needed.

2.1.2 At the beginning of Stage 1 of the consultation process, the Stage 1 Needs and Alternatives Report was produced[3] to present the full study and its findings. This report formed the basis of the Stage 1 consultation giving organisations and individuals opportunity to comment on the strategy as developed up to that stage. It was anticipated that:

- there would be questions to be answered in relation to the process of assessing need and alternatives and some specific concerns expressed on particular aspects of the strategy;
- there would be interest in giving initial consideration to the issues and opportunities related to the reservoir that will be examined in detail in Stage 2; and
- there would be interest in specific involvement at later stages, including participation in a workshop and a local panel.

2.1.3 The Stage 1 exhibition was open at local venues from 14th September to 14th October 2006 with staff available at all times to answer questions. The main means of making comments for the local community was via a feedback form available at the exhibition and at other venues such as the District Council's Local Service Points and at local libraries.

2.1.4 A total of 448 feedback forms were returned by 9th November. Any letters from the local community and any feedback forms received after 9th November are not included in the statistical analysis provided below. However they have been reviewed to identify whether any additional issues have been raised. These issues, together with those received before the deadline, have been passed to the Thames Water team so that they can be taken into account in the next stages of work.

2.1.5 A Report on Stage 1 Involvement[4] presents the findings from this process, together with an analysis of the issues raised and the responses from Thames Water. The report is available on the Thames Water website and on request. The rest of this section provides a summary of the main feedback received and some key responses.

2.1.6 The Stage 1 consultation also provided an opportunity for stakeholder organisations (including the Vale of White Horse District Council and the Environment Agency) to review the information and findings in the Stage 1 Report as presented at the exhibition, and to respond in writing. The technical nature of many of the issues raised by these organisations means that extra time has been allocated to understanding the issues and responding appropriately. The comments received from these stakeholder organisations and Thames Water's responses to them will be included in a further report due to be published early in 2007.

[3] UTMRD Stage 1 Needs and Alternatives Report, Thames Water, September 2006.

[4] Report on Stage 1 Involvement: Feedback from the Local Community, Thames Water, January 2007.

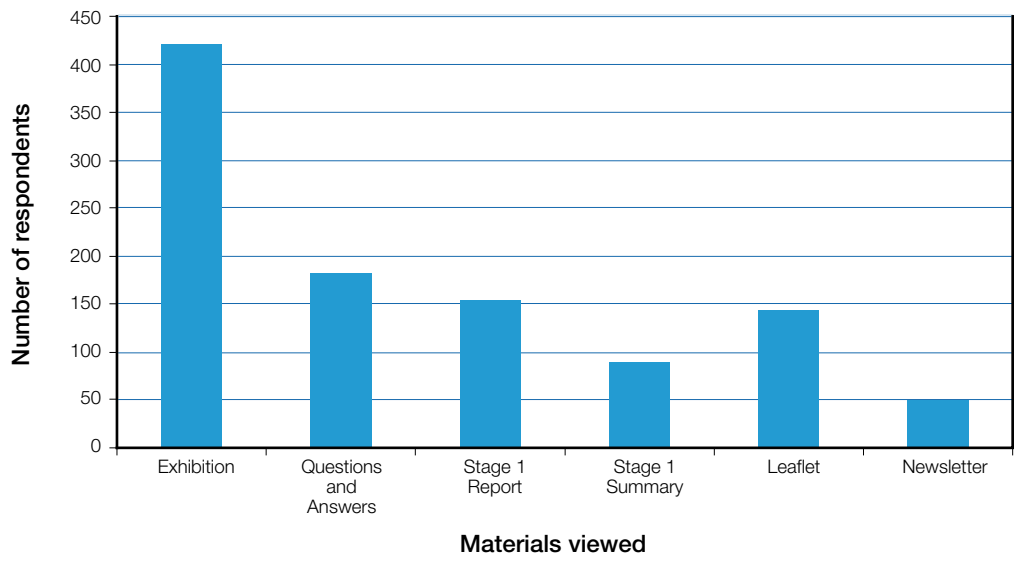
2.2 FEEDBACK

2.2.1 The main findings from the Stage 1 consultation will be used to inform the development of proposals in the stages that follow. In particular a summary will be provided to the participants in the workshops in Stage 2, and those taking part in the local panel (see Section 8).

Background of respondents

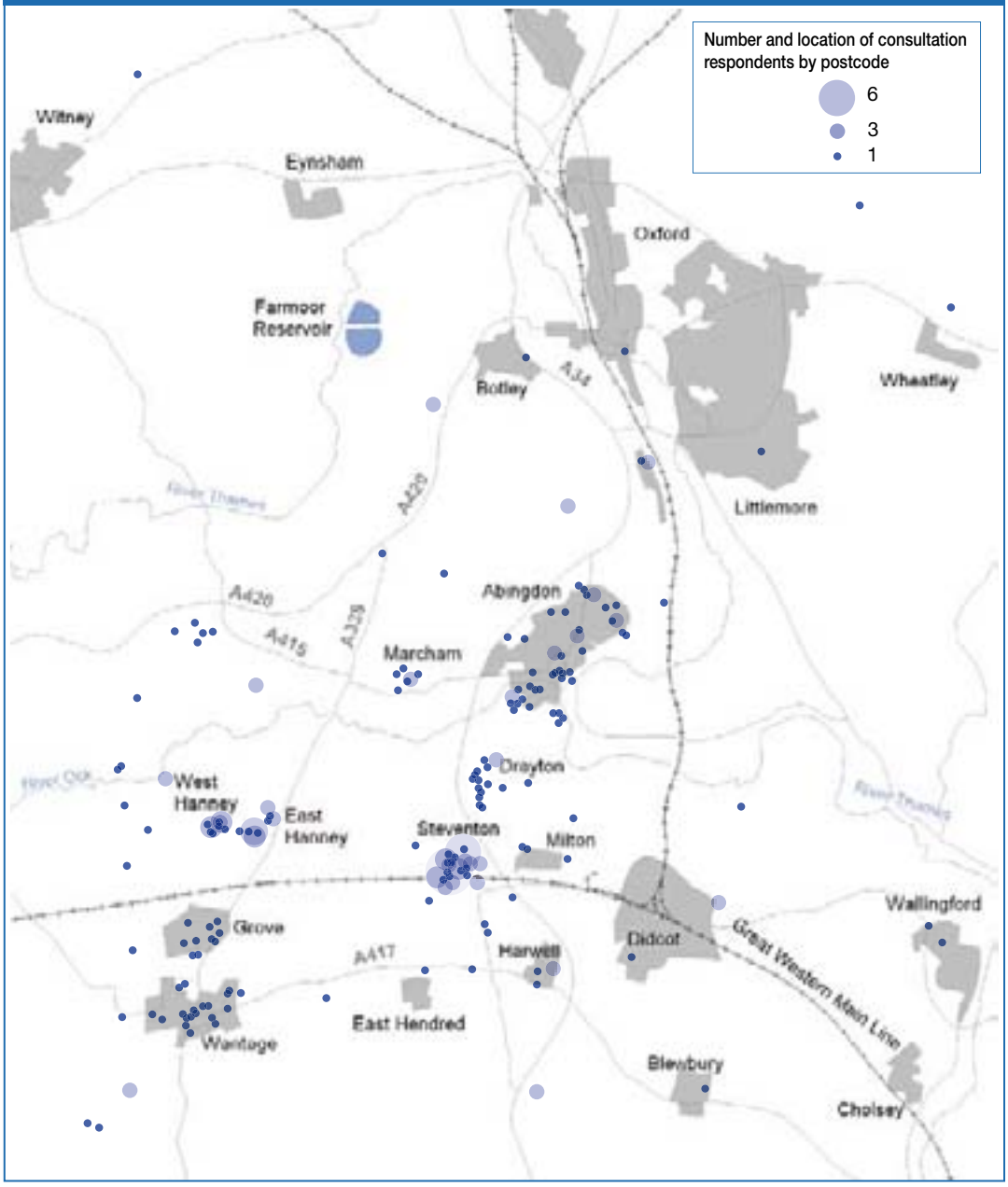
2.2.2 Figure 2.1 shows the consultation material seen by the respondents in bar chart format, with the exhibition being the main source of information followed by the questions and answers sheet. Many of the respondents had read the Stage 1 Report or the Stage 1 Summary and Overview.

Figure 2.1 Consultation materials viewed



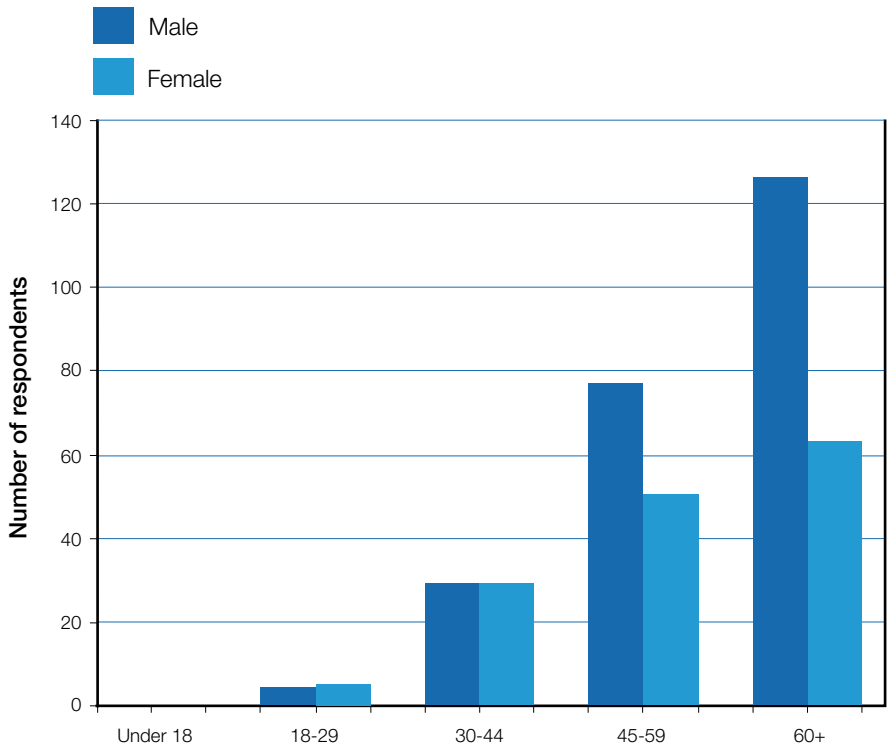
2.2.3 Figure 2.2 shows the locations of respondents by postcode, with the highest number from Steventon village, and also the concentrations at the other villages near the site.

Figure 2.2 Location of respondents



2.2.4 Figure 2.3 shows that the largest response was from males in the 60+ age group followed by males aged 45-59 and then females in both these age groups. It will be important to encourage involvement of younger people in the Stage 2 consultation, particularly in the workshops and local panel.

Figure 2.3 Age and gender profile of respondents

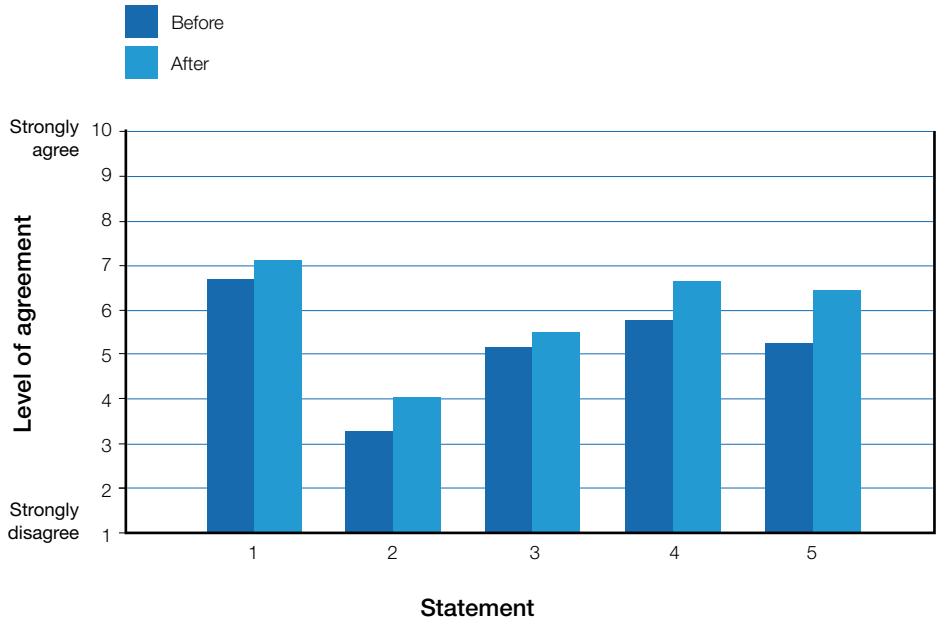


Understanding the issues

2.2.5 Figure 2.4 summarises on the scale 1 to 10 how far the understanding of each of the issues has changed following the visit to the exhibition or reading other material.

2.2.6 There is some movement on all the issues towards greater agreement with the statements after seeing the information provided. The greatest issue remains leakage control. However, there is substantial acceptance of the future water supply problem and an understanding of the need for a reservoir and the selection of the site.

Figure 2.4 Responses to key statements



Statements:
1 It is clear that there will be a major water supply problem in the future
2 Thames Water is planning for the right level of leakage control
3 Thames Water is placing the right emphasis on the careful use of water
4 I understand why a large reservoir is being proposed
5 I understand why this site has been selected

2.2.7 Table 2.1 summarises the additional comments received, with alternative means of supply and leakage control measures being the most frequently mentioned. Responses to these concerns and comments and other general issues raised are contained in the Report on Stage 1 Involvement.

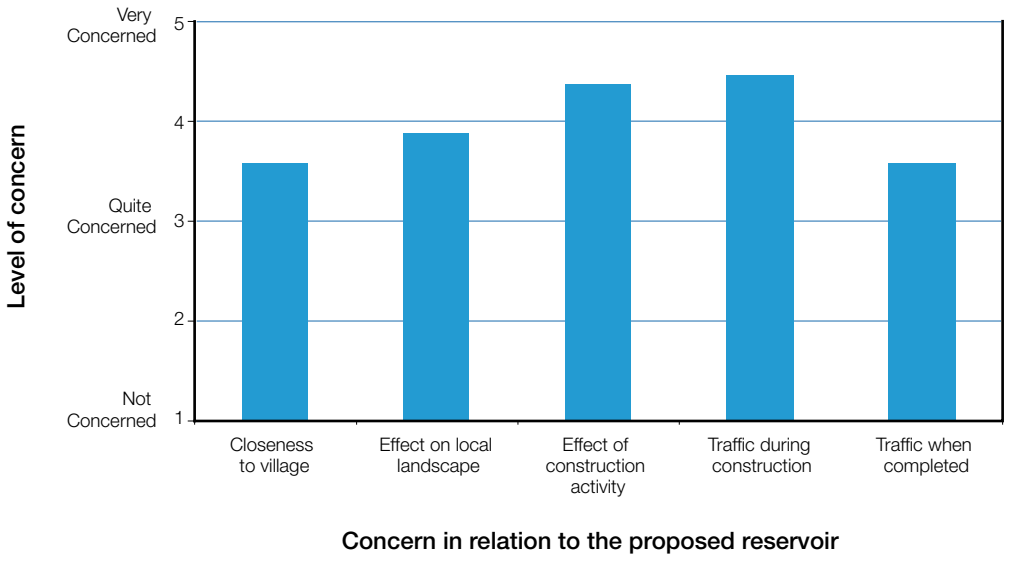
Table 2.1 General concerns and comments

General concerns and comments (in order of frequency)	
1	Thames Water needs to consider alternative approaches, such as water transfer
2	Thames Water must reduce its leakage further
3	Thames Water should encourage greater water saving measures including compulsory metering
4	There will not be sufficient flow in the River Thames to fill the reservoir
5	Thames Water should advise Government to better manage development in the South East

Expressing concerns

2.2.8 Figure 2.5 summarises on the scale of 1 to 5 the depth of concerns expressed. The majority of respondents were concerned about all the potential impacts listed, but with the greatest concerns being about traffic during construction and the effects of construction activity.

Figure 2.5 What are your concerns about a reservoir?



2.2.9 Table 2.2 summarises the additional comments received. Transport impacts during and after construction and increased risk of flooding were the most frequent concerns. The Report on Stage 1 Involvement details responses to the specific concerns raised during consultation, and provides information on how issues are being assessed further as part of the continuing design process.

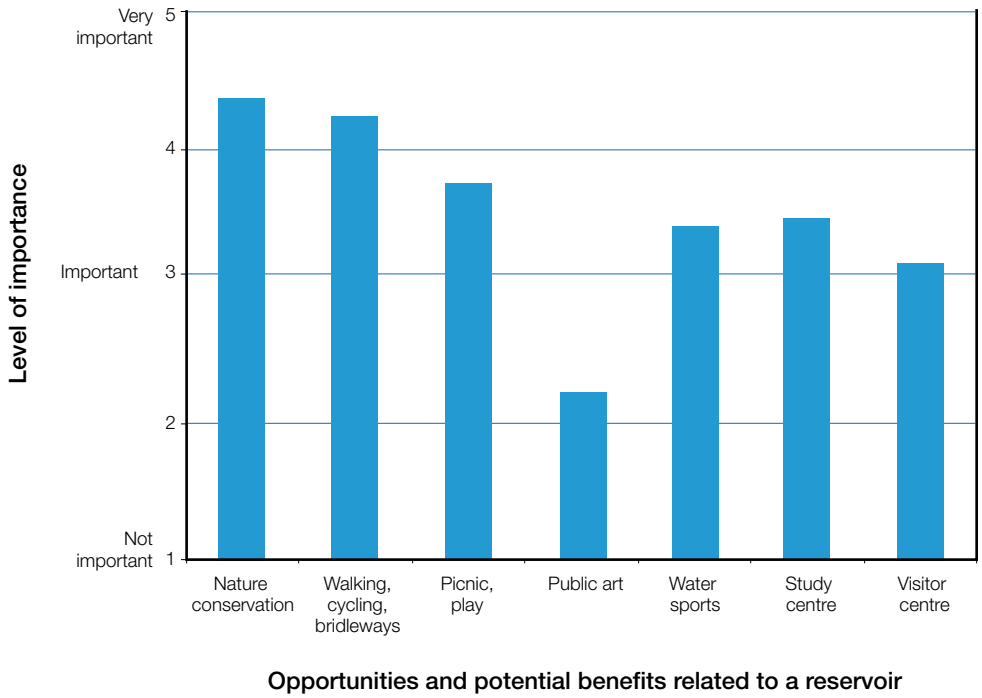
Table 2.2 Specific concerns related to the reservoir

Specific concerns related to the reservoir (in order of frequency)	
1	Traffic impacts (during and after construction)
2	Increased risk of flooding
3	Impact on microclimate
4	Impact on property values
5	Construction impacts, such as noise and dust

Identifying opportunities

2.2.10 Figure 2.6 summarises the degree of importance placed on the opportunities listed. Nature conservation and provision for walking and cycling routes and bridleways are considered to be very important, with much less emphasis on public art.

Figure 2.6 Importance placed on opportunities and potential benefits



2.2.11 Table 2.3 lists the additional comments received. The need for a range of recreational opportunities was the most frequently mentioned, followed by landscape improvements. The Report on Stage 1 Involvement responds to the issues raised and describes how opportunities are being assessed as part of the continuing design process.

Table 2.3 Opportunities and potential benefits

Opportunities and potential benefits (in order of frequency)	
1	Recreational facilities
2	Landscape improvements
3	Support for the Wilts & Berks Canal
4	Nature conservation
5	Local transport infrastructure improvements

Future involvement

2.2.12 A large number of respondents (153) expressed an interest in taking part in a workshop and/or the local panel. Invitees will be selected to ensure a range of views and interests are represented.

2.3 RESPONSE

2.3.1 The Report on Stage 1 Involvement: Feedback from the Local Community provides a full response to the issues raised via the feedback forms during the Stage 1 consultation. This subsection summarises the main elements, indicating where the issues are explored further in the Stage 2 Report.

Concerns

2.3.2 The Stage 1 consultation suggested key issues that the design team needs to address in Stage 2 and the following stages. In response to the feedback forms the following concerns need to be examined in greater depth:

- **Construction impacts including access:** in response to the concerns expressed in Stage 1, this report includes a separate section giving more information, for instance, on the construction process and timescales (Section 6). The Stage 2 consultation gives an opportunity for the local community to identify the main aspects of concern so that these can be considered in Stage 3.
- **Traffic impacts during construction:** the provision of access to the site to avoid impact on the villages is described in Subsections 6.2 and 6.3.
- **Long-term access:** the main issue of protecting the villages from traffic is covered in Subsection 5.12.

- **Proximity of the site to the villages:** information on the precise location of the reservoir and how this concern has been taken into account is given in Subsection 5.2.
- **Local landscape:** initial landscape proposals are provided in Subsection 7.2. The Stage 2 consultation provides an opportunity to influence how this is taken forward.
- **Microclimate:** the potential impact on the local microclimate can only be assessed when there is a more detailed design. This work will be undertaken in Stage 3 as part of the Environmental Impact Assessment and tested with design modifications to minimise impact.
- **Flooding and local drainage:** these concerns are examined in Subsections 5.10 and 5.11.

Opportunities

2.3.3 The Stage 1 feedback form listed some opportunities and gave the space for additional and potential benefits to be noted. The following points reflect those most often mentioned and suggest the main opportunities that the design team needs to explore as part of the continuing design process:

- **Nature conservation:** a wide range of habitats is being considered (see Subsection 7.3), and there is opportunity to suggest priorities as part of the Stage 2 consultation.
- **Provision for walking, cycling, horse riding and informal leisure:** provision for these activities is illustrated in the scenarios described in Subsection 7.5. Comments on these initial design proposals are sought at this stage.
- **Specific facilities:** a range of facilities (including recreational and educational) are suggested in the different scenarios (see Subsection 7.5 and Appendix E). Using the scenarios as a basis, comments on priorities and scales of use are sought in Stage 2.
- **Wilts & Berks Canal:** the construction of a channel which could potentially be utilised for restoration of part of the canal between the River Thames and the reservoir is detailed in Subsection 5.8. In addition Subsection 7.2 describes provision for a reserved corridor around the north-western edge of the reservoir.
- **Involvement of different sections of the community particularly young people:** Thames Water recognises the need to actively seek wider involvement including representation of young people in the workshops and the local panel in Stage 2.

Involvement

2.3.4 Due to the high level of interest in Stage 1, it has been decided to:

- increase the opportunities to take part in a workshop in Stage 2 by holding two workshops over two days (see Subsection 8.1); and
- hold exhibitions in Stage 2 at Marcham and Drayton, as well as Abingdon, Steventon, Wantage and East Hanney (see Table 8.1).

3 Sustainability: how has it influenced the proposals?

3.1 CORE ISSUES

3.1.1 Corporate responsibility is an integral part of Thames Water's business. The company's approach, and its contribution to sustainable development is outlined in the annual company Corporate Responsibility Report[5]. Working with organisations such as Forum for the Future, the company is taking positive steps to integrate sustainability principles across the whole organisation and develop sustainable approaches to its key activities and programmes.

3.1.2 Thames Water's business performance is monitored against the water industry sustainability indicators[6]. For example, the company's developing climate change strategy[7] has aspirations to generate or resource a significant amount of its operational electricity requirements from renewable sources. In addition the company undertakes its land use development activities in accordance with the relevant land use planning policy and guidance, underpinned by the core principle of sustainable development, as set out by the Government in Planning Policy Statement 1 (PPS1).

3.1.3 These policies apply across the wide range of the company's existing infrastructure and activities, but are particularly being championed for new projects, where sustainability can shape the project and be built into its design from the very beginning. Sustainability is therefore a key driver for the development of the Upper Thames Major Resource Development (UTMRD) project.

3.2 INTEGRATION WITH PROJECT DEVELOPMENT

3.2.1 The way that sustainability issues are being addressed in the studies is summarised in Figure 3.1.

3.2.2 The first level in Figure 3.1 shows that Thames Water is undertaking a voluntary Strategic Environmental Assessment (SEA) of its Water Resources Plan 2009 to the same standards as the Environmental Assessment of Plans and Programmes[8]. The SEA forms an integral part of the review of the conclusion of the earlier studies that a reservoir is a key element of the resource programme. This will ensure that environmental impacts and benefits are taken fully into account at this strategic planning stage.

3.2.3 In Stage 1, as recorded in the Stage 1 Needs and Alternatives Report (see second level of Figure 3.1), two sustainability assessments were undertaken: the first on alternative demand management and water resource schemes and programmes; and the second on alternative reservoir sites within the Thames catchment.

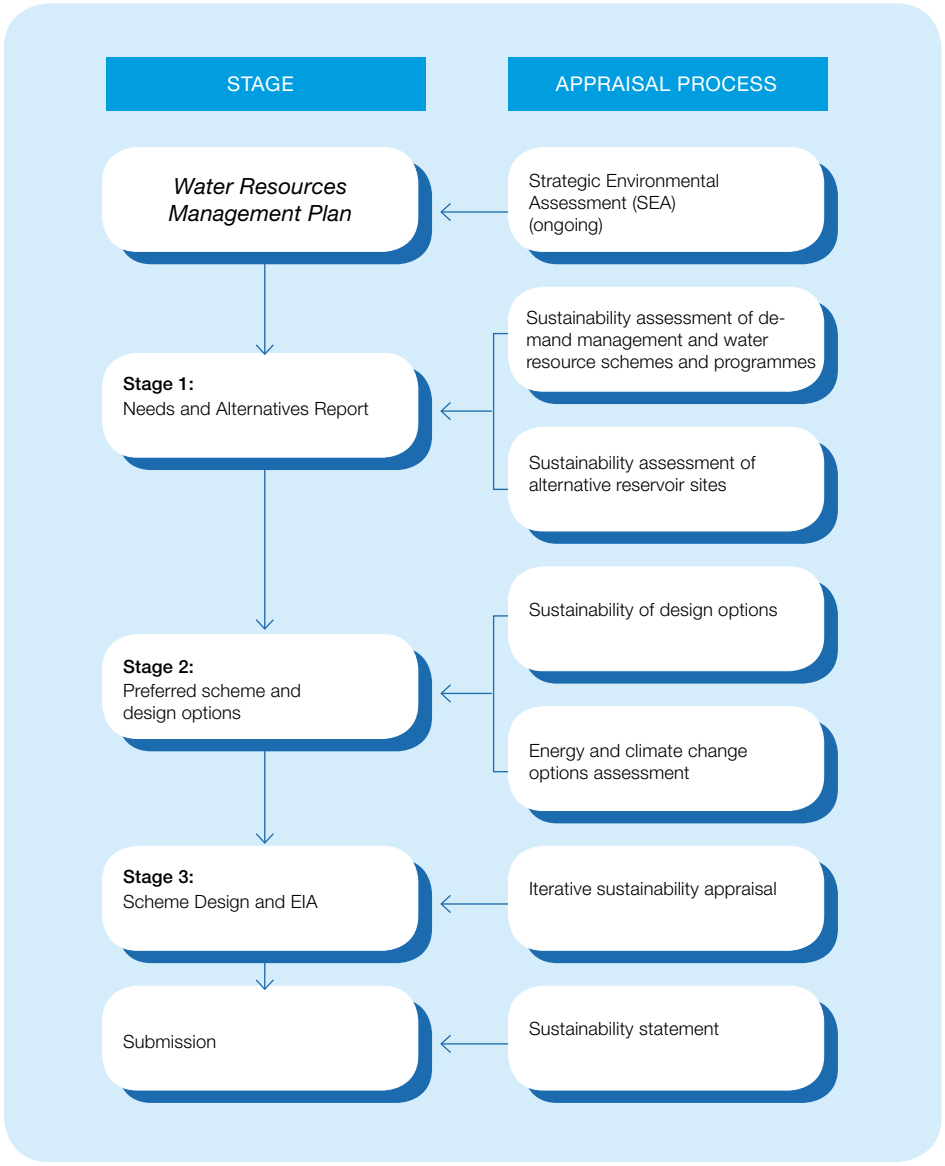
[5] Corporate Responsibility Report 2005, Thames Water, August 2006.

[6] Water UK Towards Sustainability 2004-2005 (UK Water Industry Sustainability Indicators 2004/2005).

[7] Corporate Responsibility Report 2005, Thames Water, August 2006.

[8] The Environmental Assessment of Plans and Programmes, Regulations 2004.

Figure 3.1 How sustainability is taken into account at each stage



4 The reservoir: how would it work?

4.1 INTRODUCTION

4.1.1 This section explains how the proposed reservoir and the associated water transfer, water treatment and pipelines would function. It is intended as an introduction to the proposals which are covered in greater detail in Part A of this report.

4.2 RESERVOIR OPERATION

Storage of water for use in dry periods

4.2.1 The basic function of a storage reservoir, such as that proposed, is to hold surplus river water from wet periods so that it is available for use for water supply during dry periods.

4.2.2 The water would be used for two purposes:

- to supply London by releasing untreated water from the reservoir back into the river so that it can then be taken out and treated downstream; and
- to supply water direct to the Swindon and Oxfordshire areas via a pipeline after the water has been treated.

4.2.3 The two supply functions are shown diagrammatically in Figure 4.1.

Filling the reservoir

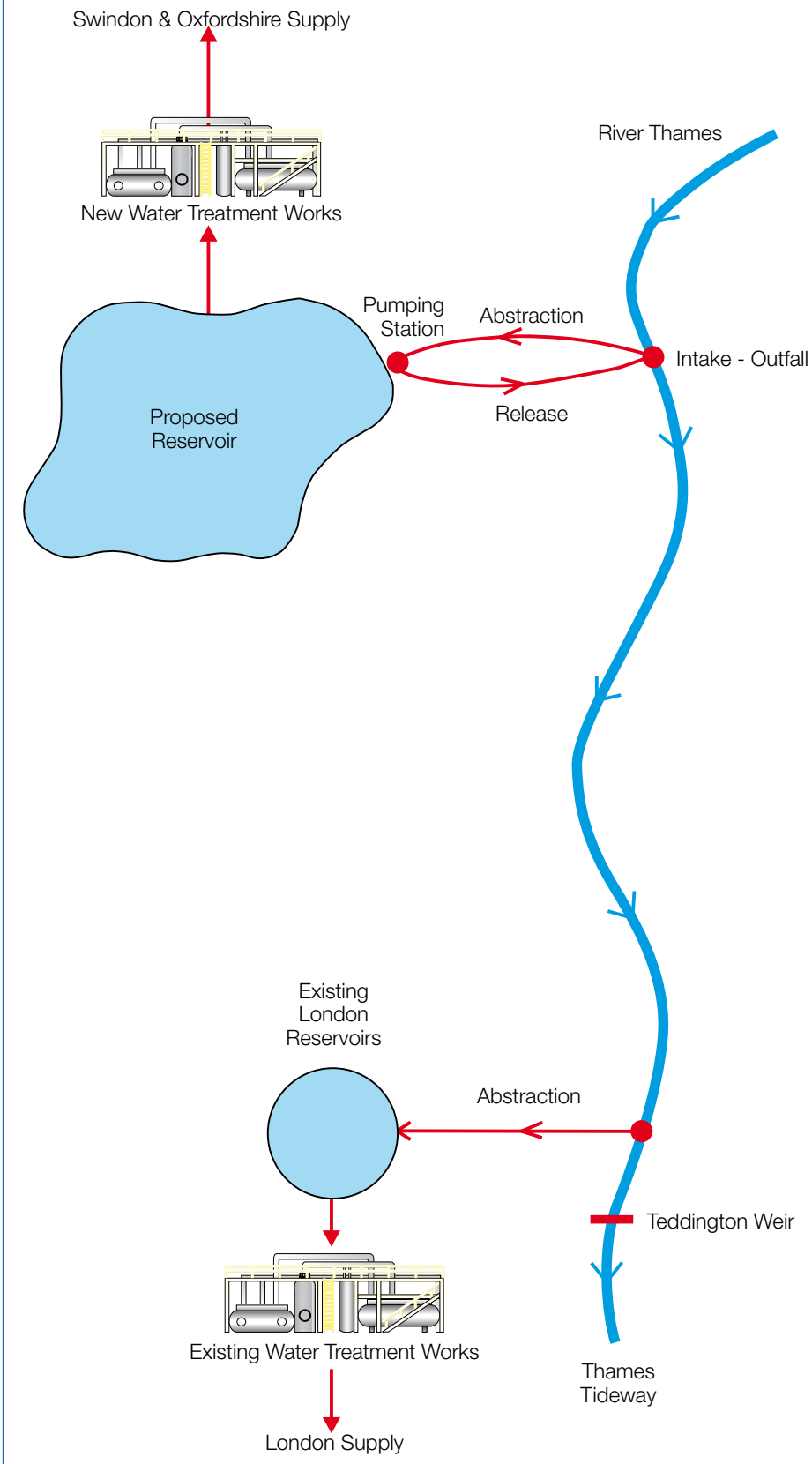
4.2.4 The stored water in the reservoir would be above river level so that it would need to be filled by pumping.

4.2.5 Water would be pumped into the reservoir, under the conditions set out in a licence issued by the Environment Agency, when both the following factors are in place:

- the level of water in the reservoir is below the full storage level; and
- the flow in the River Thames is above the minimum set by the Environment Agency in order to protect the ecology, navigation and amenity of the river.

4.2.6 During a dry period the reservoir would release stored water into the river as well as into the local direct supply system. It would then need to be refilled during the subsequent wetter months, generally in winter.

Figure 4.1: Schematic of reservoir function



Release of untreated water to the river (river regulation)

4.2.7 Since the stored water in the reservoir would be above river level, releases would normally be made by gravity. Water would be released from the reservoir when river flow is low and there is storage capacity to be filled in Thames Water's London reservoirs.

4.2.8 This process of river regulation would enable sufficient water to be pumped from the River Thames downstream (above Teddington weir) to feed London's water supply system at times when such abstractions would otherwise be restricted.

4.2.9 By increasing the flow in the river, river regulation could also potentially improve water quality and aquatic ecology. Appendix C shows how River Thames flows (measured at the Sutton Courtenay gauging station) would have been increased by the proposed reservoir in a dry summer and decreased in the following winter.

Direct supply of treated water to the Swindon and Oxfordshire area

4.2.10 Water would be drawn daily from the reservoir in both winter and summer to supply water to meet the growing demand for water in the Swindon and Oxfordshire areas. This water would be treated in a new on-site water treatment works and then pumped into the existing supply system via a pipeline.

Control of reservoir water quality

4.2.11 It is essential to prevent excess growth of algae in the reservoir to maintain good quality water for local treatment and for release back to the River Thames.

4.2.12 The growth of algae typically occurs during the summer when the temperature rises in the surface layer of water. This can be reduced by encouraging circulation of water to mix the warm surface water with the deeper cooler water, thus cooling the surface and drawing the algae deeper where sunlight cannot penetrate and therefore the algae cannot grow. Mixing can also prevent de-oxygenation of water at the bottom of the reservoir, which could otherwise have adverse ecological and water quality effects.

4.3 THE FUNCTIONS OF THE MAIN SCHEME COMPONENTS

The following is a brief description, with greater detail provided in Part A of the report. The main components are shown in diagrammatic form in Figure 4.2.

Water transfer system

4.3.1 The proposed water transfer system would require a river intake-outfall, tunnels and shafts, pumping station and reservoir inlet-outlet towers.

River intake-outfall

4.3.2 The intake-outfall is the structure through which river water would be taken from the River Thames and also through which stored water would be released. Water would flow from the river, through fine screens (to exclude fish and floating debris) situated on the riverbank, and

into a pipe connected to a vertical shaft.

Tunnels and shafts

4.3.3 When the water is being taken from the river it would flow from the intake-outfall shaft to the pumping station through a flooded tunnel. At the pumping station the water would be pumped to the reservoir through a pipe set in a separate tunnel beneath the reservoir embankment, filling the reservoir via the main inlet-outlet tower.

4.3.4 This same pipe within the separate tunnel and the flooded tunnel would be used in the reverse direction to allow water to flow back towards the river. At the river end the water would flow up the intake-outfall shaft, through to the intake-outfall structure and would be released to the River Thames over a weir.

Pumping station

4.3.5 The pumping station would connect the tunnel from the river with the tunnel under the embankment, and be situated close to the outer edge of the embankment. It would house pumps which would draw water from the river and pump it into the reservoir. It would contain control equipment to regulate releases of reservoir water to the river, and it could also house hydroelectric turbines for energy recovery during releases.

Reservoir inlet-outlet towers

4.3.6 There would be three towers in the reservoir: one main inlet-outlet tower in the north-east corner and two outlet-only secondary towers. The main inlet-outlet tower would be over a shaft at the end of the tunnels. This tower would allow:

- filling of the reservoir with water from the river through any one of three inlet jets, designed to promote the circulation of water within the reservoir. The choice of jet to be used at any one time would be controlled by valves situated in the base of the tower; and
- water to be drawn from the reservoir for release to the river or the direct local supply from any one of three outlets set at various levels in the tower, depending on reservoir water level.

4.3.7 The two secondary towers would allow the reservoir operator to select alternative locations from which to draw the stored water (for both release to the river and direct local supply) according to water quality at the time. Water from these towers would flow to the main tower via pipes located in the base of the reservoir.

Reservoir water quality control system

4.3.8 In order to ensure acceptable water quality (see paragraphs 4.2.11 and 4.2.12), the reservoir would be equipped with air mixing diffusers and water quality monitoring equipment. These would work in addition to the inlet jets that would promote natural circulation in the reservoir when water is being pumped into the reservoir (normally during the winter months) as described in paragraph 4.3.6.

4.3.9 Air diffusers, situated on the reservoir base, would mix the water by bubbling compressed air into the reservoir during the summer months when warmer water, otherwise left on the surface, could encourage excessive growth of algae. Compressors located in the pumping station would supply the air via a network of distribution pipes. Water quality in the reservoir would be monitored using equipment fixed to the towers.

Auxiliary drawdown system

4.3.10 An essential safety feature of all reservoirs built in the UK is a system which can rapidly reduce the reservoir water level. For the proposed reservoir there would be two means of reduction:

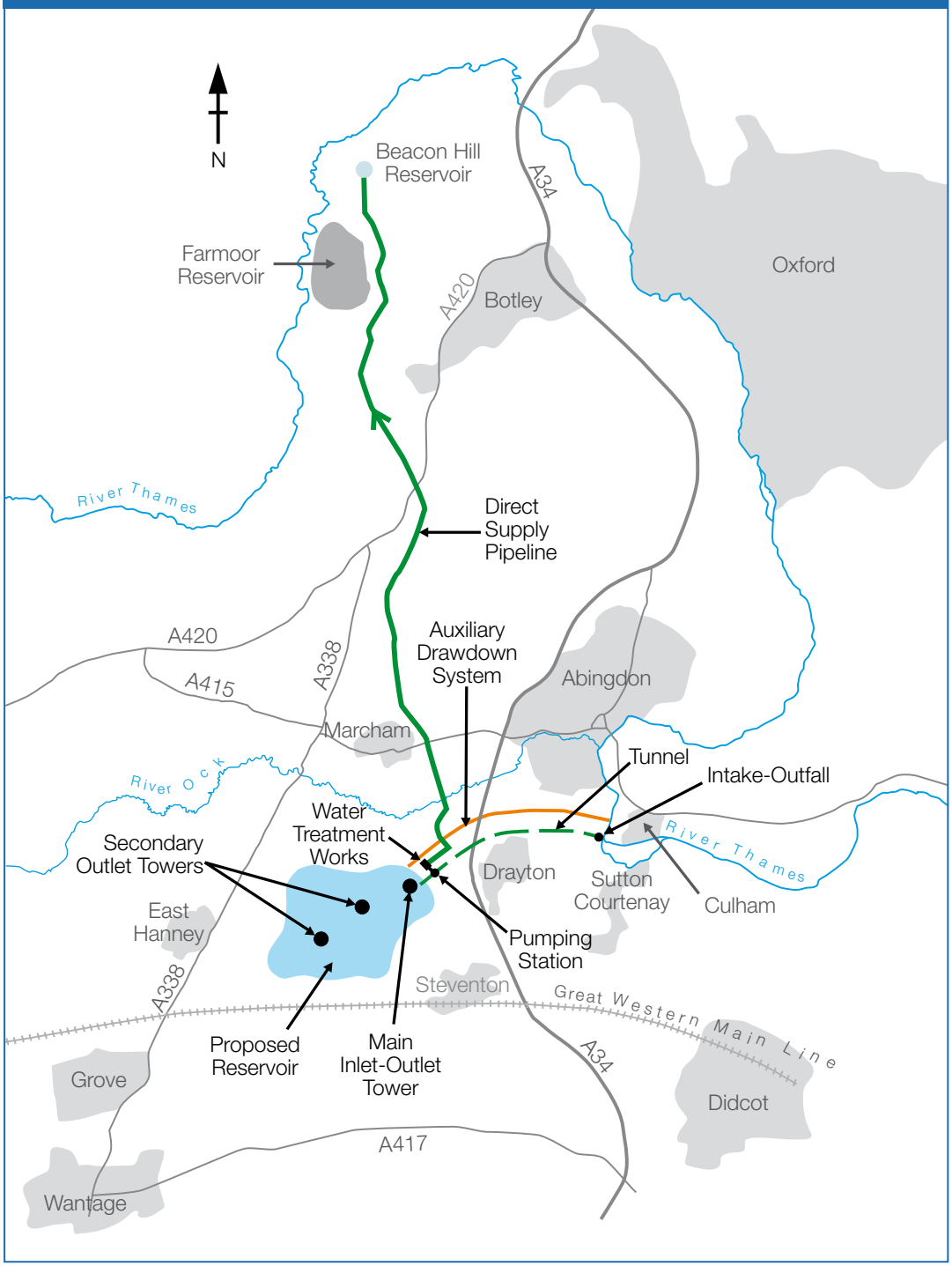
- the main tunnels, allowing water to be released to the River Thames via the intake-outfall; and
- an auxiliary drawdown system, consisting of siphon pipes over the embankment and an open channel leading to the River Thames, if a higher rate of water level reduction were required.

Direct supply system for Swindon and Oxfordshire

4.3.11 The direct supply system would comprise:

- a water treatment works to treat the stored water from the reservoir;
- a pipeline to connect the water to the Swindon and Oxfordshire supply system; and
- a plant to treat the wastewater from the water treatment process before it is discharged to the River Thames.

Figure 4.2: Main components of preferred scheme



Part A:
Reservoir Design

INTRODUCTION

Part A describes how the available options to enable the reservoir to function, have been developed and selected (Section 5), and outlines the construction tasks, their scale and likely timing (Section 6).

There is limited opportunity to change the main proposals because of the technical requirements involved, but construction impacts can be reduced by careful design. Thames Water would welcome feedback on local priorities and issues that could be addressed as the design is taken forward.

A set of questions is provided at the end of Part A.

5 Reservoir design: what are the technical requirements?

5.1 INTRODUCTION

5.1.1 A dual function reservoir of the type proposed represents a major engineering operation. Projects on this scale give rise to a number of technical requirements and there are usually choices as to the most appropriate way to meet these requirements. These choices are the design options. The purpose of this section of the report is to explain how the preferred design options have been selected. Ultimately these options come together to form the overall scheme and this is illustrated in the Reservoir Design Masterplan in Volume 2. The Masterplan also shows local features mentioned in the text.

5.1.2 The Reservoir Design Masterplan comprises the basic technical components of the scheme, selected following extensive option assessment. Sustainability considerations have featured prominently in the assessments, and the option assessment methodology referred to in Section 3 has been used to identify many, although not all, of the principal engineering design elements of the scheme.

5.1.3 The elements that have been assessed are listed below:

- Reservoir layout* (5.2);
- Embankment inner face* (5.3);
- River intake-outfall* (5.4);
- Tunnels and pumping station (5.5);
- Reservoir inlet and outlet towers (5.6);
- Water quality (5.7);
- Auxiliary drawdown system* (5.8);
- Local water supply* (5.9);
- Flood compensation* (5.10);
- Stream diversions* (5.11);
- Long-term access (5.12);
- Reservoir safety (5.13); and
- Energy (5.14).
- Means of importing construction materials*(6.2)

5.1.4 The option assessment methodology described in Section 3 has been used to select those elements marked with an asterisk and a more detailed report is available for each of these assessments (see 1.2.10). For the other elements, it was more appropriate to use another approach to selecting the preferred choice, and the reasoning for this is explained in the text. Where appropriate, figures and illustrations have been included to help explain the various preferred design options.

5.1.5 Questions related to this section can be found at the end of Part A.

5.2 RESERVOIR LAYOUT

5.2.1 The reservoir is required to store 150 million cubic metres of useable water when full. A key factor in selecting the site south west of Abingdon (see Figure 4.2) was that it is big enough to accommodate a reservoir of the size required. Selecting the preferred layout of the reservoir within the site has involved careful consideration of various physical characteristics.

Geographical considerations

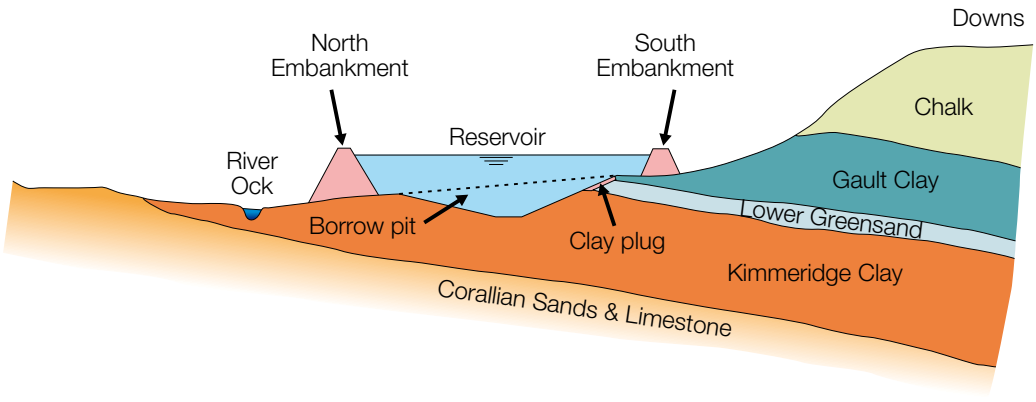
5.2.2 The area available for a reservoir has been defined by the geographical considerations listed below. These define the area within which the reservoir and associated facilities could be developed:

- the River Ock and its floodplain in the north;
- the A34 road and 132kV power transmission lines in the east;
- Steventon village in the south-east;
- the Great Western mainline railway in the south;
- East Hanney village in the south-west; and
- the A338 road in the west.

Geology

5.2.3 The geology of the site is extremely important because the underlying ground must be both strong enough to support the reservoir and impermeable enough to prevent significant leakage. The site, which is relatively flat with a gentle fall in level of about ten metres from south to north, consists of beds of Gault and Kimmeridge clay, separated by the Lower Greensand and underlain by water bearing Corallian sands and limestone. A diagrammatic cross section (with exaggerated vertical scale) of these strata is shown in Figure 5.1.

Figure 5.1: Diagrammatic geological section



5.2.4 Ground investigations at the site show that the geology is regular with no evidence of faulting, folding or significant glacial disturbance. The clay strata would provide both an impermeable foundation and an excellent embankment fill material.

Design issues

Borrow pit

5.2.5 The material for the construction of the embankment would be excavated from a borrow pit located within the proposed reservoir. The material consists of layers of overburden (disturbed material that covers the entire site) overlaying the intact clay layer. It is intended that all material excavated would be used in the embankment, with none exported from the site.
The design issues for the borrow pit are:

- it must be big enough to supply sufficient material for the embankment construction;
- the thickness of clay left in place above the Corallian sands and limestone must be sufficient (a minimum of ten metres) to limit seepage from the reservoir and prevent groundwater seepage into the reservoir when its water level is low; and
- the shape must allow good water circulation in the reservoir to help water quality.

Embankment

5.2.6 The reservoir embankment would be constructed of clay placed in horizontal layers and compacted. The overburden deposits of clay would mostly be placed on the outer face to provide landscaping and additional stability. This material, once shaped, would be covered with topsoil and planted (as described in Section 7). Internal drainage layers would be used to intercept and channel any seepage. These layers would consist of sand and gravel amounting to 1% of the total embankment volume, and would need to be imported onto the site (see Section 6).

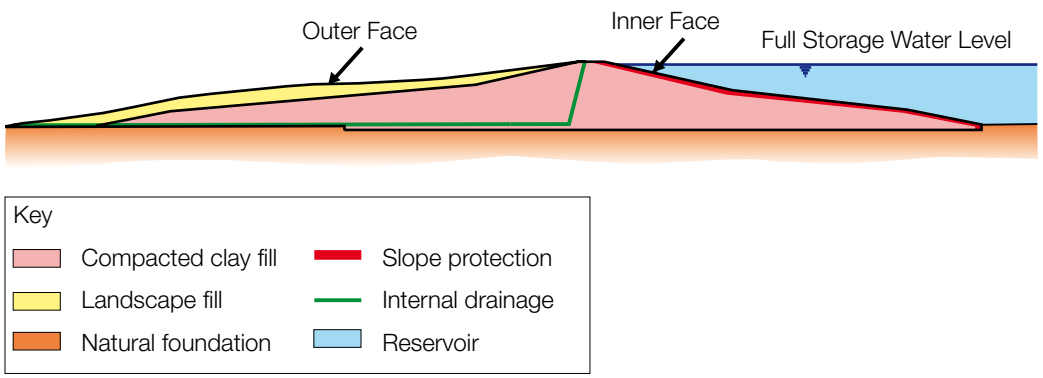
5.2.7 The profile of the embankment has been determined by the need:

- to ensure that it is stable under all conditions; and
- to use the minimum quantity of material consistent with safety to reduce importation of material.

5.2.8 The embankment profile would vary from place to place depending on the ground level and the landscape design. A typical profile is shown in Figure 5.2.

2 Corporate Responsibility Report 2005, Thames Water, August 2006.

Figure 5.2: Typical embankment profile



Height and area

5.2.9 Reservoir water volume is directly related to water depth and reservoir surface area and it is necessary to have an understanding of these dimensions before considering the specific reservoir layout. For the proposed reservoir the required storage capacity is for 150 million cubic metres of useable water. The general constraints of the site area in terms of geography (paragraph 5.2.2), and opportunities in relation to geology (paragraphs 5.2.3 to 5.2.8) would indicate a water surface area of about 6.7 square kilometres and a maximum water depth of 33 metres.

5.2.10 These dimensions of depth and surface area would require a maximum embankment height of between 15 and 25 metres above ground level (compared to the 20 metre height of the local electricity pylons).

5.2.11 Allowing one metre difference in level between the embankment crest and the maximum water level (known as 'full storage level') would result in the following basic dimensions:

- Embankment crest level: 80 metres above sea level
- Full storage water level: 79 metres above sea level
- **Bottom operating water level:** 51 metres above sea level

(Note that the existing ground level varies between 55 and 65 metres above sea level)

- Water surface area at full storage level: 6.7 square kilometres
- Water surface area at bottom operating level: 2.7 square kilometres

Reservoir layout options

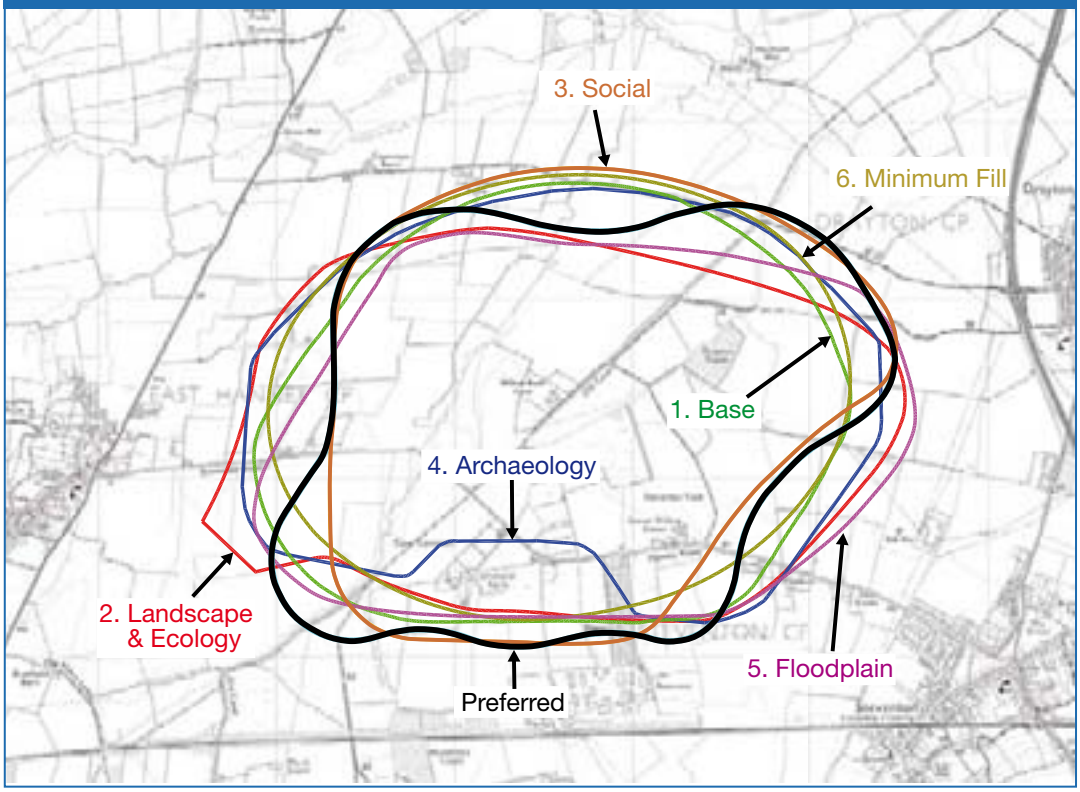
5.2.12 The basic physical characteristics described above create the parameters within which to fit the reservoir layout. There are many shapes that could fit into this site while still providing the size of reservoir required. This made it possible to experiment with different layouts, reflecting

different concerns. For example, the most efficient way to store water would be in a perfectly shaped oval bowl, but this would not create the most interesting landscape form. Therefore, for the purposes of defining the preferred reservoir layout, six options were prepared for assessment, all of which had the same area and water depth, but reflected different priorities. The six options were:

1. **Base –** a preliminary option which took account of the various constraints in a general rather than specific way.
2. **Landscape and Ecology –** where the layout was modified to reduce impacts on identified landscape and ecological features.
3. **Social –** where distance from settlements was maximised to reduce potential disruptive impacts.
4. **Archaeology –** where the layout sought to minimise damage to known archaeological resources.
5. **Floodplain compensation –** where development within the floodplain was minimised.
6. **Minimum fill volume –** a simple uniform embankment shape.

These options are shown in Figure 5.3.

Figure 5.3: Reservoir layout options



Assessment

5.2.13 There was no significant difference between the six options when considered against the sustainability criteria. Also, it was to be expected that options formulated to reflect particular concerns (e.g. Option 2 Landscape and Ecology) would perform well against the sustainability criteria which relate to these specific topic areas (e.g. impact on visual amenity).

5.2.14 However, the use of resources, expressed principally in terms of the energy required during construction, did highlight some difference between options. Options 1, 5 and 6 performed relatively well in terms of resource use. In contrast, Option 4 would be the most resource intensive because of the extra volume of fill required to construct the embankments.

5.2.15 Particular attention was paid to the potential impacts on local communities of noise and dust during construction, and of possible disturbance from traffic after completion of construction. The basic parameter used was the distance of the embankment from the villages. Option 3 performed well against this criterion. Options 2 and 4 would have corresponding distances half those of Option 3 from Steventon and East Hanney, thereby giving rise to greater potential impacts on these villages.

5.2.16 Of the environmental criteria, Options 3 and 5 perform better in terms of floodplain considerations, since they have sufficient land available to provide the required compensation flood storage. Option 5 would also result in the smallest loss of floodplain. Again, Option 4 performs relatively poorly because of the area of floodplain that would be lost, and the smaller area of land available to provide compensation storage. Options 1 and 6 performed poorly against the visual amenity criterion, principally because of the lack of visual interest that would be created if the layout simply took the form of an ellipse compared to a more sinuous embankment. Option 2 performed well against the landscape criteria, both in terms of minimising the loss of existing landscape features and creating visual interest once constructed.

5.2.17 Judged against all the criteria, Options 1, 4 and 6 were rejected. The reasons are summarised in Table 5.1.

Table 5.1: Layout options rejected

Option	Rejected on sustainability criteria	Criteria
1	Yes	Impact on visual amenity
2	No	
3	No	
4	Yes	Resource use, impact on floodplain and local villages
5	No	
6	Yes	Impact on visual amenity

5.2.18 Options 2, 3 and 5 were retained and were further assessed against risk, opportunities and cost. This further assessment did not identify a single clear preference. Since the differences between the options were slight and all had merit, a combination of the best features of Options 2, 3 and 5 was generated to provide an optimised solution. This is labelled the 'Preferred' in Figure 5.3.

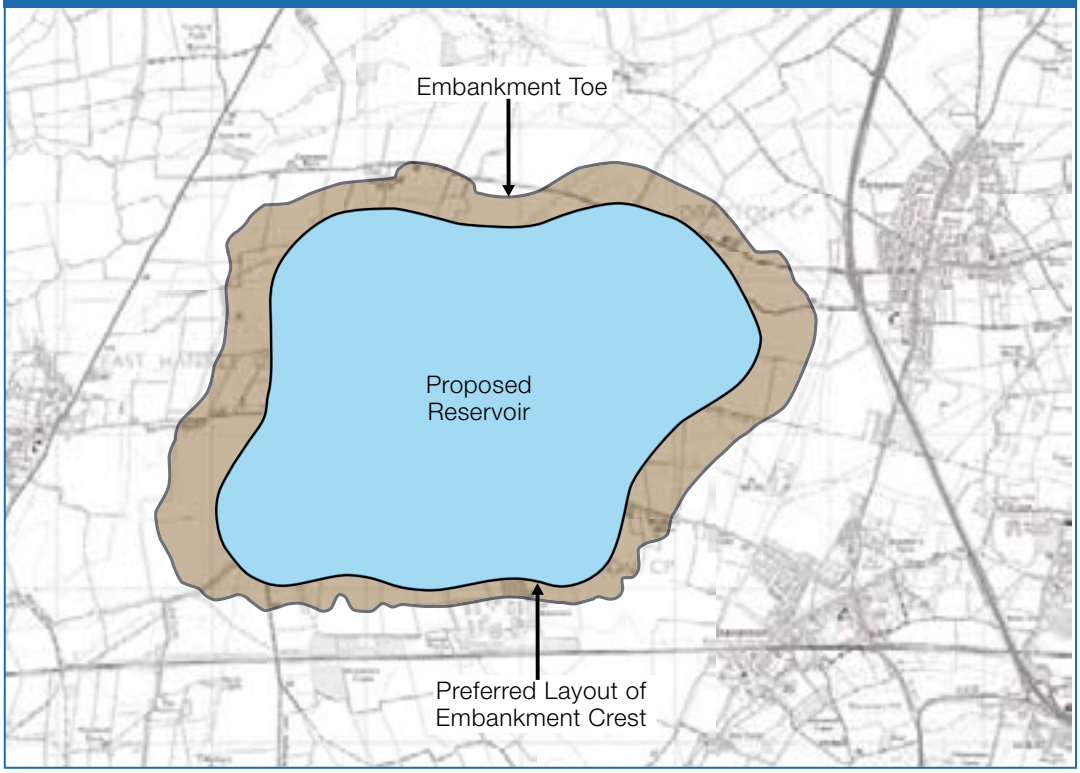
Preferred layout option

5.2.19 The preferred layout option was developed, mindful of the following points:

- the reservoir was shaped to provide the maximum distance between the embankment and the villages closest to the construction: East Hanney, Steventon and Drayton;
- in order to minimise the loss of floodplain, the reservoir was located as far south as possible and the northern boundary shaped to accommodate the Cow Common Brook floodplain as far as possible;
- locating the reservoir further south also served ecological interests by preserving as much as possible of the Drayton to Venn Mill Green Lane and the River Ock landscape, while still avoiding disturbance to Hutchins's Copse to the south; and
- the resulting modifications created a sinuous shoreline at the expense of a 5% greater volume of embankment fill (and thus **embodied energy**) but it was considered that this was outweighed by the social, ecological and landscape benefits.

5.2.20 The proposed reservoir layout is shown in Figure 5.4 and forms the basis for the Reservoir Design Masterplan (see Volume 2).

Figure 5.4: Preferred reservoir layout



5.3 EMBANKMENT INNER FACE

5.3.1 The inner face of the reservoir is the area on the inside of the embankment. For much of the time, the majority of the inner face would not be visible because it would be submerged. At other times, when the water level is drawn down, large areas of the inner face would be exposed and visible from the crest. The fluctuating water level poses a number of design challenges, notably to produce a landscape treatment which is visually acceptable while at the same time able to withstand changing water levels and erosion from wave action. For the inner face design, the assessment of options considered only materials which could provide effective protection from waves which would otherwise damage and erode the embankment. A preliminary assessment of a longlist of measures was undertaken, including bio-engineering treatments that could provide a 'natural' appearance (for instance, live willow bush, branch frameworks or floating islands). Against the criteria of effectiveness, cost and maintenance, the bio-engineering treatments were judged to perform considerably less well than other measures and were consequently rejected at an early stage in the process.

Options

5.3.2 The remaining types of inner face treatment were assessed:

1. loose rock, known as riprap;
2. beaches of sandy gravel;
3. cast concrete slabs;
4. pre-cast concrete blockwork (i.e. manufactured off-site and imported); and
5. open stone asphalt.

Assessment

5.3.3 The different types of inner face treatment were assessed against sustainability criteria. As with the layout options, the energy required to construct the inner face was important in differentiating between options. Most significantly, concrete requires energy for manufacture and construction. Pre-cast concrete blockwork requires more energy than cast concrete slabs because of the greater volume of concrete involved. Beaches would require the greatest quantity of energy for construction and the greatest volume of imported granular material because of the need for greater layer thickness and flatter slopes.

5.3.4 Landscape considerations also suggested significant differences between options. Beaches and, to a lesser extent, riprap performed better than concrete blockwork or slabs in terms of colour and texture, perceived naturalness, continuity of materials with landscape and ecological treatments and flexibility. Of particular note is the ability of riprap and beaches to provide variety in the way they could be laid. Given the length of shoreline and extent of visible shore even in only moderately drawn down conditions, the ability to provide effective variation is an important attribute.

5.3.5 Overall, Options 3 and 5 were rejected as summarised in Table 5.2.

Table 5.2: Protection material assessment summary

Option	Rejected on sustainability criteria	Criteria	Rejected on risk, opportunities and cost	Criteria
1	No		No	
2	No		Yes	Cost Limited habitat potential
3	Yes	Energy use and visual amenity		
4	No		Yes	Cost Limited habitat potential
5	Yes	Energy use and visual amenity		

5.3.6 Options 1, 2 and 4 were retained and were further assessed against risk, opportunity and cost. Options 2 and 4 were rejected as the preferred inner face treatment. Most notably, both beaches and pre-cast concrete blockwork would be significantly more expensive to construct, as well as not offering the same opportunities for habitat enhancement as riprap.

Preferred inner face treatment option

5.3.7 Riprap would be the best option from the point of view of embodied energy. Its visual characteristics (see Figure 5.5) mean that it would fit well with landscape and conservation objectives. Riprap would also be the least cost option.

5.3.8 The results of the assessment led to the conclusion that the inner face design should be based on riprap as the preferred primary protection but with other shortlisted materials used for specialist purposes in specific locations. A range of specific design solutions based mainly on riprap but with use of beaches (and some use of concrete blockwork) is described in Section 7.

Figure 5.5: Typical riprap (left) and blockwork (right) slope protection

5.4 RIVER INTAKE-OUTFALL

5.4.1 Central to the functioning of a dual-purpose reservoir is the ability to get water to and from the River Thames in the most efficient way possible. In practical terms, this suggests locating the intake and outfall facilities at the point on the right (west) bank of the River Thames closest to the reservoir site. However, there may be good reasons why the closest location may not necessarily be the most sustainable, for example, because of adverse environmental effects on a particular stretch of riverbank.

5.4.2 Thames Water undertook a comprehensive study of potential locations for an intake-outfall for the proposed reservoir as part of its earlier work in 1999. The study covered those stretches of the river between Shifford Lock and Goring from which sufficient water could be taken to enable refilling of the reservoir in one winter season following a drought. Consideration of hydraulic (water transfer) issues and costs led to the identification of three sections (or reaches) to be assessed in more detail at Abingdon, Culham and Clifton.

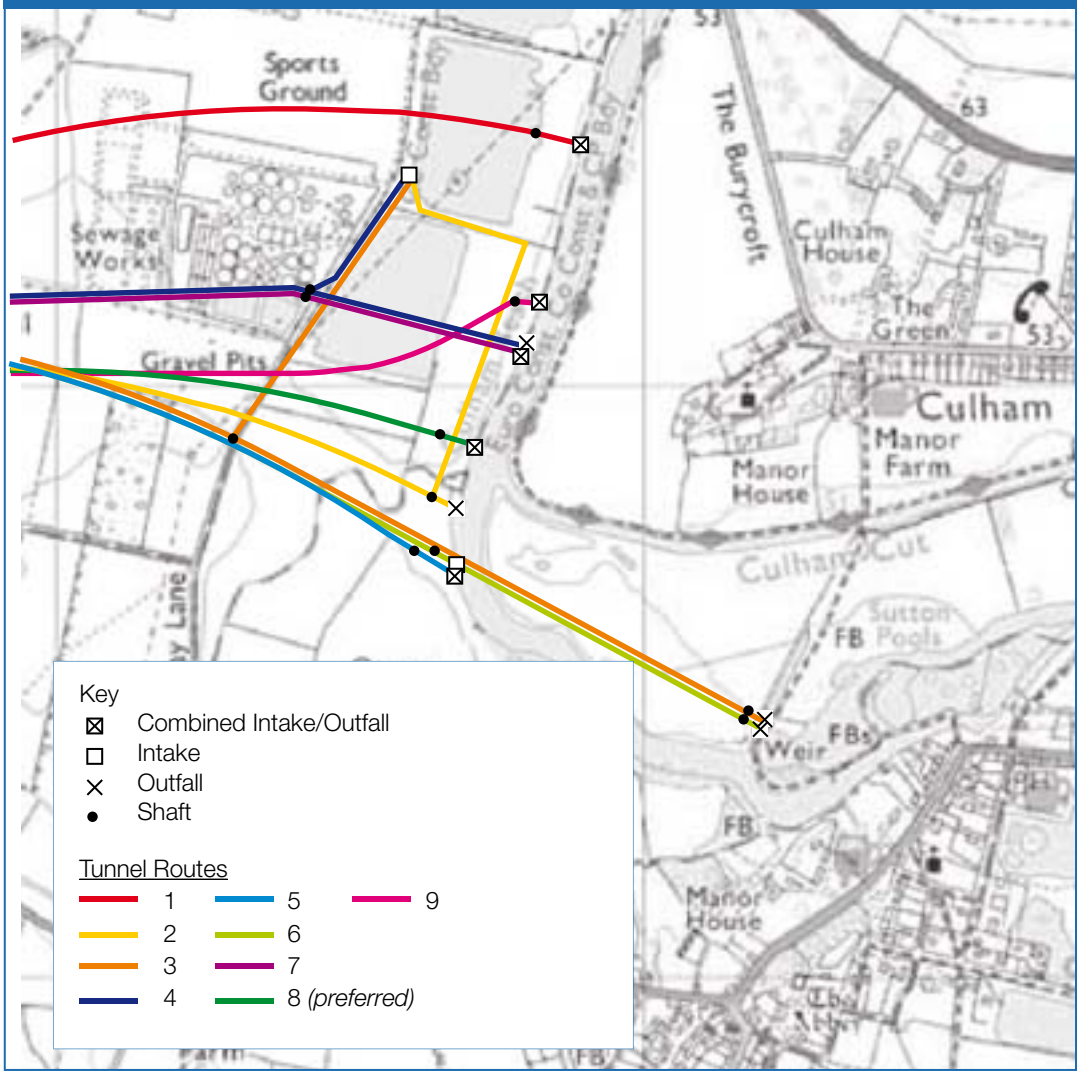
5.4.3 The detailed assessment included technical criteria (such as geomorphology, construction access and tunnel route, hydraulics and geology) and environmental criteria (such as nature conservation, water quality, landscape value, navigation, local amenity and archaeology). Culham Reach was identified as including the most favourable sections for the intake and outfall structures.

5.4.4 The more recent option assessment work has concentrated on the Culham Reach, as it was considered that the conclusions reached in 1999 remain valid.

Options at Culham Reach

5.4.5 All the options considered for intake and outfall locations identified at Culham Reach are shown in Figure 5.6. As well as considering different potential locations, the options explored the opportunity to combine the intake and outfall in a single structure or provide separate facilities at different locations along the reach.

Figure 5.6: Intake-outfall options



5.4.6 Six options were identified initially, as summarised in Table 5.3.

Table 5.3: Intake-outfall options

Option	Combined or separate intake-outfall	Intake location	Outfall location
1	Combined	Culham Reach west bank north of Abingdon Sewage Treatment Works (STW) outfall	
2	Separate	Flooded gravel pit adjacent to the river immediately south of Abingdon Marina	Culham Reach west bank south of Culham Lock Cut junction
3	Separate	Flooded gravel pit adjacent to the river immediately south of Abingdon Marina	Sutton Pools
4	Separate	Flooded gravel pit adjacent to the river immediately south of Abingdon Marina	Culham Reach west bank north of Wilts & Berks Canal junction
5	Combined	Culham Reach west bank south of Culham Lock Cut junction	
6	Separate	Culham Reach west bank south of Culham Lock Cut junction	Sutton Pools

Assessment

5.4.7 The assessment of the intake and outfall options took place in two stages. Firstly, the six options listed in Table 5.3 were assessed against the sustainability criteria. Only Options 4 and 5 were carried forward as a result of the assessment. Options 3 and 6, which would discharge into Sutton Pools, were rejected largely on the advice of the Environment Agency, who raised concerns about the impact on the sensitive habitats and flow conditions in the pools. It was also the case that these two options would require significantly more construction activity, with correspondingly greater levels of disruption, because of the longer tunnel distances involved.

5.4.8 The performance of Options 1, 2, 4 and 5 against the criteria was variable. Option 1 performed poorly on **fluvial geomorphology** (notably sedimentation in the vicinity of the intake), terrestrial ecology and landscape and visual amenity impacts. Option 2 performed poorly on energy and resource use as it would require a long pipeline along the River Thames (approximately 750 metres) in addition to the tunnel, while offering no advantages over Option 5.

5.4.9 Concerns about potential contamination were raised in relation to Options 2 and 4 because both make use of the flooded gravel pit south of Abingdon marina for the intake. There is a low risk that an intake operating in the vicinity of the gravel pit could cause releases of contaminants into the water. However, the Environment Agency has confirmed that this is not considered significant, and consequently should not be a reason for rejecting an option.

5.4.10 On balance, it was decided to reject Options 1 and 2, leaving 4 and 5 respectively as the most sustainable separate and combined intake-outfall options. The results of the assessment are summarised in Table 5.4. Options 4 and 5 were taken through to an assessment of their risks, opportunities and cost. Option 4 performed less well than 5, as shown in the last two columns of Table 5.4.

Table 5.4: Intake-outfall assessment summary

Option	Rejected on sustainability criteria	Criteria	Rejected on risk, opportunities and cost	Criteria
1	Yes	Sediment load in Culham Reach.		
2	Yes	Energy and resource use.		
3	Yes	Resource requirements, impact on aquatic ecology (Sutton Pools), and recreation		
4	No		Yes	Construction risk for tunnels, less operational flexibility, 60% more expensive than Option 5
5	No		No	
6	Yes	Resource requirements, impact on aquatic ecology (Sutton Pools), and recreation		

5.4.11 While Option 5 emerged as the preferred option for the intake and outfall works, it would result in the temporary and permanent loss of some land in the Green Belt. Given the availability of other options which would not affect the Green Belt (notably Option 4), it would be difficult to argue (in order to comply with planning policy) that alternatives outside the Green Belt are not viable. For this reason three further options, combining the best features of Options 4 and 5 but situated outside the Green Belt, were identified (see Figure 5.6), and a second round of assessment using the sustainability criteria was undertaken. The options assessed were:

- **Option 7** Culham Reach west bank north of the Wilts & Berks Canal junction
- **Option 8** Culham Reach west bank opposite Culham Lock Cut junction, south of the Wilts & Berks Canal junction
- **Option 9** Culham Reach west bank north of the Wilts & Berks Canal junction

5.4.12 The second round of assessment showed Option 8 to be clearly preferable in terms of sustainability when compared to Options 7 and 9.

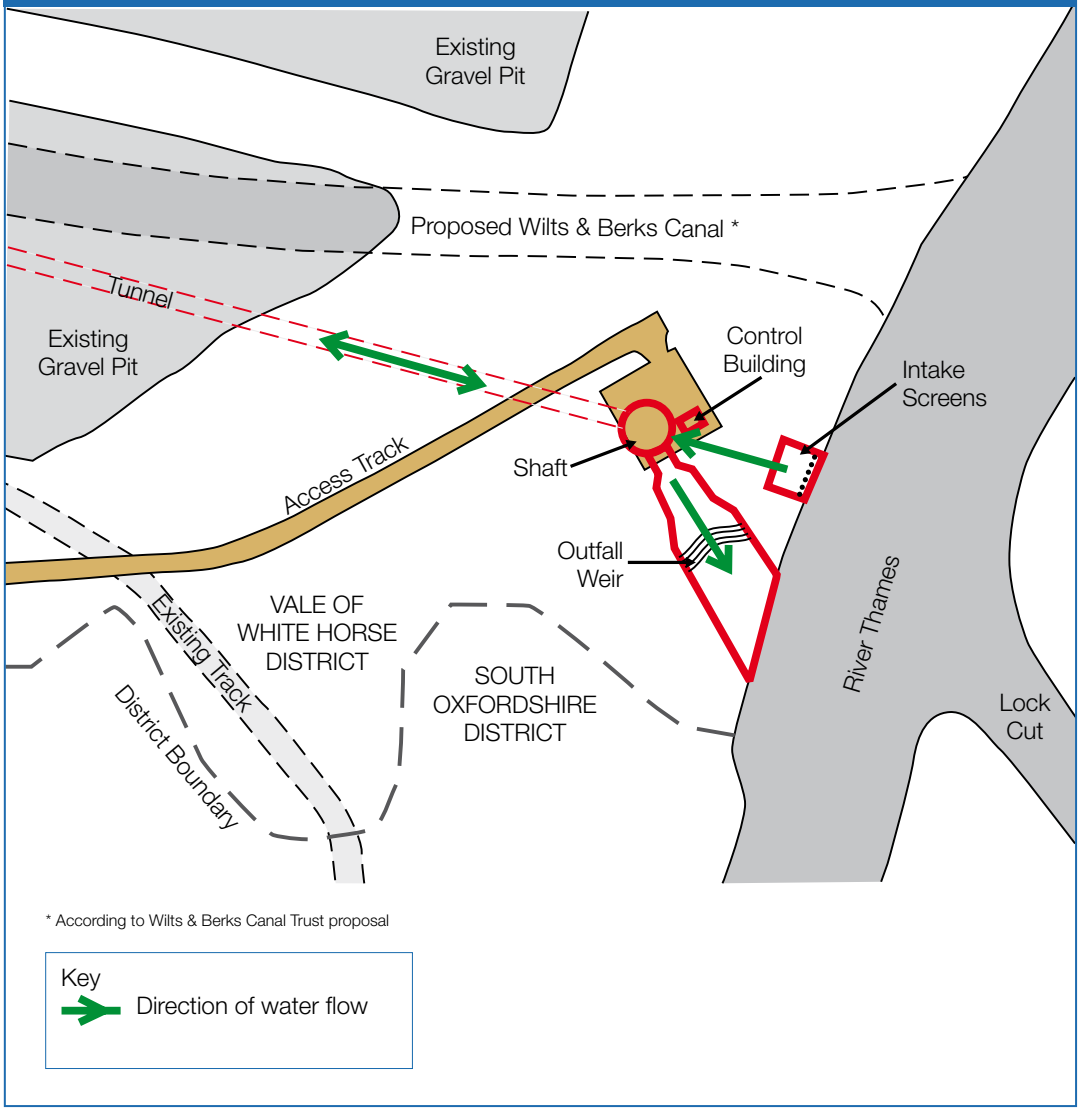
5.4.13 Comparing 8 to the previously preferred 5, Option 8 performed less well in terms of landscape, recreation, visual amenity and navigation, but equally well on other criteria, and critically did not lie within the Green Belt.

Preferred intake-outfall option

5.4.14 The preferred intake-outfall (Option 8) would be a combined structure located on the right (west) bank of the river opposite the entrance to the Culham Lock Cut, as shown in Figure 5.7, and comprising:

- an intake from the River Thames with screens to prevent the entry of fish and floating or submerged organic material and debris;
- an outfall to the River Thames to provide a controlled flow to the river which results in minimal disturbance to natural river currents during releases;
- an access road for operation and maintenance purposes; and
- a power supply and telecommunications link.

Figure 5.7: Layout of preferred intake-outfall



5.5 TUNNELS AND PUMPING STATION

5.5.1 Functioning of the reservoir would require water to be pumped into it from the River Thames when sufficient flow is available in the river (normally in the winter months) and discharged back into the river during drier periods. This would require the construction of tunnels between the intake-outfall and the reservoir, and a pumping station to pump the water. The preferred location of the intake-outfall and the reservoir layout mean that there is very little opportunity to consider options in relation to tunnel routes or pumping station location.

Tunnels

5.5.2 Theoretically, the means of filling the reservoir and discharging water from the reservoir to the river could be achieved by a tunnel, pipelines or an open channel. The choice of a tunnel was made on reservoir safety grounds. The construction of a tunnel in the clay deep under the embankment foundation minimises the risk to the integrity of the embankment foundations.

5.5.3 Combinations of a short tunnel under the embankment with either a surface channel or with pipelines were rejected for the following reasons:

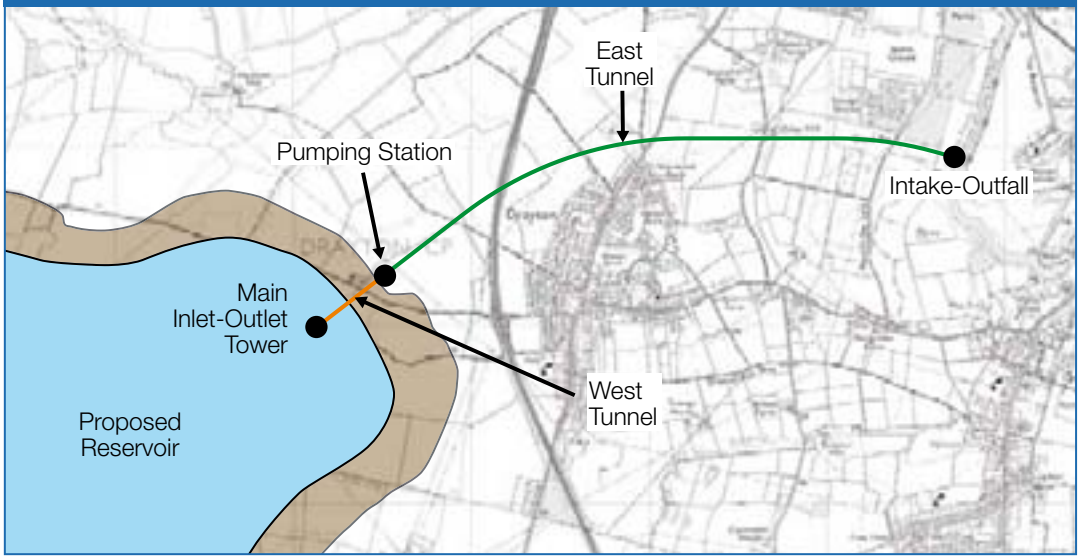
- a tunnel and pipeline combination cannot be used for emptying the reservoir by gravity and would require pumping to abstract water from the reservoir at low levels, thereby increasing energy use;
- adoption of a tunnel and pipeline combination would involve the construction of four to five large diameter pipelines in parallel which would cause considerable disruption during construction;
- adoption of a tunnel and open channel combination would involve the excavation of a 15 metres deep open excavation through Oday Hill immediately to the north of Drayton;
- pipelines or an open channel, both involving crossing under the A34 at surface level, would have a greater environmental and social impact than would the continuation of a tunnel; and
- a major component of the cost of the construction of a tunnel is the provision and recovery of a tunnel boring machine. The marginal cost (and embodied energy) of a longer tunnel compared with a short one would be low.

Design of the tunnels

5.5.4 There would be two tunnels: the east tunnel would link the intake-outfall to the pumping station; the west tunnel would link the pumping station to the reservoir (see Figure 5.8). The tunnels would be excavated in Kimmeridge clay and the routes have been designed to avoid tunnelling beneath surface structures where possible so as to minimise the risk of damage arising from settlement. The tunnels would slope gently downwards from the reservoir to the river intake-outfall.

5.5.5 The east tunnel would always be flooded during normal operation and its size (4.2 metres diameter) is the optimum one to allow pumping into the reservoir at the maximum rate.

Figure 5.8: Location of tunnels and pumping station



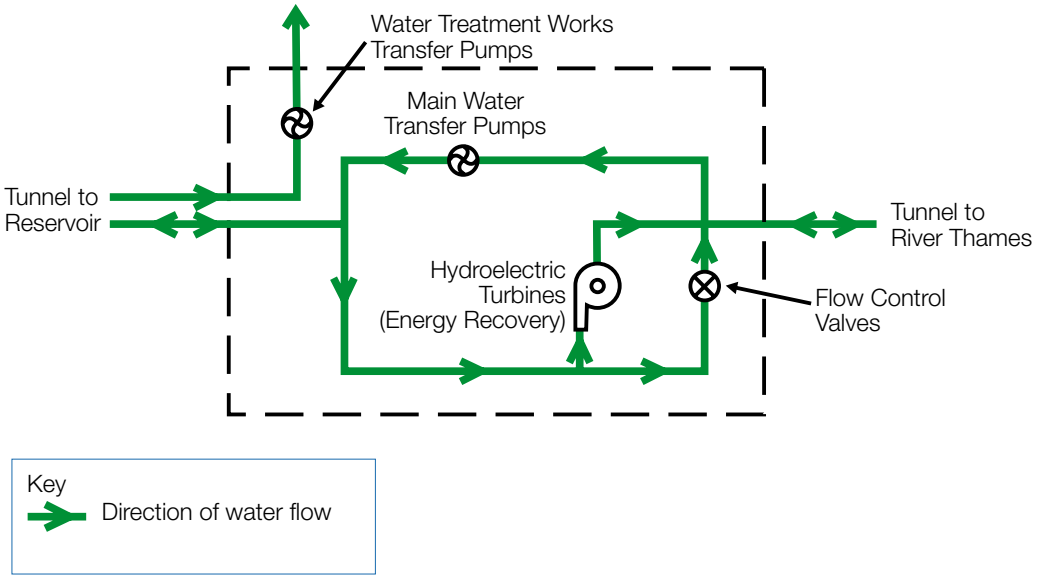
5.5.6 The west tunnel would be dry during normal operation. Its greater diameter (4.8 metres) is determined by the space required to fit the main filling/release pipe, three water supply pipes, electric cables, ventilation ducting within it and provide access for personnel.

Pumping station

5.5.7 To minimise the length of tunnel to the River Thames the pumping station would be situated in the north-east corner of the site, at the junction of the east and west tunnels, and adjacent to the outer toe of the reservoir embankment as shown in Figure 5.8.

5.5.8 The pumping station would house five electrically powered pumps with a total operational capacity of 1000 million litres per day (Ml/d), and turbines which would enable electrical power to be produced during release of water to the river. The pumping station would be largely underground with relatively little showing above ground level. A diagrammatic illustration of the pumping station's function is shown in Figure 5.9.

Figure 5.9: Pumping station diagram



5.6 RESERVOIR INLETS AND OUTLETS

5.6.1 Water would be pumped into the reservoir through any one of three inlet jets connected to the bottom of the main inlet-outlet tower situated in the north-east corner of the reservoir. The jets would be set at a range of different vertical angles and directions to encourage circulation. Water would be jetted into the reservoir at a maximum rate of 1000 Ml/d.

5.6.2 Water would be released by gravity from a range of levels in the reservoir, through controlled openings in the walls of the main inlet-outlet and secondary outlet towers. If, in exceptional circumstances, it were necessary to abstract water from the reservoir when water levels were below the Bottom Operating Level, additional pumping would be required.

5.6.3 No other options were considered for the design of the reservoir inlet and outlet towers for the following reasons:

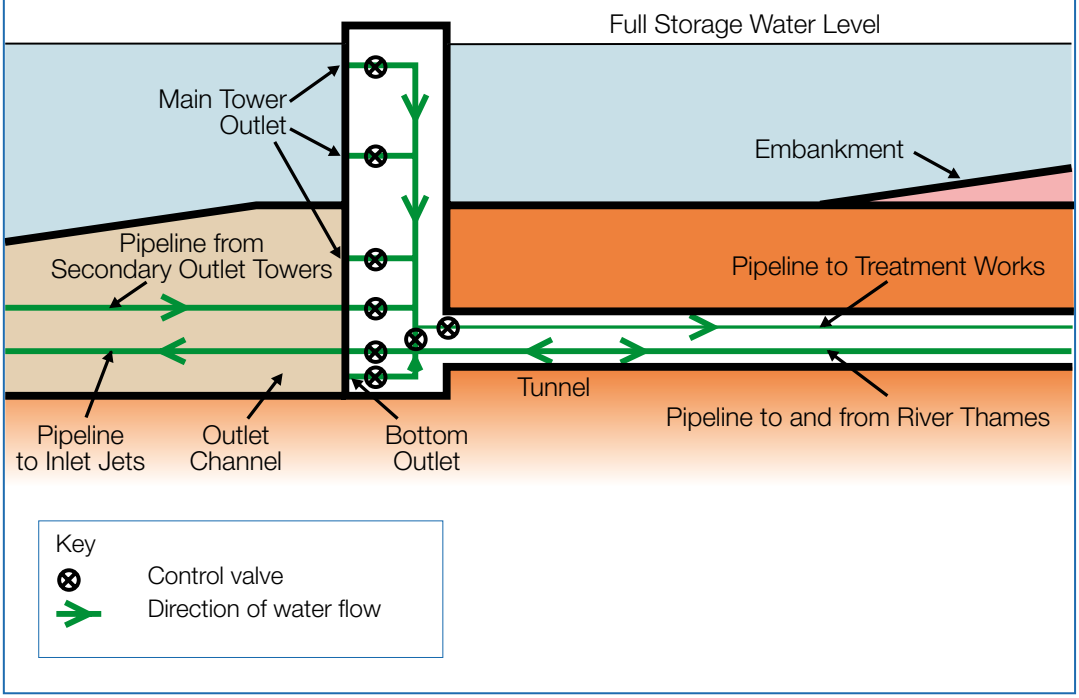
- the main tower must be located close to the inner toe of the embankment and on the tunnel alignment;
- the secondary towers must be placed in deep water at a precise location to be determined by modelling of reservoir water quality; and
- the design of the towers is dictated by engineering and operational considerations (with the exception of architectural treatment as considered in Section 7).

Main inlet-outlet tower

5.6.4 The main inlet-outlet tower would be situated at the reservoir end of the west tunnel close to the inner toe of the reservoir embankment. It would contain the pipework through which water would flow into and out of the reservoir. It would have an internal diameter of about 7 metres and a total height of 38 metres, of which 5 metres would be permanently above water level.

5.6.5 The structure would sit on a chamber within a shaft constructed below natural ground level. This shaft contains the valves and pipework required to control delivery of water to the reservoir, and release of water to the river and the water treatment works. It would be connected to the secondary towers by means of concrete pipes built on the reservoir bed. Figure 5.10 shows a diagrammatic section through the main inlet-outlet tower.

Figure 5.10: Main inlet-outlet tower: diagrammatic section



Secondary outlet towers

5.6.6 There would be two secondary outlet towers so that the separate releases of water (for river regulation to supply London and for the direct supply to Swindon and Oxfordshire) could be made simultaneously from different locations within the reservoir.

5.6.7 The opening mechanism would be operated by remote control. Water would be released from the reservoir to the main tower through pipes buried in the reservoir floor. Each connecting pipe would have sufficient capacity to allow the total release of water, for both river regulation and direct supply, to be made from a single tower.

5.6.8 Access to the towers would be by boat only, and then using steps set into their external faces.

5.7 WATER QUALITY

5.7.1 The reservoir would generally be filled during the wetter winter months, when the water is relatively cold. As described in Subsection 4.3, water would be jetted into the reservoir through pipes of differing alignment to augment the natural mixing of water in the reservoir.

5.7.2 However, when inflows into the reservoir cease as river flows reduce or when the reservoir is full, the water will tend to become stratified (forming layers) with the possibility of excessive growth of algae (see Subsection 4.2). Prevention of stratification could possibly be achieved by biological, chemical or mechanical means, and the suitability of each has been assessed.

Options

5.7.3 The options assessed for preventing excessive algal growth were:

1. **physical:** based on jetting, air mixing, artificial shading (using, for instance, floating reed beds), filtration, containment, or ultra-sonic control;
2. **chemical:** based on chemical algaecides; and
3. **biological:** based on use of barley straw as an algaecide, or fish removal.

Assessment

5.7.4 Chemical and biological treatments were rejected because they would be ineffective or impractical on the scale required for the proposed reservoir, leaving some form of physical treatment as the preferred approach. Mathematical modelling has been undertaken to test the effectiveness of air mixing compared to re-circulation (in which water is abstracted from near the reservoir surface from one of the secondary towers and is jetted into the reservoir through the main tower inlet jets). Results indicate that air mixing alone is effective whilst re-circulation is not; therefore the former was selected as the preferred option.

Preferred option

5.7.5 It is therefore proposed to mix reservoir water in the summer by means of air diffusers set on the reservoir bed. Compressed air would be pumped into the diffusers to create a stream of bubbles which would generate vertical currents within the reservoir. These vertical currents would push cold water to the surface as the air rises. The cold water would displace the warm surface water and move it downward. Preliminary results from mathematical modelling have shown that this system, if operated for about 12 hours a day from April to October, would be effective in preventing stratification of the reservoir water and thus the formation of excessive algae.

5.8 AUXILIARY DRAWDOWN SYSTEM

5.8.1 All reservoirs operated by Thames Water are required to have a drawdown facility, to reduce the reservoir level and hence minimise the risk of uncontrolled water releases if problems should arise. So, for example, in the very unlikely event that the regular safety monitoring detected a weakness in the embankment, it would be necessary to lower the level of water in the reservoir to address the problem. While the water transfer tunnels to the River Thames would provide sufficient capacity to release water in most circumstances, it would also be necessary to provide an auxiliary drawdown system.

5.8.2 The whole drawdown system needs to allow the reservoir water level to be reduced by one metre per day. This would equate to a total release rate of 6500 Ml/d. Given that the maximum capacity of the transfer tunnels would be 2600 Ml/d, the auxiliary drawdown system would need to provide an additional capacity of 3900 Ml/d. Various combinations of tunnels and open channels were assessed using the option assessment methodology and these are described below. In each case, the requirement is to provide an additional link between the reservoir and the River Thames.

Options for the auxiliary drawdown system

5.8.3 Four options for providing the auxiliary drawdown capacity were identified. These are shown in Figure 5.11 and summarised below:

1. Siphon and channel, comprising:

- a siphon over the reservoir embankment in the north-east corner consisting of steel pipes buried under the surface of the embankment with their inlets below water level;
- a concrete stilling basin at the toe of the embankment, and an area, approximately 100 metres wide, of lowered ground level to direct the water into a basin at the western end of an open channel; and
- an open channel passing under the A34 and through Oday Hill by means of a cutting approximately eight metres deep. The channel could potentially be utilised for restoration of the Wilts & Berks Canal between the River Thames and the reservoir site.

2. Additional tunnel via a flooded gravel pit:

- an additional outlet tower in the reservoir situated south of and close to the main inlet-outlet tower to house a flow control gate for the tunnel;
- a 4.5 metre diameter tunnel running from the outlet tower to the channel which forms part of the restored Wilts & Berks Canal immediately to the east of Peep-O-Day Lane. The tunnel route would be parallel to and approximately 50 metres south of the main transfer tunnels; and
- a shaft connecting to an outfall structure which would be approximately 20 metres wide and would allow water to discharge into the gravel pit east of Peep-O-Day Lane, with a short channel connecting to the River Thames.

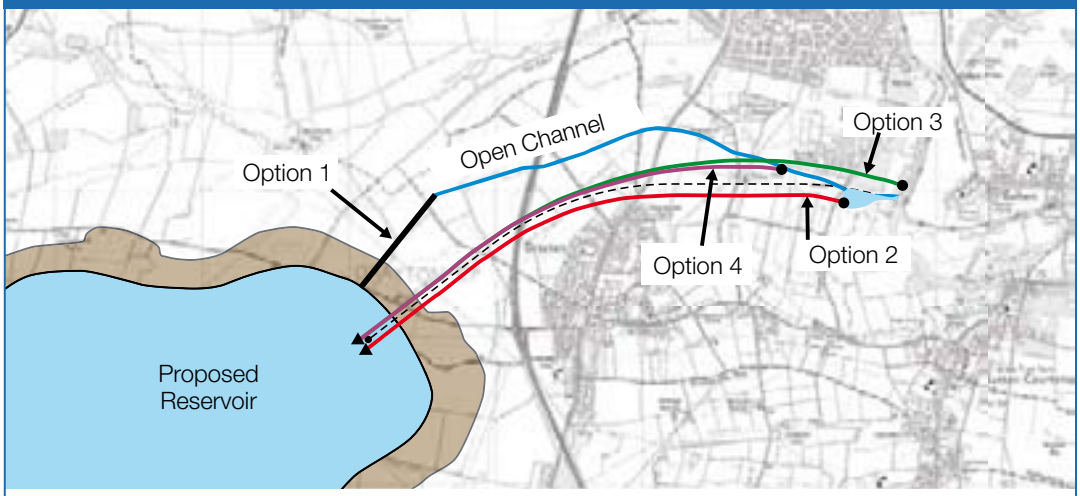
3. Tunnel discharging directly into the River Thames, similar to Option 2 except that:

- the outlet tower would be situated to the north of the main inlet-outlet tower;
- the tunnel route would diverge from the transfer tunnel route east of the A34; and
- a shaft would be situated on the riverbank 200 metres north (upstream) of the restored junction of the Wilts & Berks Canal with the River Thames.

4. Combined tunnel and channel discharge, similar to Option 3 except that:

- the tunnel would terminate approximately one kilometre west of that of Option 3;
- the shaft and outfall would be situated south of the proposed Wilts & Berks Canal route, immediately east of the proposed locks; and
- an 800 metres long channel would be excavated on the proposed canal alignment from the outfall structure to the river, as in Option 1.

Figure 5.11: Auxiliary drawdown options



Key

- Option 1 - Siphon discharging to open channel
- Option 2 - Tunnel discharging to gravel pit
- Option 3 - Tunnel discharging to river
- Option 4 - Tunnel discharging to open channel
- Tunnel between reservoir and intake-outfall
- Auxiliary outlet tower
- Shaft and outfall

Assessment

5.8.4 The four options were assessed against a shortlist of relevant sustainability criteria including energy consumption, impact on cultural heritage, landscape, visual amenity and navigation. Since all the options performed very variably against these criteria, all four options were retained for the next stage of assessment covering risk, opportunities and cost.

5.8.5 All four options would carry risks associated with construction and generally, these would be greater with tunnels than open channels. The exception would be the greater risk of construction delay and additional cost arising from Option 1 because the open channel might encounter important archaeological remains. The open channel would be located some 50 metres south of Sutton Wick Settlement Site Scheduled Ancient Monument and associated features outside the Scheduled Area may be affected. The channel would also pass to the north of an area of cropmarks adjacent to Drayton Village, and hitherto undetected features associated with these cropmarks may be affected. It is considered that the risk of the construction encountering a hitherto unknown significant archaeological site is very low, but that of finding minor features (which may result in construction delays) is high.

5.8.6 Set against these risks however, are the significant opportunities that would arise with Option 1. The principal opportunities would be:

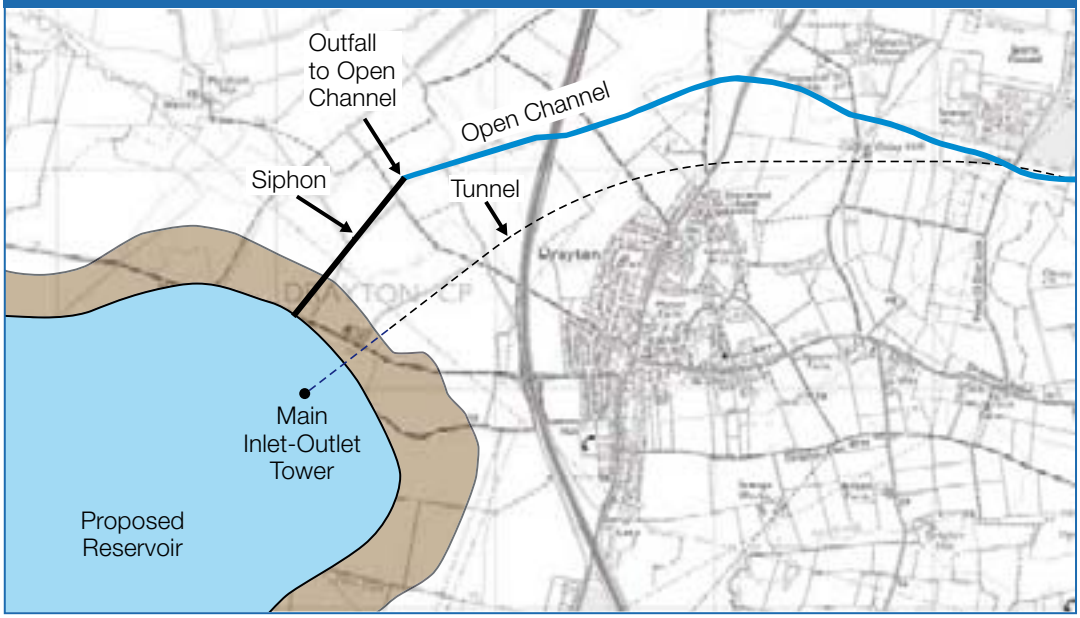
- extension of the restored Wilts & Berks Canal from the River Thames to the reservoir if the channel is made navigable in the future;
- provision of safe access for pedestrians, cyclists and horse riders from the Drayton and Abingdon areas beneath the A34 westwards towards the reservoir site, thus enabling the recreational benefits of the reservoir to be enjoyed by a larger community without corresponding increases in motor traffic; and
- potential for the channel and associated corridor to become important landscape and ecological features.

5.8.7 In terms of cost Option 1 would be significantly cheaper than any of the tunnel options.

Preferred auxiliary drawdown option

5.8.8 The preferred auxiliary drawdown option is the siphon and channel option, illustrated in Figure 5.12.

Figure 5.12: Preferred auxiliary drawdown option



5.9 LOCAL WATER SUPPLY

5.9.1 The proposed reservoir would have two principal functions. One would be to release water into the River Thames for abstraction downstream to supply water to London. The other would be to provide additional water for the Swindon and Oxfordshire supply system, referred to as the 'local water supply'. The site at Abingdon is well placed in relation to the existing local water supply network. However, some additional works would be required to provide the connection. These would comprise:

- a new water treatment works with a maximum sustained output of 65 Ml/d over a period of 21 days with a short-term peak capacity of 70 Ml/d, and with space for expanding this output or enhancing the treatment if required in the future;
- a pipeline to connect to the existing Swindon and Oxfordshire supply system; and
- a plant to treat the wastewater arising from the water treatment works before it is discharged to the River Thames.

5.9.2 An option assessment for the location of the water treatment works, the destination of the treated water and the route by which it would be transferred has been undertaken and this is summarised below. The options for the wastewater treatment plant have not been assessed at this stage because the technical requirements have not yet been defined and these would determine how and where the wastewater could be treated. For example, it could be pumped via a pipeline to a nearby sewage treatment works or it could be treated locally at the reservoir site. Either of these options would probably require the construction of new plant and associated pipelines.

Options for local water supply

5.9.3 The options considered for local water supply are illustrated in Figure 5.13 and listed in Table 5.5. Each option comprises four components: where the water treatment works would be located, whether the water transferred from the reservoir would be treated (at the reservoir site) or untreated, the destination of the water (i.e. which existing Thames Water water storage facilities) and the route of the pipeline.

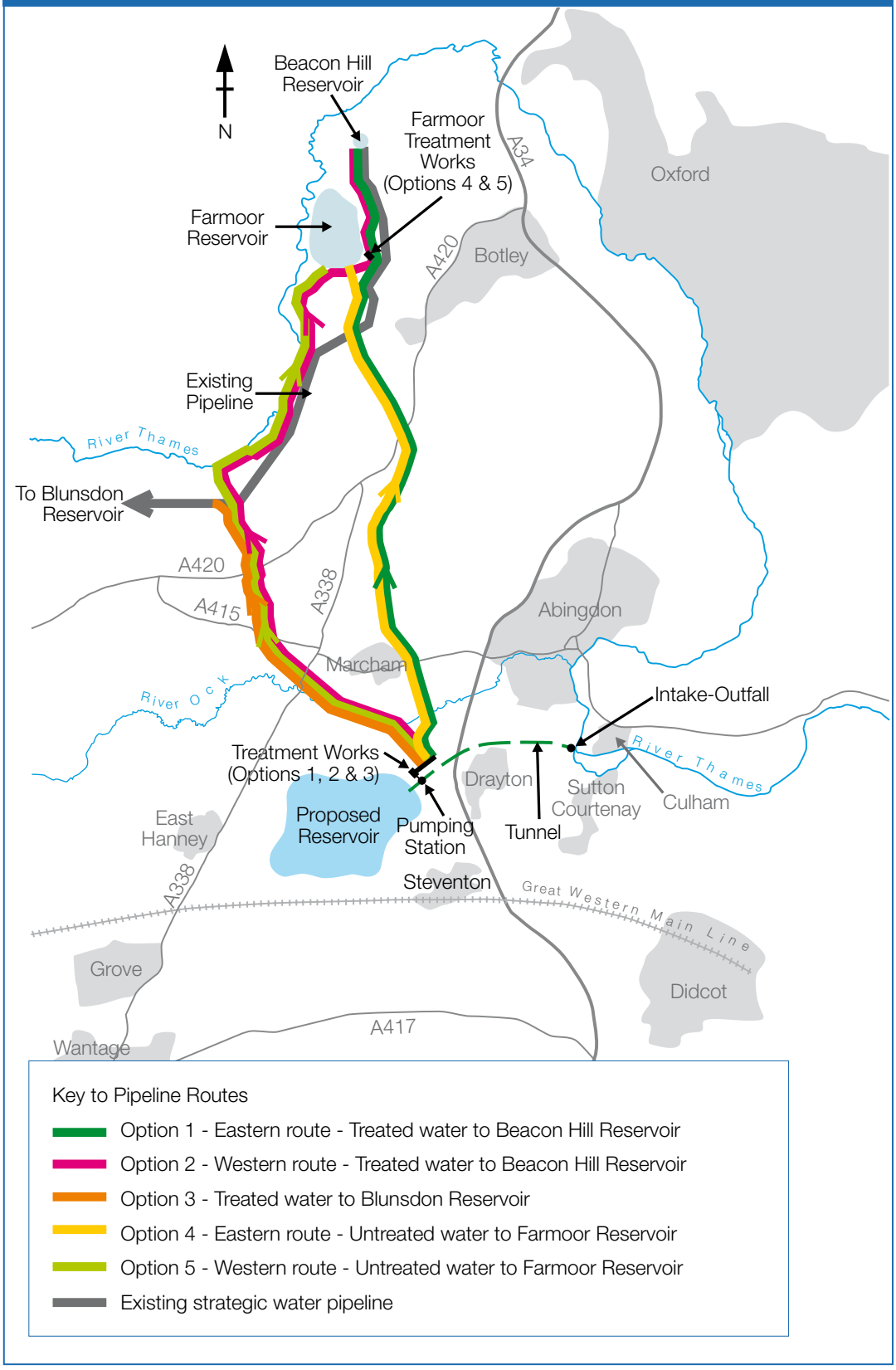
Table 5.5: Local water supply options

Option	Treatment works location	Transferred water	Destination	Pipeline route
1	UTMRD proposed reservoir	Treated	Beacon Hill Reservoir*	Eastern
2	UTMRD proposed reservoir	Treated	Beacon Hill Reservoir*	Western
3	UTMRD proposed reservoir	Treated	Blunsdon Reservoir* (via existing strategic treated water pipeline)	Western (connecting to existing strategic treated water pipeline)
4	Farmoor	Untreated	Farmoor Reservoir*	Eastern
5	Farmoor	Untreated	Farmoor Reservoir*	Western

Note * Beacon Hill and Blunsdon Reservoirs are both smaller covered (service) reservoirs for treated drinking water. Farmoor Reservoir is a larger open (storage) reservoir for storing untreated river water. Beacon Hill Reservoir is located to the west of Oxford. Blunsdon Reservoir is located to the north of Swindon. Farmoor Reservoir is located west of Oxford and south-west of Beacon Hill.

5.9.4 Option 3 was not taken forward to the assessment stage. This was because a separate study undertaken by Thames Water showed that using the existing strategic treated water pipeline to Blunsdon Reservoir would be the least effective point of entry of water to the network for operational reasons.

Figure 5.13: Swindon and Oxfordshire supply pipeline route options



Assessment

5.9.5 Generally, Options 1 and 2 performed better than Options 4 and 5 against sustainability criteria. Construction of a new water treatment works at the existing Farmoor Reservoir site would involve the permanent loss of a significant area of land in the Green Belt, a situation that would not arise if it were located at the proposed reservoir site. This was, together with the impact on landscape and visual amenity, one of the main reasons for rejecting Options 4 and 5. The choice between Options 1 and 2 concentrated on the length of pipeline required to link the proposed reservoir to Beacon Hill Reservoir, and the relative environmental sensitivity of the eastern and western routes. Option 2 (western route) would require a longer length of pipeline than Option 1 (eastern), resulting in greater energy use and disruption during construction. Option 2 would also potentially affect more sensitive ecological and archaeological sites than Option 1. However, it was decided to progress both options to assess risks, opportunities and cost in more detail.

5.9.6 Risks and opportunities do not favour either option over the other, but Option 2 is more expensive than Option 1. The findings of the assessment are summarised in Table 5.6.

Table 5.6: Local water supply assessment summary

Option	Rejected on sustainability criteria	Criteria	Rejected on risk, opportunities, cost	Criteria
1	No		No	
2	No		Yes	Costs greater than Option 1
3	Prior exclusion	Lack of operational flexibilty		
4	Yes	Green Belt encroachment Landscape and visual amenity		
5	Yes	Green Belt encroachment Landscape and visual amenity		

Prefered local water supply option

5.9.7 Option 1 (with the treatment works located at the proposed reservoir, and the treated water pipeline following the eastern route to Beacon Hill) has been adopted as the preferred option. It would be less expensive than the main alternative (Option 2), include a shorter pipeline route and use less materials and energy. It would have less ecological and archaeological impact.

5.9.8 The new water treatment works would be sited immediately adjacent to the pumping station in the north-east corner of the reservoir site (see Reservoir Design Masterplan in Volume 2). This is because siting the works here would:

- concentrate all the operational facilities in one location, enabling them to be secured in a single compound;

- enable road access and power supply to be shared with the pumping station;
- minimise the impact on the floodplain compared with alternative locations on the northern or western perimeter of the site; and
- minimise the length of the treated water pipeline compared with alternative locations on the eastern or south-eastern perimeter of the site.

5.10 FLOOD COMPENSATION

5.10.1 River floodplains store floodwater during high river flows, holding back water from the river and thus reducing flows and water levels. If this storage is removed the risk of flooding land and property downstream is increased, and it is for this reason that national planning policy (PPG25)[9] requires floodplain storage to be retained.

5.10.2 The proposed reservoir would have two main effects on flooding associated with the River Ock:

- a potentially positive effect by capturing the rain falling directly on the reservoir (approximately 6.5 square kilometres) that would otherwise contribute to flood flows in the River Ock; and
- a potentially negative effect by displacing the existing local floodplain.

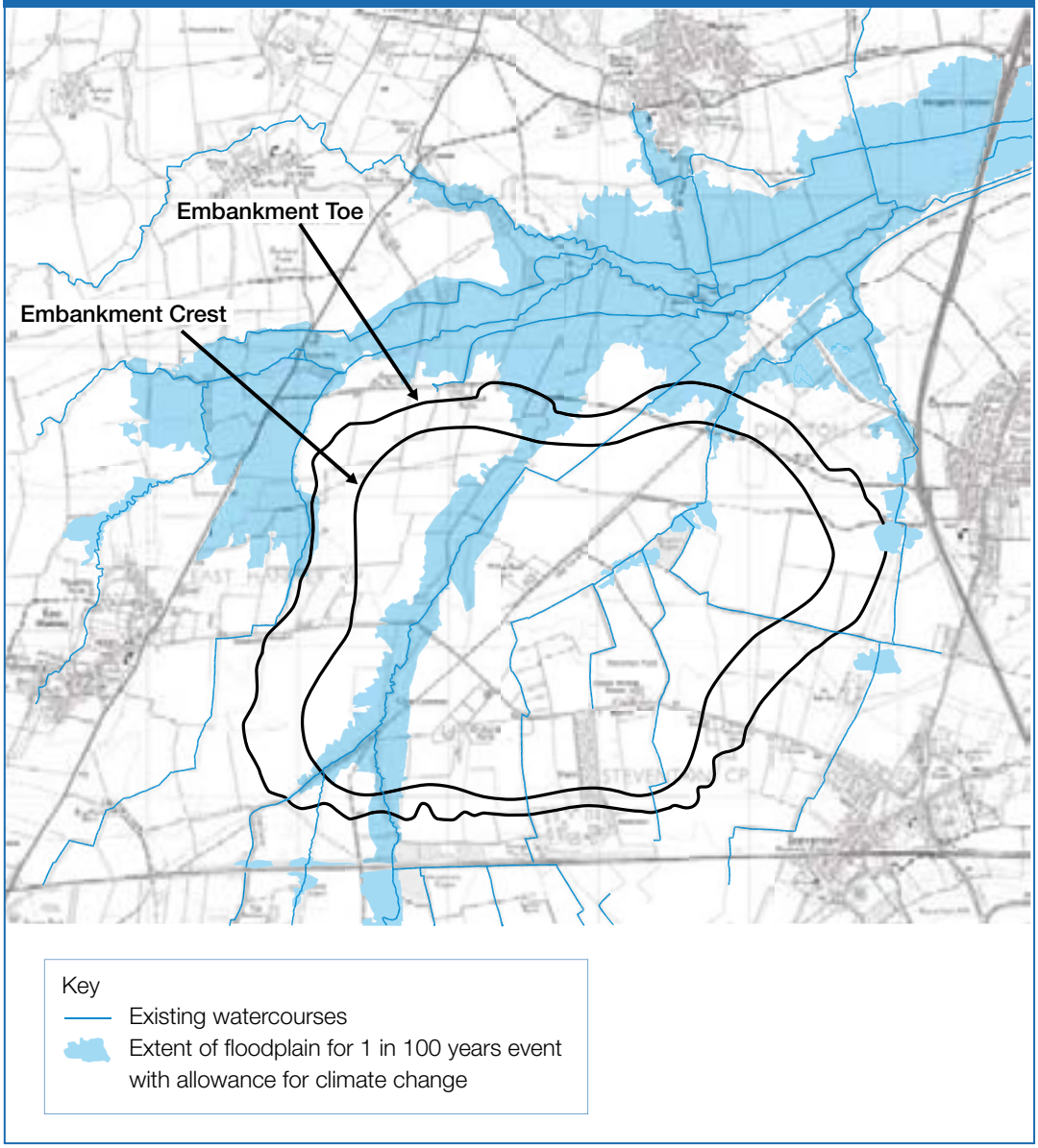
5.10.3 The reservoir site occupies part of an area forming natural floodplain storage within the catchment of the River Ock. The extent of the floodplain potentially affected by the reservoir is illustrated in Figure 5.14. Without suitable mitigation, the reservoir would result in a loss of flood storage and a potential increase in flood flows and water levels further downstream in Abingdon.

5.10.4 To prevent this from occurring, the natural floodplain storage lost to the reservoir would have to be replaced by compensation flood storage on a like for like basis.

5.10.5 The Environment Agency (EA) requires (as stated in PPG25) that any compensation flood storage provided is large enough to store floodwater from a flood event expected to occur once in 100 years. Climate change may result in flood flows being greater in the future, and the EA therefore requires that the compensation flood storage area is also able to store flood flows up to 20% greater than the 100 year flood. The existing 1 in 100 year plus 20% floodplain storage lost to the reservoir scheme is estimated to be approximately 500,000 cubic metres.

[9] Planning Policy Guidance Note 25: Development and Flood Rise

Figure 5.14 Existing floodplain



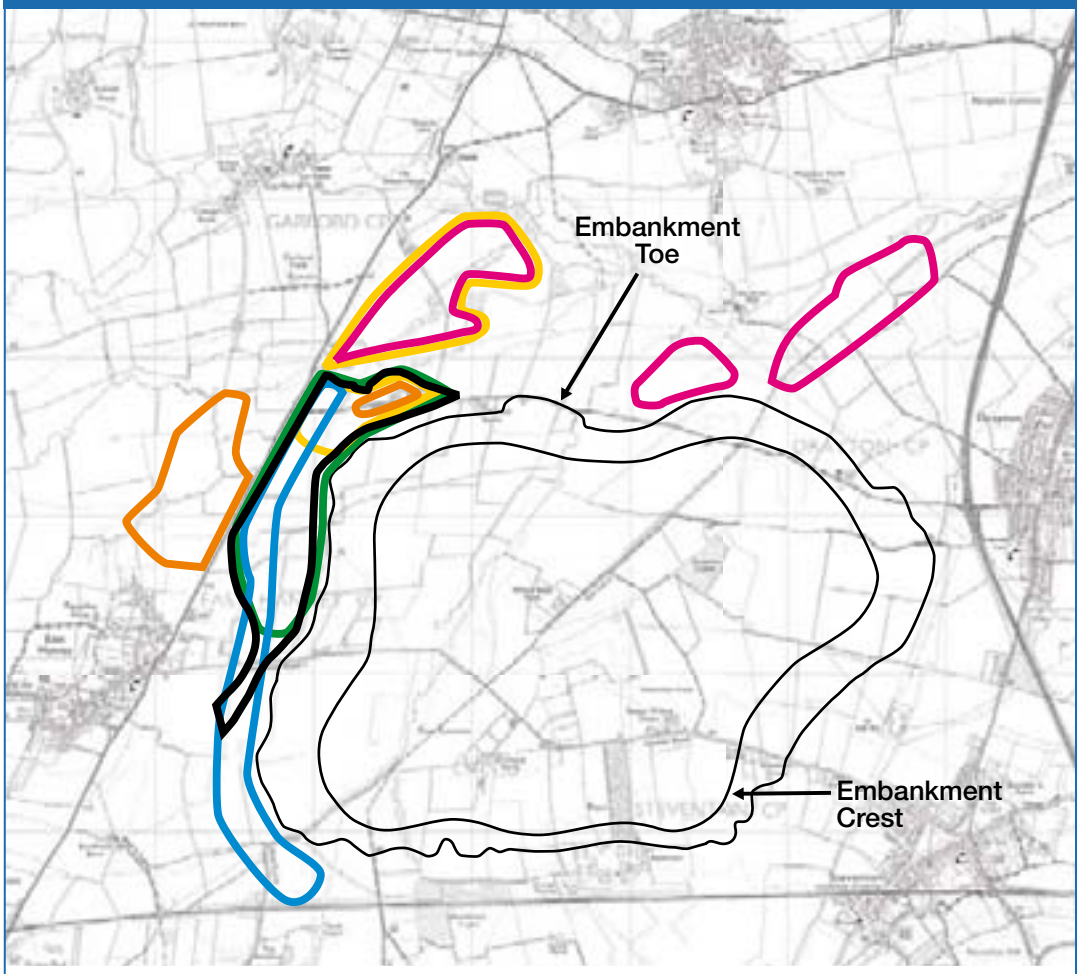
Flood compensation options

5.10.6 Five areas, shown in Figure 5.15, were identified which could be used to create compensation flood storage. All the options are located adjacent to the current floodplain and are designed to be excavated to a lower level to provide the required volume of compensation flood storage. The options are described below:

1. land situated around the north-west side of the proposed reservoir;
2. a combination of a bigger area west of the A338 and north of East Hanney and a smaller area north-west of the proposed reservoir;

3. land situated between the River Ock and the Childrey Brook;
4. a combination of smaller areas overlapping or adjacent to the existing floodplain north of the proposed reservoir; and
5. a long and narrow strip of land situated around the west side of the proposed reservoir and stretching between the railway line and the Childrey Brook.

Figure 5.15: Flood compensation options



Key
Potential areas for provision of flood compensation
Option 1 Option 2 Option 3
Option 4 Option 5 Preferred

Assessment

5.10.7 Ecological and geomorphological (stream sediment movement) impacts emerged as the most significant sustainability criteria during the assessment. Options 2, 3 and 4 do not have the same potential to establish connectivity with new or existing habitats as that indicated by Options 1 and 5. Options 2, 3 and 4 would also cause more disruption to the geomorphological characteristics of watercourses. All five options were judged to be sufficiently distant from existing settlements to reduce impacts of noise and dust during construction (i.e. further than 350 metres). The results of the option assessment are summarised in Table 5.7.

Table 5.7: Flood compensation assessment summary

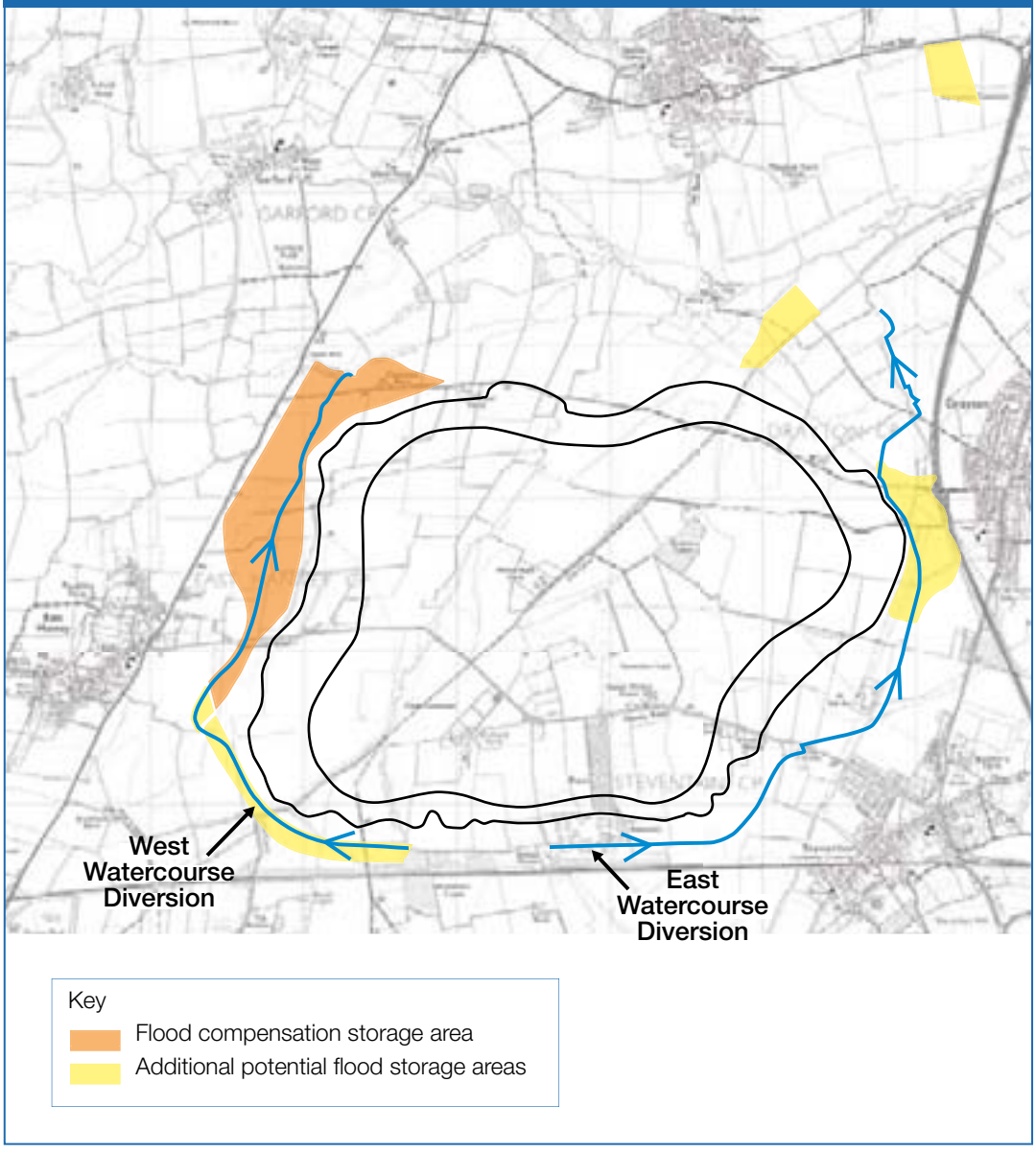
Option	Rejected on sustainability criteria	Criteria
1	No	
2	Yes	Impact on ecology, on movement of river sediment and social criteria
3	Yes	Impact on ecology and on movement of river sediment
4	Yes	Impact on ecology and on movement of river sediment
5	No	

Preferred flood compensation option

5.10.8 After discussions with the Environment Agency, the preferred option was identified as a combination of Options 1 and 5. This is shown in Figure 5.16 and combines the positive attributes of Options 1 and 5 to maximise ecological and geomorphological benefits, allow for wetland habitat creation, and maintain existing levels of flood protection to property in East Hanney. Figure 5.16 also shows the selected watercourse diversions considered in Subsection 5.11.

5.10.9 Four additional potential **flood storage areas** have been identified (see Figure 5.16). It is possible that some additional compensation flood storage will be required once more detailed hydraulic modelling has been completed. It is also possible that new and emerging policy guidance (notably draft Planning Policy Statement (PPS) 25 Development and Flood Risk) will require that additional flood storage is provided in **flood compensation** areas. For example, draft PPS 25 recognises that the impacts of climate change may lead to increased and new risks of flooding. There is an indication that future policy may require new development to help reduce flood risk to existing communities, in contrast to the current approach where development should not increase flood risk.

Figure 5.16: Preferred flood compensation areas and watercourse diversions



5.11 STREAM DIVERSIONS

5.11.1 The proposed reservoir scheme occupies an area containing small streams and ditches. Most of these ditches and streams have been altered from the natural state for land drainage and to meet agricultural requirements. The majority of these watercourses therefore have limited ecological interest. A significant length of these small artificial watercourses would be lost as a result of the proposals. Some would have to be diverted so that their land drainage functions are maintained in the future.

5.11.2 There are two stream diversions required to accommodate the proposed reservoir; one each to the east and west. Both of these would drain from south to north, and would join the River Ock to the north of the reservoir.

5.11.3 The design for these diversions needs to take into account geomorphological requirements and provide opportunities for environmental enhancements by maximising the water and floodplain available for habitat creation. In addition, a toe drain, which collects rainwater from the reservoir embankment, would be required around the outer perimeter of the reservoir, also providing opportunities for ecological improvement.

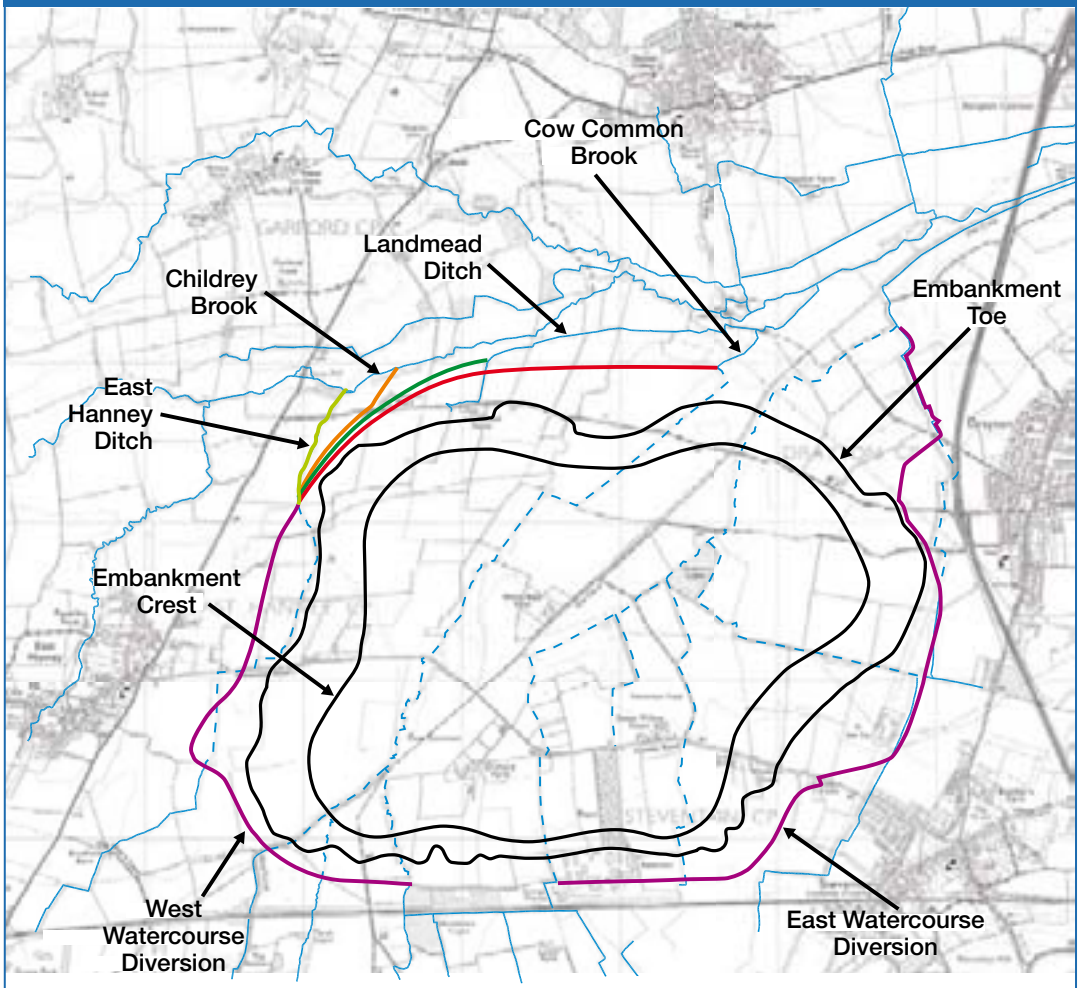
Stream diversion options

5.11.4 The East Watercourse Diversion (EWD) would divert three smaller watercourses (Orchard Farm Ditch, Goose Willow Ditch and Steventon Ditch West) to the east and flow into the Steventon Ditch East and Mere Dyke north of Steventon. The West Watercourse Diversion (WWD) would combine the flows of the Hanney Ditch and the Cow Common Brook on a route around the west of the reservoir.

5.11.5 There was only one viable option for the EWD. However, there were four options identified for the route of the northern section of the WWD and the location of its re-connection back to the River Ock, each of which is shown in Figure 5.17:

1. into the Hanney Ditch;
2. into the Childrey Brook downstream of its confluence with the Hanney Ditch;
3. following the potential route of the canal and discharging into the Landmead Ditch; and
4. following the potential route of the canal and discharging into the Cow Common Brook to the north of the reservoir.

Figure 5.17: Stream diversion options



Key to stream diversion options

- Existing watercourses to be diverted
- Existing watercourses to be retained
- Proposed main diversion routes
- Diversion into East Hanney Ditch (preferred)
- Diversion into Childrey Brook
- Diversion into Landmead Ditch
- Diversion into Cow Common Brook

Assessment

5.11.6 The assessment of the options concentrated on the following considerations:

- the potential to enhance the water movement and hence ecological value of the new diversion and the existing watercourses;
- the requirement for long-term management and maintenance, including integration with existing land use;
- the existing geomorphological function and potential to enhance the system; and
- the ability of existing channels to absorb the effects of the diversions.

5.11.7 Option 1 and 2 would make use of the potential that the Childrey Brook offers to store sediment before it enters the River Ock. These two options would also reduce the interaction between the WWD and the potential provision for the canal alignment, and minimise the amount of agricultural land disrupted.

5.11.8 Option 1 results in a smaller reduction of gradients than Option 2. The flows in the WWD would increase as a result of the proposals, compensating for these reduced gradients.

Preferred stream diversion options

5.11.9 The current preferred option for the West Watercourse Diversion is therefore using the existing Hanney Ditch, Option 1. It achieves biodiversity and habitat enhancement and supports morphological diversity and stability of the existing drainage network. The preferred routes for both watercourse diversions are shown in Figure 5.16. Their detailed designs would take into account mitigation, environmental enhancement and habitat creation.

5.12 LONG-TERM ACCESS

Access to the reservoir

5.12.1 Access issues related to construction are considered in Section 6, with rail movement (via purpose-built sidings) forming an important part of the strategy. However, for long-term access (as well for some construction access) road connections would be vital. Road access would enable maintenance of the reservoir and the water treatment works, and would provide access for visitors (as considered further in Section 7).

5.12.2 The options available for road access to the reservoir are limited. A main access road for the reservoir off the A338, the B4017 Steventon to Abingdon road, or the Hanney to Steventon road has been discounted because of the likely impact of the additional generated traffic on the local villages.

5.12.3 Main access to the reservoir would therefore be via the A34 as shown on the Reservoir Design Masterplan in Volume 2:

- The A34 is a trunk road managed by the Highways Agency. The Highways Agency normally permits only primary roads to have direct access from the trunk road network. The Agency would therefore not permit a direct access off the A34 solely for the reservoir.

- The most appropriate location for the main access road is considered to be off the A415 Marcham Road between the A34 and Marcham village. This provides the most direct route to and from the A34 without passing through any settlements, thereby minimising the impact of additional generated traffic.
- Access to the reservoir site would then be via a new road connecting with the A415 Marcham to Abingdon road in the vicinity of the existing Gozzards Ford Lane. Subject to agreement with Oxfordshire County Council, it is proposed that the new junction with the A415 would be a traffic signal controlled junction also incorporating Gozzards Ford Lane.
- The proposed access road, whilst avoiding the allotments on Marcham Road, would generally head towards the River Ock, crossing it on a new bridge beside the A34. The road would terminate at the north-east corner of the site.

Road diversions

5.12.4 The location of the proposed reservoir would necessitate the diversion of the Hanney to Steventon road around the southern perimeter of the site, but remaining north of the railway line. The diversion would comprise 5.4 kilometres of single two-lane carriageway with the provision of an off-road cycle path, to replace the existing County Council designated 'on road' cycle route between the two villages. The proposed diversion route is shown in the Reservoir Design Masterplan.

5.12.5 The reservoir would add little, if any, traffic to the road, since the main access will be via the A415. Consequently, the only requirement would be to divert it as close as possible to its existing alignment.

5.12.6 A full assessment of the traffic impacts of the reservoir will be included in the Transport Assessment and Environment Impact Assessment being prepared in Stage 3. The Transport Assessment may identify the need for further additional mitigation measures, such as other changes to local roads.

Access for walkers, cyclists and horse riders

5.12.7 Alternatives would be provided for all the existing public footpaths, cycleways and bridleways that are severed by the reservoir. These would be supplemented by new routes in the vicinity of the reservoir to ensure that it is easily accessible. For further details see Section 7.

Access by public transport

5.12.8 The new access would provide for vehicle journeys, but could also be used by public transport connections.

5.12.9 There are a number of existing bus services operating along the A415 Marcham Road to the north of the proposed reservoir, the A338 Wantage to Frilford road to the west and the B4017 Steventon to Abingdon road to the east. These bus services skirt the site and would provide links to the local villages and towns including Abingdon, Didcot, Wantage and Oxford. Opportunities to enhance local bus services will be investigated.

5.12.10 The expected number of visitors to the reservoir is most unlikely to be sufficient to justify a new station on the railway line, regardless of the intensity of recreational use.

5.13 RESERVOIR SAFETY

5.13.1 It is absolutely essential that the design of the reservoir includes all appropriate measures to ensure safety and takes into account all identified potential risks. This will build on Thames Water's extensive experience and safety record in both the UK and abroad in designing, building, operating and maintaining reservoirs.

Reservoir legislation

5.13.2 The safety of reservoirs in the UK is legislated through the Reservoirs Act (1975) which is enforced by the Environment Agency. The design and operation of all reservoirs in the UK with a capacity greater than 25,000 cubic metres must comply with the provisions of the Act, which requires:

1. the appointment of a qualified Construction Engineer to design and supervise the construction of a large raised reservoir. The intention of this requirement is for a single engineer to be responsible for the design of a reservoir;
2. inspection of a large raised reservoir within two years of completion and thereafter at least once every ten years by an independent qualified Inspecting Engineer. Recommendations made by the Inspecting Engineer on measures that should be taken in the interests of safety must be complied with; and
3. all existing reservoirs to be in the care of a Supervising Engineer who keeps the owner advised of its condition and behaviour, and who supervises the implementation of all measures required in the interests of safety. The Supervising Engineer submits an annual report on the performance of the reservoir.

5.13.3 In addition it is accepted good practice that the design of a new reservoir should be reviewed by a panel of independent experts (a Reservoir Advisory Panel).

Design philosophy

5.13.4 Potential causes of reservoir failure are (in decreasing order of historic likelihood):

- stored water overtopping the embankment;
- internal erosion of the embankment or its foundations due to concentrations of seepage flow;
- instability of the embankment; and
- deliberate attack or sabotage, or meteor or aircraft strike.

5.13.5 The risks posed by the potential causes of failure outlined above would be mitigated by:

- scrupulous observance of the requirements of the Reservoirs Act;
- the appointment of an independent Reservoir Advisory Panel to review the design; and
- the adoption of a 'defensive' design strategy as described below.

Overtopping

5.13.6 The proposed reservoir is not inherently susceptible to overtopping as it is supplied by pumping and not by the damming of a river. Overtopping by accidental over-pumping would be prevented by failsafe control systems. Overtopping due to wave action would be prevented by the design of the inner face protection, and by a suitable margin of embankment level above full storage level.

Internal erosion

5.13.7 Although the clay, of which the embankment would be constructed, is intrinsically unlikely to be susceptible to internal erosion, internal drains would be incorporated into the design in order to safely convey any seepage away into the drainage system.

5.13.8 The risk of internal erosion associated with the water transfer facilities would be mitigated by means of the following design elements:

- use of a deep tunnel under the embankment for water transfers rather than a buried culvert to minimise the possibility of internal erosion in the foundation;
- use of a single tunnel for reservoir filling and discharge rather than two smaller tunnels to minimise the possibility of internal erosion as well as increasing security; and
- use of a pipeline for reservoir filling and discharge within the tunnel under the embankment between the pumping station and the main reservoir tower to provide double protection and enable access for inspection at all times.

Embankment stability

5.13.9 Embankment stability would be assured by the following measures:

- a comprehensive ground investigation;
- adoption of conservative design assumptions for material strengths and loads;
- the consideration of extreme seismic (earthquake) loading within the analyses;
- use of state-of-the-art soil stress/strain models; and
- a flexible design approach to allow adjustments to be made to the construction of the embankment as the work progresses.

5.13.10 In particular a full-scale trial embankment would be constructed before the start of construction as part of the final design process. The trial embankment would be instrumented and monitored and this data would be used to validate and re-calibrate the design analyses.

Mitigation measures

5.13.11 The reservoir would be kept under close surveillance both during construction and throughout its life. Robust but sensitive instrumentation would be provided in the embankment and its foundations to monitor seepage flows and movements. The reservoir would be inspected by qualified engineers at regular and frequent intervals as required by the Reservoirs Act and enforced by the Environment Agency.

5.13.12 The design responses outlined above are defensive measures to minimise the possibility of a failure and to provide the maximum opportunity for isolation and repair. In addition to these measures, it is Thames Water's policy that all its reservoirs should be capable of having their water levels reduced at a rate of one metre per day if surveillance indicates this is required in the interests of safety. This capacity would be provided by the transfer tunnels and an auxiliary drawdown system, as described in Subsection 5.8.

5.14 ENERGY

5.14.1 This section explores the various options for reducing energy use and greenhouse gas emissions from the construction and operation of the reservoir. This preliminary assessment has been carried out in order to influence the initial design of the reservoir. As the design evolves, its energy requirements will be considered in more detail. Through this process, Thames Water is pursuing the principles of Government policy by following a hierarchy of: minimising energy use; using energy efficiently; and exploring renewable energy options.

Policy guidance on emissions targets

5.14.2 Emissions of greenhouse gases such as carbon dioxide cause global warming and are implicated in climate change. Guidance on levels of carbon dioxide reduction and the use of renewable energy sources are set out in national and regional policy and provide an indication of expectations in relation to carbon dioxide emissions and use of renewable energy sources. They are summarised briefly as follows:

National Energy Policy [10]

- 12.5% cut in carbon dioxide emissions (compared with 1990 levels) from the UK by 2010, and a 60% cut by 2050; and
- 10% electricity used in the UK to be generated from renewable sources by 2010 and 20% by 2020.

South East England Regional Planning Policy (draft) [11]

- 10% of energy used in South East England to be generated from renewable sources by 2020;
- 10% of energy from commercial developments to be generated from renewable sources; and
- developments to minimise energy requirements and maximise energy efficiency.

Reservoir development emissions

5.14.3 Acknowledging the link between energy use and carbon dioxide emissions, Thames Water is studying the reservoir's energy requirements over its lifetime (expected to be at least 100 years). Target levels for the reservoir have not yet been defined but would reflect the regional planning policy guidance, with a strong focus on energy reduction, energy efficiency and energy generated from renewable sources when it is commissioned in approximately 2020.

[10] UK Government Energy White Paper 2003; PPS 22 Renewable Energy 2004; Energy Review Report 2006

[11] South East England Regional Assembly South East Plan March 2006(Policy EN2/EN3)

5.14.4 Operational energy over time is the biggest factor likely to influence climate change. Much of the operational energy is likely to be used in water treatment. However, the studies of the likely treatment processes have not yet been concluded, so it is not yet possible to arrive at a firm estimate of the overall energy use.

Options

5.14.5 A range of options is being considered within each of the phases of reservoir development.

5.14.6 **Phase 1, embodied energy** (energy used in extracting or making the materials imported to build the reservoir, including their transport to the site). The elements assessed for embodied energy are: the materials used in buildings; concrete used on site; the concrete linings for the tunnels; and materials used in construction of the rail sidings.

5.14.7 Two elements involving embodied energy have already been examined in earlier option assessments: these are the quarried materials to be used for drainage within the embankment and for protecting the inside of the embankment (Subsection 5.3) and how these materials would be transported to the site (i.e. by rail rather than road) (Subsection 6.2).

5.14.8 **Phase 2, construction energy.** As well as considering the fuel for the main phase of construction and its transportation to the site, the use of electricity (both from conventional and green sources), different types of road building materials and different transport modes for on-site workers are being examined.

5.14.9 **Phase 3, operational energy** (to drive the pumps, water treatment works and to mix the water in the reservoir). Sources of electricity are the main options being considered. In addition to the purchase of green electricity from external sources, on-site generation options could include the use of hydropower to recover energy, by powering turbines with the water on its release back to the River Thames for abstraction in London. Other options could be: photovoltaic cells to capture solar energy; turbines to utilise wind energy; or a biomass plant generating heat and power from the combustion of organic material such as woodchip or energy crops.

5.14.10 **Phase 4, recreation facilities** (for example a visitor centre). Embodied energy of different building designs and the use of different energy sources to provide heat, cooling and power are being examined.

Assessment

5.14.11 As for the other option assessments reported in Section 5, a wide range of engineering, planning, environmental and social criteria are being taken into account. These include factors such as: land area and use; waste; and impacts on ecology, air quality, noise, visual amenity, transport and employment. Additional criteria were identified from the Building Research Establishment (BRE) UK Ecopoints methodology.

5.14.12 The key criteria for this assessment have been identified as: resource use/fossil fuel depletion; energy use; and climate change (in terms of carbon dioxide emissions).

5.14.13 The options which perform well in terms of sustainability include: low embodied energy materials for the buildings; on-site mixing of aggregates and manufacture of tunnel segments; the use of biodiesel for construction plant; using fewer, more efficient vehicles and biodiesel for site workers transport; and the use of on-site or off-site green electricity. The relative performance of on-site green electricity options vary, as some could have potentially more positive or negative impact than others.

5.14.14 There are planning and environmental impacts associated with the use of renewable energy sources. They can, however, provide an opportunity to improve the security of supply when used to supplement the conventional sources. Some on-site green energy sources (hydropower and wind turbines) could have a cost advantage over the use of conventional fossil fuel energy from the National Grid.

5.14.15 The potential options identified to date in this and other assessments could comprise a suite of measures integral to the design of the reservoir. They include use of the following:

- limestone riprap for inner slope protection because of its relatively low embodied energy;
- rail rather than road for importing construction materials;
- biodiesel for construction machinery;
- low-energy design (for energy-efficient construction and operation) for all new buildings; and
- a proportion of green electricity for reservoir operations such as pumping.

5.14.16 Work will continue on developing options to reduce carbon dioxide emissions. The final reservoir design, including any renewable energy infrastructure, will be subject to a detailed EIA.

6 Construction: what are the issues?

6.1 INTRODUCTION

6.1.1 This section describes in broad terms the various activities associated with the construction of the proposed reservoir, the methods that might be used and the resources that would be required. In response to public interest expressed on the Stage 1 consultation, the means of importation of materials and other potential traffic impacts are the first issues covered, followed by an indicative programme and then the details of the construction activities.

6.1.2 Whilst this section gives examples of impacts and mitigation measures, the full determination of the impacts of the construction would be carried out within the EIA to be undertaken after this consultation period. A comprehensive set of mitigation measures would then be incorporated into the design, the Environmental Management Plan and eventually, the Construction Method Statements.

Sustainable construction

6.1.3 It is the intention to construct the reservoir taking into account sustainability principles:

1. limiting consumption and production requirements by, for instance, using on-site materials in construction of earthworks;
2. minimising energy use and consequent climate change impacts by, for instance, use of rail for importation of bulk materials;
3. protecting natural resources and the environment by, for example, reducing production of waste;
4. minimising construction impact on local residents and businesses by implementing mitigation measures informed by an EIA; and
5. developing the Environmental Management Plan and Construction Method Statements in the next stages of work to take into account the EIA and the feedback from Stage 1 and Stage 2 of the consultation.

6.2 MEANS OF IMPORTING CONSTRUCTION MATERIALS

6.2.1 While the clay and soil for the embankments would be sourced from material excavated on-site, it is estimated that a total of 3.5 million tonnes of imported aggregates would be required to construct the embankments of the reservoir (representing 1% of the total embankment). There are two types of aggregates that would be required:

- riprap to protect the inner face (approximately 75% of the total). There are numerous potential UK sources that could supply aggregates of this type; and
- sand and gravels for the filter drainage within and beneath the embankments (approximately 25% of the total). These materials are not as readily available as other types of aggregates. The potential sources in the UK for this type of aggregate (that also have sufficient reserves to supply all the requirements for the reservoir) are: marine dredged material from the Thames estuary; quarries in Leicestershire; and quarries in Argyll, Scotland.

6.2.2 The sources of aggregates for the construction of the reservoir would only be determined once a decision is made to proceed with the project and would depend on availability at that time.

Options considered

6.2.3 The options considered for the transportation of aggregates include road based, rail based and water based, as listed below:

- road haulage direct to site from quarries or ports;
- rail haulage direct to purpose-built dedicated on-site sidings from quarries or ports;
- rail haulage from quarries or ports to existing rail sidings with onward transportation by conveyor or road;
- water haulage direct to site from quarries or ports via the River Thames and the Wilts & Berks Canal (if reinstated); and
- combinations of the above modes.

The assessment of these options is described in more detail in a separate report (see Subsection 1.2.10).

Assessment criteria

6.2.4 The criteria used to evaluate and compare transportation options are drawn from the Government's Sustainable Distribution Strategy[12], which fulfils the Government's commitment to set out a comprehensive, integrated strategy for the sustainable distribution of goods and services in the UK.

6.2.5 The specific assessment criteria adopted are listed below:

- alignment with policy objectives;
- efficiency of distribution: economic viability, flexibility, commercial risk;
- impact on infrastructure: congestion effects, use of existing transport infrastructure;
- environmental and social impacts: pollution and emissions, noise and disturbance, development pressures; and
- impact on health and safety.

Option assessment: rejected options

Road haulage

6.2.6 Road haulage is only likely to be competitive with the direct rail option for aggregates sourced locally. However, it is highly unlikely that suitable aggregates in the required volume would be available in the local area. This option would also run contrary to national, regional and particularly local development plan policy. It is also likely to have a significant negative impact in terms of local traffic congestion, pollution and emissions, noise and disturbance, and health and safety.

Rail haulage to existing rail sidings

6.2.7 Rail haulage to the Didcot Power Station terminal with onward transportation by rail conveyor is not viable because of physical barriers between the terminal and the reservoir site.

[12] Sustainable Distribution: A Strategy, Department for Transport, March 1999; modified 2004.

Water haulage

6.2.8 Transporting all the required aggregates by water is not a practical proposition due to navigational constraints on the River Thames.

Haulage by a combination of modes

6.2.9 Transporting some of the aggregates direct to site by rail and some direct to site by water would require temporary rail sidings as well as temporary wharves resulting in unnecessary capital investment and operating costs. It is not therefore a practical option.

6.2.10 The option of transporting some of the aggregates direct to the site by water and some direct to the site by road would in practice be heavily reliant on road haulage. This is because the amount of material that could be transported by water would be limited due to navigational constraints on the River Thames.

6.2.11 Transporting some of the aggregates by rail and some by road would be viable. However, the road haulage component is only likely to be commercially favourable for aggregates sourced locally. The local availability of suitable aggregates in significant volumes is uncertain. Assuming that the majority of aggregates were transported by rail and only a minority by road, then overall this option would probably not be considered counter to policy, and (comparatively) the impact on traffic congestion, health and safety and the environment would be limited. Nonetheless, the road haulage element of this option would still have negative local impacts on traffic congestion, pollution and emissions, noise and disturbance and health and safety, although routes could be chosen to minimise impacts on local communities.

Preferred option for transportation of aggregates

6.2.12 Transporting aggregates by rail direct to purpose-built dedicated sidings immediately adjacent to the site is the preferred option taking all the sustainable distribution criteria into account.

6.2.13 This option is likely to provide the following advantages over the other options considered as it:

- is in alignment with national, regional and local policy;
- is commercially favourable, taking into consideration that it would provide access to a large number of potential sources and suppliers;
- has scope to use the new infrastructure to transport efficiently other construction materials in addition to just aggregates;
- has no detrimental effect on traffic congestion;
- minimises pollution and emissions;
- minimises noise and disturbance impacts; and
- has negligible health and safety impacts.

6.2.14 However, rail is much less flexible than road haulage in terms of controlling and regulating the supply of materials and there would always be a high degree of reliance on third parties (the rail-freight operating company, of which there are a limited number, and Network Rail).

6.2.15 Approximately two to three train loads of aggregates per weekday over a four year period will be required to deliver all the 3.5 million tonnes of imported aggregates which will be needed.

Transportation of other materials

6.2.16 Although a large majority of the construction materials for the reservoir could either be sourced on the site or imported by rail, a proportion, including materials and plant manufactured elsewhere, would still need to be delivered using road transport.

6.3 ROAD TRAFFIC MOVEMENTS

6.3.1 During construction of the reservoir, lorries involved in deliveries to the site would only be permitted to access the site directly to and from the A34 via the A415 Marcham Road i.e. they would not be permitted to drive through Marcham village or any other local settlements.

6.3.2 However, a limited number of lorries associated with the construction of the intake-outfall, the pipeline to Beacon Hill Reservoir and the channel between the reservoir and the River Thames would inevitably have to use local roads passing through settlements in some instances.

6.3.3 Permitted construction vehicle routes for all elements of the reservoir would be defined in the Environmental Management Plan. This would also define the days of the week and times of the day when construction vehicles would be permitted to access each of the sites associated with the construction of the reservoir.

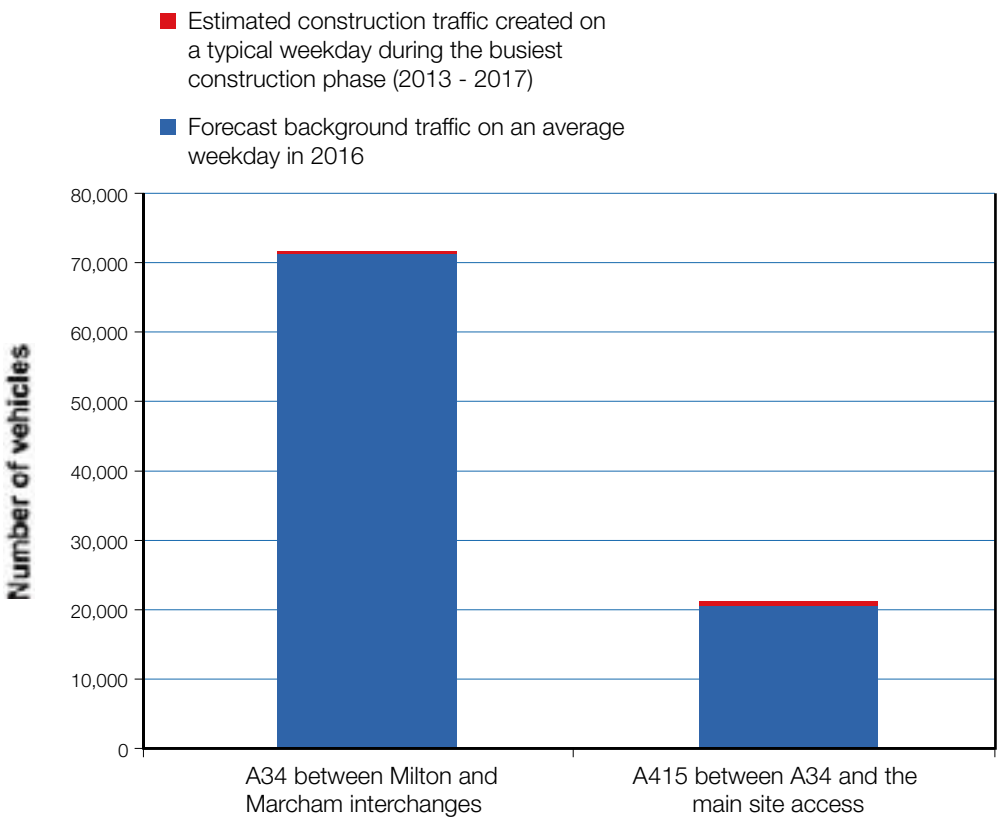
6.3.4 It is estimated that about eight million person-hours would be required to construct and commission the reservoir. At the peak of construction the workforce is likely to be approximately 600 workers, of which about half would be living on-site during the week. The construction workers commuting to and from the site will create additional traffic on the A34 and the A415 Marcham Road between the main site access and the A34.

6.3.5 However, the additional traffic on these roads created by the construction of the reservoir is likely to be small compared to forecast background traffic flows. Furthermore, the additional generated vehicle trips are likely to be made predominantly during off-peak periods.

6.3.6 Initial estimates indicate that the combined traffic created by the construction workers and the transportation of those construction materials that cannot be delivered to site by rail would increase average weekday traffic flows on the A34 by no more than 0.5% and on the A415 Marcham Road between the main site access and the A34 by between 3 and 4% (see Figure 6.1). The majority of the additional traffic during construction is likely to be cars and vans, with only approximately 20% being lorries.

6.3.7 The traffic impacts of the construction and after use of the reservoir would be fully assessed in the Transport Assessment and Environmental Impact Assessment that will be prepared as part of the CWO submission planned for 2008.

Figure 6.1: Estimated construction traffic

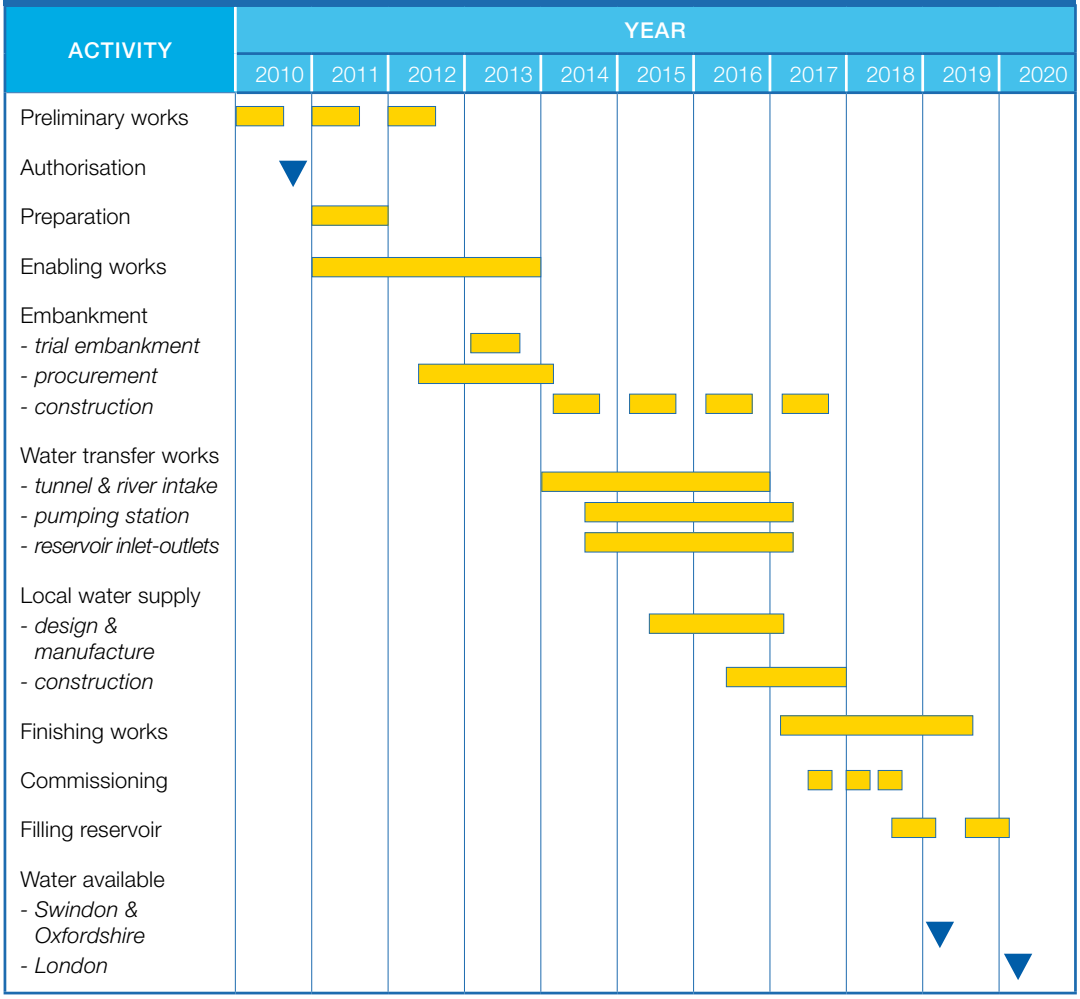


6.4 PROGRAMME

6.4.1 The overall construction period is estimated to be eight years from the authorisation of the project (if granted). After the first two to three years, which would be taken up with the construction of the enabling works, the critical activity would be the earthworks which would be completed over four seasons of eight to nine months each (March to October).

6.4.2 The construction of the water transfer and associated works would be completed during the construction of the embankment. It is likely that the reservoir would be filled over two winters, starting in the first winter after completion of the earthworks and the water transfer works. Water would be available for use nine to ten years after authorisation. An indicative programme of the principal activities is shown in Figure 6.2.

Figure 6.2: Indicative construction programme



6.5 PRELIMINARY AND ENABLING WORKS

6.5.1 This subsection examines the preliminary works (needing a long lead time prior to the start on-site) and enabling works (needing to be completed prior to the main works). The following subsection (6.6) describes the main works.

Preliminary works (starting 2010)

Archaeology

6.5.2 In conjunction with Oxfordshire's County Archaeologist (and in consultation with English Heritage), the site has been surveyed to identify, as far as possible, the archaeological resource across the site. Where possible archaeological remains would be preserved in-situ. Where construction work necessitates the removal of archaeological remains, recording would be undertaken in accordance with the project's Written Scheme of Investigation. This scheme

would be produced, in line with the national guidelines as set out in Planning Policy Guidance 16: Archaeology and Planning and agreed with the County Archaeologist.

Wildlife relocation

6.5.3 Before any site clearance can be started, there would be a programme of habitat creation and enhancement, based on habitat survey work carried out over at least one annual seasonal cycle. Provision for protected species which currently exist on the site would be made by creating alternative suitable habitats away from construction activity so that protected species could be caught and transferred to ensure their survival. These alternative habitats are likely to be created mainly towards the west of the reservoir. Clearance of vegetation would be undertaken at the appropriate time of year (for example to avoid the bird nesting season), and in phases designed to allow other animals to relocate to adjacent habitats. Wildlife would be relocated safely before construction begins.

Enabling works (starting 2011)

Access road and rail sidings

6.5.4 One of the first operations to be undertaken would be the construction of the main access road from the Marcham Road to the site compound in the north-east of the site. This would be followed by the haul roads, including access to the railway sidings (crossing by bridge over the Hanney to Steventon road) where handling facilities for importation of materials would also be built.

Site compound

6.5.5 The site compound (comprising temporary offices, living accommodation for some 300 personnel, workshops, stores and materials testing laboratories) would be situated in the north-east corner of the site.

Services relocation

6.5.6 This would comprise the relocation of pole mounted power cables, drinking water pipes, and telecommunication cabling. It is also proposed to re-lay a length of the 132kV power transmission line underground in the north-east corner of the site.

Compensation flood storage

6.5.7 Construction of the flood storage areas would be programmed so that sufficient area is created in time to ensure that there is no nett loss of flood storage during the preliminary and enabling works or the construction of the reservoir. The work on the flood storage areas would require the excavation of the areas shown on the Reservoir Design Masterplan, the biggest being to the west of the proposed reservoir. This would be accomplished by:

- stripping and stockpiling the topsoil;
- excavating up to one metre depth of subsoil; and
- replacing the topsoil and replanting.

6.5.8 In order to protect the River Ock from muddy runoff it would be necessary to plan and build settlement ponds. As part of the same operation the streams that flow across the site, principally the Cow Common Brook, would be diverted around the reservoir footprint.

Road diversion

6.5.9 A direct link between Steventon and East Hanney would be maintained. The Hanney to Steventon road would need to be diverted before the main construction of the embankment and before the closure of the existing road.

Fencing

6.5.10 The site perimeter would be protected by appropriate fencing according to local land use requirements. More secure fencing would be provided around the boundary of the main construction activities, such as the tunnel shafts, the pumping station, treatment works and the intake-outfall.

Recycling

6.5.11 As much as possible of the materials arising out of the demolition of the existing Hanney to Steventon road and from the demolition of buildings within the reservoir footprint, including the Steventon Storage Facility, would be recycled using an on-site plant. The recycled material would be used in the construction of the reservoir, so reducing the volume of material imported into the site. Demolition waste which could not be recycled (e.g. asbestos) would be removed to a licensed tip.

6.6 MAIN WORKS

Building the embankment

6.6.1 The method of working would be guided by the desirability to minimise both haul distances and the need for double handling of material, in order to reduce cost and minimise energy use.

Trial embankment

6.6.2 A trial embankment would be constructed to validate the geotechnical design of the embankment in advance of its construction and also to confirm the suitability of the earthmoving plant for the actual conditions and characteristics of the excavated clay. The trial embankment would be situated in the north of the site, inside the reservoir footprint and constructed over a six month period after the completion of the flood compensation and watercourse diversions but before the main reservoir construction.

Drainage system

6.6.3 A temporary surface water drainage system to deal with the runoff from rainfall would need to be constructed within the reservoir borrow pit. The runoff would be stored to provide water for dust suppression in dry weather. In wet weather it would be necessary to pump water from the internal storage areas into the settlement ponds for treatment before discharge into the River Ock. This would require a discharge consent from the Environment Agency.

Excavation and transport

6.6.4 Material would be excavated from the borrow pit in the following sequence:

1. Topsoil would be stripped to a depth of approximately 0.25 metres and placed into piles by means of bulldozers and subsequently loaded into articulated dump trucks and transported to on-site topsoil storage mounds. These mounds could potentially be located near to the site boundary to provide screening.

2. Overburden material would be excavated to its full depth, nominally two metres, using hydraulic excavators and transported to either the earth mounds or the embankment by articulated dump trucks.
3. Clay material of acceptable moisture content would be excavated using the same plant as for overburden material and loaded into dump trucks for transport to the embankment work area.

Figure 6.3: Illustration of bulldozer, excavator and dump truck

Bulldozer

45 tonne hydaulic excavator

40 tonne articulated dump truck

Earthfilling

6.6.5 Once delivered to the work surface, the fill material would be spread into 0.3 metre thick horizontal layers by bulldozer and compacted by heavy roller. Quality control tests (to ensure the correct soil strength and moisture content) would be carried out on each layer. At the end of the working day the clay surface would be graded and 'sealed' by rolling with a smooth roller so that any rainfall is encouraged to run off.

Inner face protection

6.6.6 Riprap materials would be delivered from the railway sidings to the placement site in articulated dump trucks and then positioned on the trimmed embankment face in three metre wide strips using an excavator and bulldozer. Construction of the inner face slope protection would be phased together with the construction of the inner face to maintain a smooth supply of materials during the construction period.

Building the water transfer works

Tunnels

6.6.7 The tunnels would be driven by means of a tunnel-boring machine from the base of the main tower through the pumping station location to the intake-outfall shaft adjacent to the river. Spoil from the tunnel drive would be extracted from the reservoir end of the tunnels and used in the embankment construction. The tunnel would be lined with pre-cast concrete. After completion of tunnelling the tunnel boring machine would be removed through the intake-outfall shaft.

Intake-outfall shaft

6.6.8 The intake-outfall shaft would be constructed using pre-cast concrete linings. The shaft would be excavated by an hydraulic excavator working within the shaft. Spoil removal would be by means of a crane or hoist loading trucks for disposal in the reservoir site via the access road.

Intake-outfall structure

6.6.9 The intake-outfall structure construction would commence after the shaft is complete, and would include limited excavation, concrete construction and some river work.

Pumping station

6.6.10 This structure would be partly underground and would be constructed of reinforced concrete in an open excavation supported by concrete retaining walls.

Reservoir inlet and outlet towers

6.6.11 The towers would be constructed on reinforced concrete foundations either by slip forming, in which the formwork is slowly but steadily raised as the concrete is placed, or by jump forming, in which the tower is raised in a succession of discrete stages (which offers more flexibility in accommodating changes in tower section).

Auxiliary drawdown

6.6.12 There are three methods that could be employed to provide a structure under the A34 for the auxiliary drawdown channel to pass through:

- temporary diversion of the A34 outside of its current boundaries and construction of the channel structure in open-cut;
- temporary diversion of the A34 within its current boundaries and construction of the channel structure 'from top down'; and
- jacking, involving the construction of the channel structure in a pit on one side of the A34 and then pushing it under the existing carriageways.

6.6.13 The first two options involve diverting the A34 but this is balanced against the increased risk of differential settlement inherent in the third option. A decision on which method to adopt would be made at a later stage in the project.

6.6.14 Once the crossing is in place the channel would be excavated, from west to east, so that the excavated material can be used in the embankment construction. This construction, which would require the temporary diversion of the Drayton to Abingdon road, would be completed in one earthworks season. The final operation would be the construction of the weirs and the siphon pipework.

Building the local water supply infrastructure

6.6.15 Construction of the water treatment works would last for approximately two years, and would comprise the following operations:

- clearance of the pipeline route of vegetation and stripping the topsoil;
- construction of a temporary access road;
- delivery of the pipes along the length of the route;

- progressive excavation of the pipe trench, placing and jointing the pipes and backfilling the trench (excess earthfill would be used in the reservoir embankment);
- construction of the seven road crossings and the one river crossing; and
- replacement of topsoil, restoration and planting.

6.6.16 Details of the wastewater treatment arrangements have not yet been determined.

6.7 REDUCING THE IMPACTS

6.7.1 As part of any application for consent for the reservoir, an Environmental Impact Assessment (EIA) would be prepared and an Environmental Statement produced.

6.7.2 An EIA involves the compiling, evaluating and presenting all the significant environmental effects of a proposed development. It also operates as part of the design process to ensure the final design reduces environmental impact and includes appropriate mitigation measures.

6.7.3 For example, the construction contractor would be required to prepare a travel plan showing how the volume of traffic and impact on other A415 users could be minimised. Typical measures might include shared transport schemes and the provision of a transport service to the site from neighbouring towns. The Environmental Management Plan would define the days of the week and times of the day when construction vehicles would be permitted to gain access to the site. These restrictions would be subject to agreement with the relevant authorities and would be drawn up following consultation.

6.7.4 The Environmental Statement would explain and assess the environmental effects that are likely to be significant in this project, what the environment is like now and how it might change as a result of the project. The ways in which likely impacts have been reduced or addressed by mitigation measures would be explained. The current Stage 2 consultation will assist in identifying which issues are important. The Environmental Statement would be submitted as part of the application for consent.

Questions on Part A: Reservoir Design

On the basis of the information provided in Part A, it would be useful to provide feedback to Thames Water on the reservoir design and construction.

These comments will help Thames Water understand local priorities as the design of the reservoir is taken forward and as consideration is given to what can be done to lessen the impacts.

There are two main questions:

- ***Do you, after you have read this report, still have concerns about specific issues?***

We have described in Part A of the Report the different aspects of the reservoir design. In the feedback form there is a list of the issues most often mentioned in the Stage 1 consultation. Let us know where you have outstanding concerns in relation to these issues.

- ***Thinking about the issues identified in the first question, please select up to four where you have most concerns, including any others you think are relevant. Please tell us about the specific solutions you would like Thames Water to explore in the next stage of work.***

There is space on the feedback form for your descriptions.

Part B: Landscape, Conservation, Recreation and Building Design

INTRODUCTION

Part B describes the principles developed and the first suggestions for creating new landscapes, improving the ecological value of the area and introducing a range of recreation facilities.

There is a major opportunity to influence these aspects of the proposal, by indicating aspects liked or disliked, identifying priorities and making suggestions on what could be incorporated as the design is taken forward.

A set of questions is provided at the end of Part B.

7 Landscape, conservation, recreation and building design: what are the opportunities?

7.1 INTRODUCTION

7.1.1 While the principal function of the reservoir will be to supply water, the development of a major area of open water in lowland England offers important opportunities to create a new landscape, support improved wildlife habitats and act as a setting for a wide range of related recreational activities.

7.1.2 Thames Water is required to consider conservation, local access and recreation in relation to all its functions, a duty enshrined in the Water Industry Act 1991. Careful attention has been paid to this duty in formulating the reservoir design. At the same time, any scheme of this sort is subject to relevant national, regional and local land use planning policies covering: protection of the countryside and of valuable environmental features and local amenity; the provision of recreation, leisure, sport, community and educational facilities; landscape and biodiversity enhancement; and building design.

7.1.3 This section of the report explains how the landscape, conservation and recreational opportunities have been addressed in the design of the reservoir to date. It also considers the potential design of the buildings and other structures.

7.1.4 A set of scenario drawings are provided in Volume 2 to illustrate how the overall scheme could be designed. These drawings are not alternative options but starting points for the Stage 2 consultation. The aim is to seek views on what is particularly liked or disliked, together with ideas and suggestions for developing potential solutions. Feedback forms are provided separately for recording comments and suggestions.

7.2 LANDSCAPE

7.2.1 The new landscape that could be created is an integral part of the construction process. All the materials used to form the proposed landscape would be by-products of the earthworks needed to form the reservoir borrow pit and embankments. For example, the topsoil could be reused on the embankments to support new vegetation and habitats.

7.2.2 The immediate landscape of the reservoir would comprise two zones: the inner slopes of the reservoir itself; and the outer slopes of the embankment forming a transition into the surrounding countryside. The crest of the embankment would divide the inner slopes from the outer slopes, and both would display dramatically different characteristics.

7.2.3 The inner slopes and the reservoir water body would not be visible from the outer slopes except when viewed from the crest of the embankment. In the wider locality, views would be limited to brief glimpses of the water's surface, notably from higher ground such as The Ridgeway. This is because awareness of the water body would be restricted by the angle of view and the intervening distance.

7.2.4 The outer slopes would face the surrounding countryside and have the potential to enhance the character of these areas. The relative lack of technical restrictions on the outer slopes means there would be considerable opportunities for the landscape enhancement of this zone.

7.2.5 Only on the embankment crest would there be shared views of the inner and outer slopes of the reservoir.

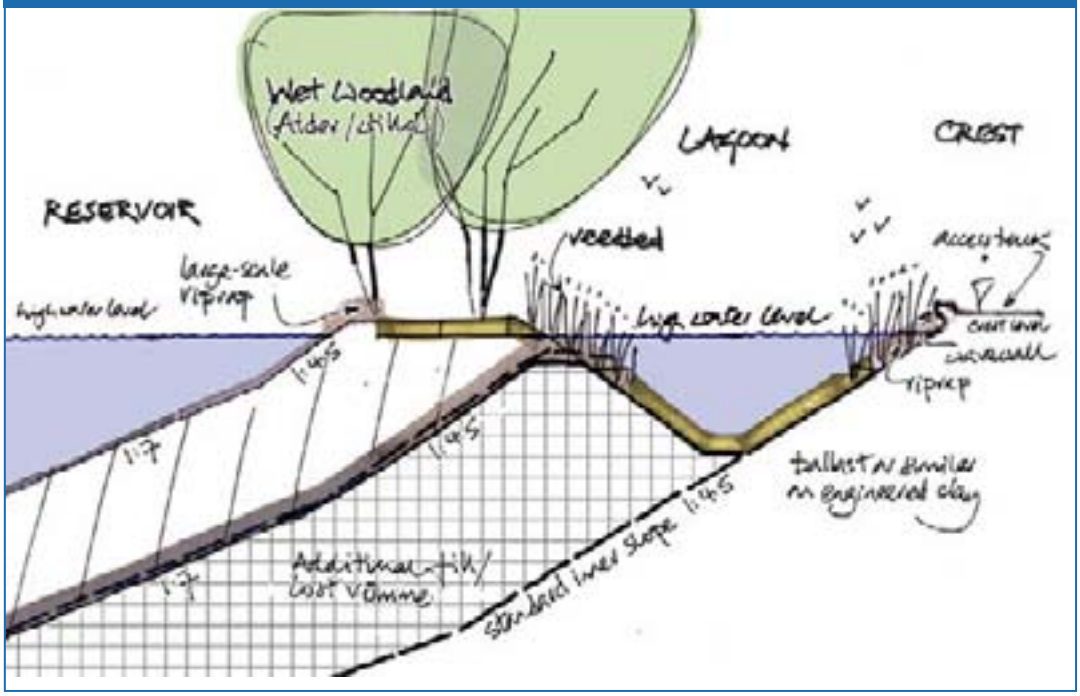
Inner zone

7.2.6 **The inner slopes of the reservoir could make an important contribution to the landscape** character of the inner zone within the crest of the embankment. This is primarily because the operating regime would involve fluctuating water levels, revealing the exposed inner slope when the reservoir is drawn down. Wave action on these slopes requires a protective layer to avoid putting the integrity of the embankment at risk. The options assessment for the selection of the protective layer (see Section 5) concluded that loose stone or riprap was the preferred protection type. One of the principal landscape benefits of riprap is its dark colour and texture, compared to the glare of large areas of concrete. These attributes would reduce the visual intrusion of the inner slope when water levels are low.

7.2.7 **The potential for introducing vegetation on the inner slope is limited because the fluctuating** water levels would drown any plants on the lower slopes during periods of higher water levels. However, there are further measures that could be taken to enhance the landscape of the inner face. These include:

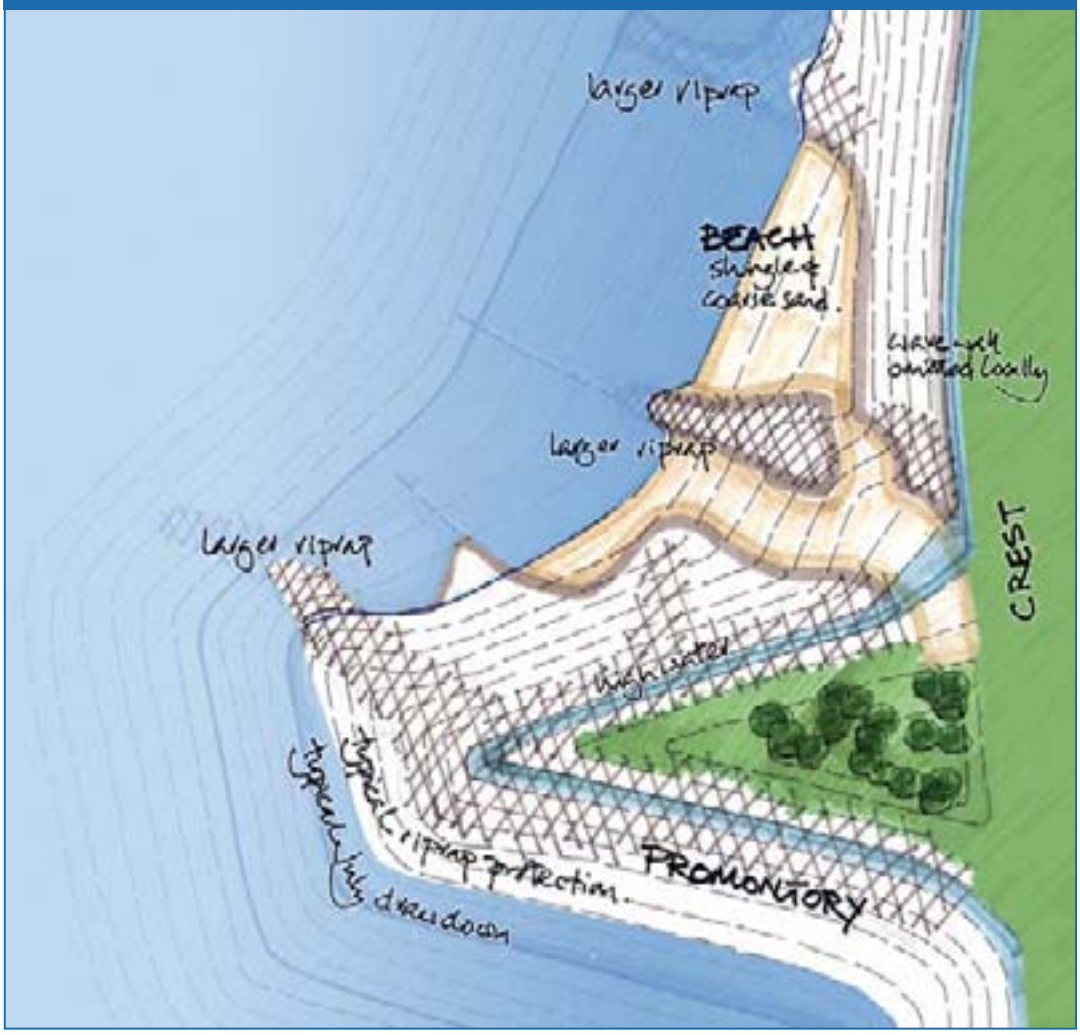
- **Lagoons** which could be constructed as a series of interlinked linear ponds immediately adjacent to and parallel with the high water mark. The lagoons would be formed by trapping water in these ponds at high water levels, as water overtops the inner rim. Water in the lagoons would either be allowed to evaporate as reservoir water levels drop or could be kept topped up by pumping water from the reservoir. By combining separate lagoons with different inlet levels and/or pumping options, a range of habitats could be encouraged. A typical lagoon section is shown in Figure 7.1.

Figure 7.1: Lagoon section



- **Promontories** at various locations around the reservoir which could be constructed of compacted clay as part of the main embankment and protected on all sides by riprap. The crest of the promontory would be at, or marginally above, the main embankment crest level and could be planted with trees. A sketch of a typical promontory is shown in Figure 7.2.
- **Beaches** composed of coarse sand and shingle, and **coves** composed of larger shingle and rocks, could be created in the spaces between promontories. The beaches and coves would be confined to an elevation appropriate to the typical summer reservoir level – approximately five metres below full storage level. Movement of the material would be reduced by the construction of a number of terrace walls using riprap and by timber walls as well as by the promontory. The protection material around the beaches and coves would be riprap with a gradual transition both in terms of slope and size of stones. These features could also provide a degree of visual containment and echo natural features. A typical layout is shown in Figure 7.2.

Figure 7.2: Promontory and beach arrangement



- **Small-scale undulations** which could be provided over large portions of the inner face protection layer. These would give added relief and interest to the inner face when waters levels are low and would also provide small-scale variation of the water line. The effects of both would be accentuated by foreshortening of views from the embankment crest, as illustrated in Figure 7.6.

Figure 7.3: View of inner face lagoon

Figure 7.4: View of inner face cove

Figure 7.5: View of a beach

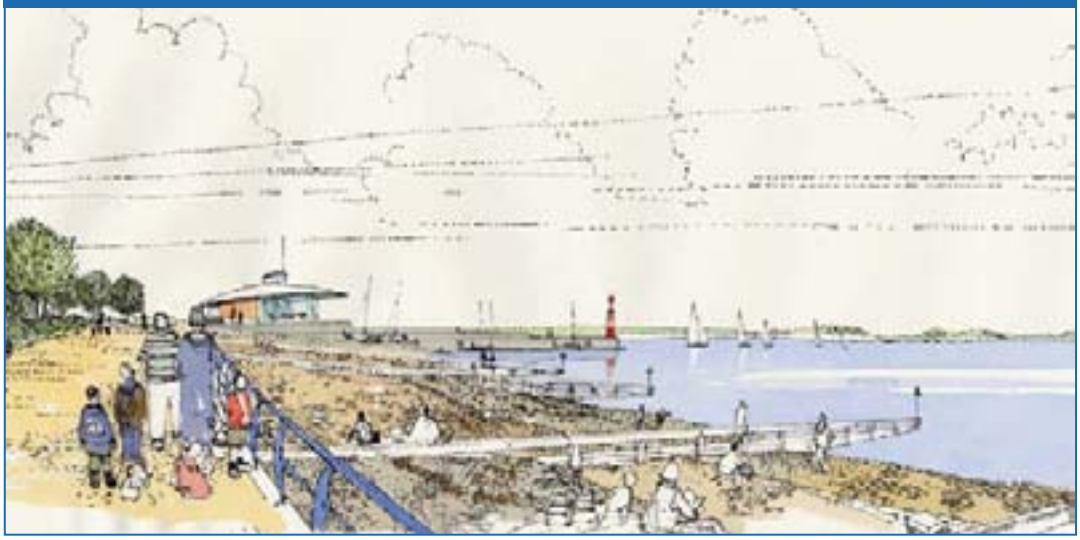


Figure 7.6: View of inner face

Outer zone

7.2.8 The scale of the outer embankments offers major opportunities. With heights above adjacent land ranging from 15 to 25 metres and a total outer slope area of approximately 2.5 square kilometres, the outer embankment would form the principal visual presence of the reservoir.

7.2.9 Outer bank treatments need to meet a number of requirements. They need to be stable (which is a function of the gradients) and practical in terms of construction (which is a function of complexity of design and the large machinery that would be used to construct the earthworks). It is also important that the embankment design allows inspection for safety reasons and access for maintenance.

7.2.10 The outer slopes would consist of engineering fill and landscape fill. The latter is made up of poorer quality excavated soils, subsoils and rock not suitable for use for construction of the embankments. The landscape fill is an inevitable product of the excavation required for the reservoir and the quantity involved offers a significant opportunity to modify (and to plant up) what could otherwise be uniform and regular outer slopes.

7.2.11 The degree of planting permitted on the outer slopes is directly related to the ability to undertake regular inspections of the embankment face. Extensive and thick planting would not therefore be acceptable. However, small copses, hedgerows and areas of open scrub and trees would be permitted, and the anticipated extent of planting on the outer face could be significantly more than at a typical existing reservoir using embankments, such as Farmoor.

7.2.12 The outer slopes would also provide considerable opportunities to make provision for new recreation uses and the slopes could be designed accordingly. The recreation opportunities are discussed in Subsection 7.4.

Landscape strategy for the outer slopes

7.2.13 The landscape strategy adopted for the outer embankments has been based on four main principles:

- maximum integration with the surrounding landscape;
- use of localised earth sculpting to produce variation in landform at specific locations;
- adaptability so that it can deliver any of the potential recreational scenarios; and
- minimal management obligations.

7.2.14 In relation to the first main principle, the junction between existing and proposed landscapes will be important. The strategy could seek to blur the transition between the two in most locations so as to restrict awareness of the scale of the reservoir from any one viewpoint:

- the outer slopes could act as a component of a number of differing landscapes rather than being read as a whole;
- the existing field pattern and the relatively flat landscape could provide an opportunity for developing a number of screening layers of vegetation and landform between the viewer and the outer slopes; and
- the relatively gentle outer slopes would mean that the crest, where visible, could be well back from the base of the slope.

7.2.15 In a limited number of places the outer slopes could be modelled to form local landmarks, to signal activities out of sight over the reservoir crest (and access to these), or act purely as landform art.

Working with different design components

7.2.16 The outer slopes consist of three key components, the crest (which determines the silhouette of the embankment), the profile (which determines the embankment gradients) and the elevation (which determines the perceived height of the embankment). The specific design principles for these components are indicated below:

Crest

Landform significantly above the crest level could be appropriate in the north-east corner. A widening of the embankment would be needed in this area to accommodate access to facilities required for operational purposes and potential recreational activities (discussed in Subsection 7.4). There could be other smaller scale adaptations to the crest, particularly on the south-east, south and south-west perimeters where there would be more wide-scale views and the embankments would be steeper in order to accommodate the Hanney to Steventon road.

Profile

Although the outer slopes would have fairly gentle gradients, there is still a need to provide a variety of both gradients and visible profiles, and to reduce awareness of the scale of the reservoir slopes as they recede into the distance. This would be particularly important from certain viewpoints such as when travelling along the realigned Hanney to Steventon road where there are oblique rather than direct frontal views of the slopes.

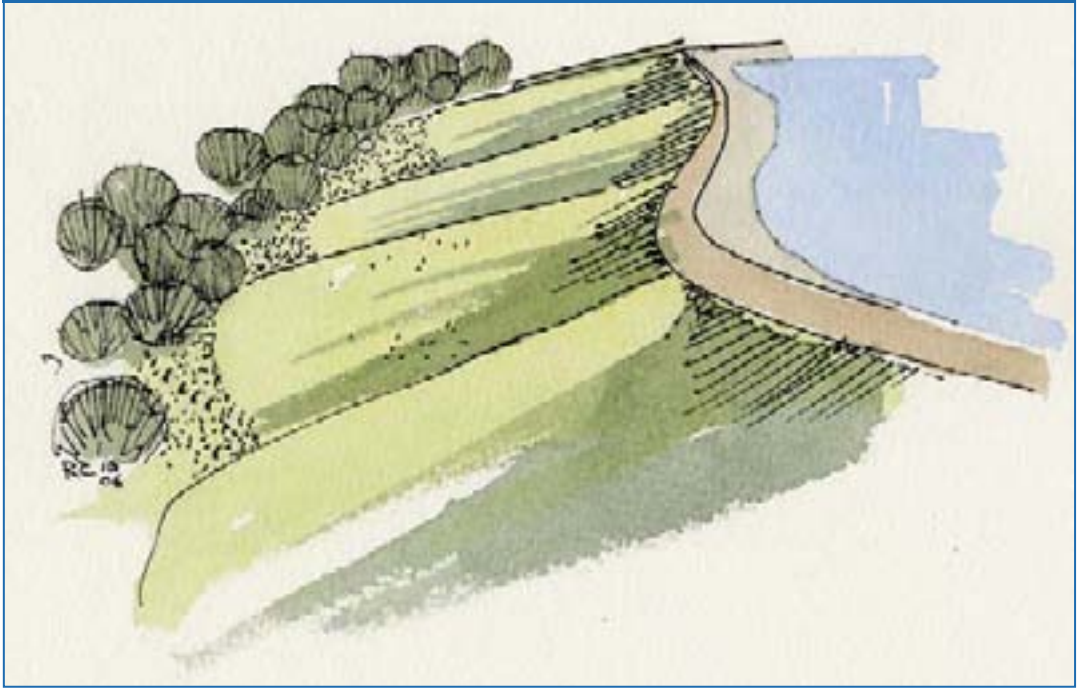
Design principles that could be used to provide a varied profile include:

- variation of slope angles and the combinations in which they are used;
- variation in the position of the base of the slope; and
- use of vegetation.

Elevation

Where the main view is a direct frontal one as opposed to oblique, the aim would be to blur awareness of the location of the base of the slope. This could be done through subtle changes in gradient and by carrying vegetation such as hedges and copses up the slope from the surrounding landscape. A similar technique could extend agricultural and other land uses from the hinterland up the slopes where appropriate.

Figure 7.7: Sketch of the outer face



Working at different scales

7.2.17 The creation of new landform associated with the reservoir could provide opportunities for landscape enhancement at different scales – macro, medium and micro. The principles which could be adopted at each scale are summarised below:

Macro

At macro scale, the reservoir shape and its broad curves could reduce its perceived extent from the air.

Medium

At medium scale, a variation of the profile, embankment slopes, break point of changes in gradient and the location of the base of the embankment could help to reduce the perceived bulk of the embankment. These variations, together with the introduction of broad land shelves, could also help to introduce shadow and prevent the whole of any one side of the embankment being visible from any one viewpoint.

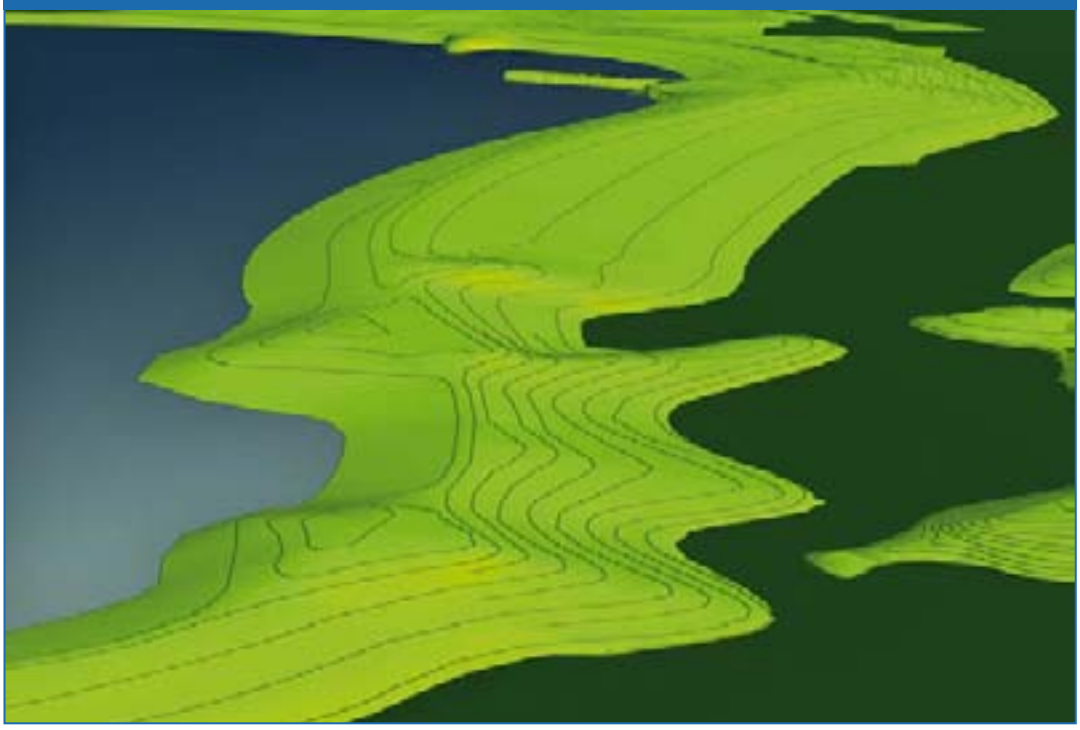
Micro

At micro scale, the use of narrow land terraces could create texture and visual interest for closer views.

Figure 7.8 View from the south-west

7.2.18 These principles have all been applied in preparation of the earthworks plan (Figure 7.9) to illustrate the opportunities available.

Figure 7.9: Earthworks plan



Landscape strategy beyond the embankment

7.2.19 **The extent of land affected by construction would stretch considerably from the base of the** embankment. It is this land that presents the major opportunity for significant landscape enhancement. For example, it would be possible to return areas to agricultural use, and to reinstate lost hedges, ditches, ponds and copses so that field patterns could run unimpeded to the base of the embankment and up the slope itself. The track and drain at the toe of the reservoir embankment (see Section 5) could be integrated into this treatment.

7.2.20 **Part of the landscape fill could be used to form mounds detached from the embankment.** These mounds could have a number of functions, including:

- provision of screening for the site compound, haul roads and storage areas (see Section 6);
- use of topsoil which may be unsuitable for use in depth on the outer slopes;
- provision of middle ground banks further reducing awareness of the actual embankment toe; and
- ability to accommodate substantial tree planting, with added opportunities for the middle distance breaking of views of the embankment.

7.2.21 **Parallel to this could be a programme of hedge and copse planting on land not directly** affected by construction but where additional breaking of views of the reservoir over a distance could be beneficial. This could be undertaken in conjunction with landowners within an area bounded by the A34, River Ock, A338 and railway.

7.2.22 **The landscape strategy for these areas would also need to take into account the variety of** other proposals for the area, including the reservoir ancillary works (Section 5), and the range of potential recreational uses (Subsection 7.4).

7.2.23 **The reservoir ancillary works (pumping station, water treatment works etc) would be in the** north-east corner of the site. Extensive earthworks would therefore be appropriate in this corner both as large-scale extensions to the embankment and as detached mounds. These could integrate the ancillary works within the overall landscape and also provide visual and noise screening from the A34. The latter would be particularly important if visitor facilities are developed in this area as indicated in Subsection 7.4.

7.2.24 **In addition to the main recreational proposals discussed later in the section, Thames Water** would facilitate the restoration of the Wilts & Berks Canal around the outer edge of the reservoir. This would take the form of a reserved corridor of land extending from the south-west to the north-east corner of the site, around the north-western edge of the reservoir. The provision of this alignment has been the subject of discussion with the Wilts & Berks Canal Trust, and would connect with the length of the canal to be constructed to provide auxiliary drawdown capacity for the reservoir (see Section 5).

7.3 NATURE CONSERVATION AND HABITAT CREATION

7.3.1 **Nature conservation would be a key component of the proposed environment of the reservoir.** There are few projects nationally of this scale and the proposal is to use this opportunity to provide extensive and lasting habitat creation and enhancement. The new habitats would be an integral part of the new landscape to be created around the reservoir.

7.3.2 The area of the proposed reservoir site is primarily under arable farming. While there are no national nature conservation designations, the site includes local habitats which provide a refuge for wildlife (including the corridor of the River Ock), some areas of woodland and numerous hedgerows. These habitats support various protected animal populations including water vole, great crested newt, bats and badgers, along with species of breeding and over-wintering birds.

7.3.3 The overall principle guiding nature conservation and habitat creation is that of achieving of a 'habitat balance sheet'. This involves defining the habitats that would be lost (based on comprehensive ecological surveys) and comparing the loss with habitat gains through reinstatement and new habitat creation.

7.3.4 The reservoir provides an excellent opportunity to create some of the priority habitats identified in the Oxfordshire Biodiversity Action Plan[13] in areas currently supporting arable farming. Examples include dry and wet grassland, woodland, species-rich hedgerows and reedbed. Provision of these habitats would deliver very significant biodiversity benefits and be consistent with national land use planning policy as set out in Planning Policy Statement 9 (Biodiversity and Geological Conservation). An Ecology Forum, comprising representatives of all the main statutory and non-governmental nature conservation organisations with an interest in the reservoir site, has been set up to provide advice to Thames Water throughout the entire design and construction process.

7.3.5 Provision for protected species which currently exist on the site would be made by creating alternative suitable habitats away from construction activity so that protected species could be caught and transferred to ensure their survival.

Proposed habitats

7.3.6 The main proposed habitats (as shown on Figure 7.10 in Volume 2 and the photographs in Figure 7.11) are described below.

Neutral unimproved grassland

7.3.7 This could be one of the primary habitats, including some that are seasonally flooded and some that remain dry. Dry grassland could be located: on the eastern and western embankments; on the upper part of the north embankment; on land immediately adjacent to the embankments; and in the vicinity of the Cuttings Ponds and the temporary railway sidings. Wet seasonally flooded unimproved grassland could be created in low-lying areas along the East and West Watercourse Diversions and in lower parts of the flood storage area.

Species-rich hedgerows and hedges on banks

7.3.8 These could be created in most of the areas surrounding the embankment and could extend up all embankments except that on the southern perimeter with its steeper and drier slopes.

Broadleaved woodland

7.3.9 Blocks of broadleaved woodland could be created around the reservoir particularly to the south-east and north of the embankments. Woodland in the south-east could be associated with screening mounds created at the start of construction to protect the local environment, and could be linked to form a woodland corridor managed as coppice. Woodland north of the reservoir could be in the form of small copses which would link with, and complement, existing small woodland blocks near the River Ock and Childrey Brook.

[13] http://www.ukbap.org.uk/lbap.aspx?ID=454

Wet woodland

7.3.10 Areas of wet woodland could be created in two parts of the low-lying floodplain subject to frequent inundation: the upper reaches of the West Watercourse Diversion near Cuttings Ponds; and north-west of the reservoir in association with lower reaches of the Cow Common Brook and the decommissioned settlement ponds (built as part of the reservoir construction).

Small streams and wet ditches

7.3.11 The creation of a network of streams and ditches around the reservoir could be located to connect with: the West Watercourse Diversion (and its associated wetland habitats including wet woodland, reedbed and wet grassland); the East Watercourse Diversion; the embankment toe drain (mainly open channel discharging via open water and reedbeds to permanent settlement ponds) and a series of ditches in the flood storage area.

Scrub habitats

7.3.12 Scrub habitats could be created in association with: unimproved grassland (particularly on the east and west embankments), broadleaved woodland; flood storage areas (as wet and dry scrub); the stream diversions and around the settlement ponds.

Ponds, scrapes and flushes

7.3.13 A series of ponds and seasonally wet scrapes could be formed along the perimeter of the embankment (fed by runoff from the embankment), as well as within the natural floodplain and flood storage areas. Flushes or small marshes could be formed close to the lower end of the Cow Common Brook and Cuttings Ponds.

Reedbeds

7.3.14 Two areas of reedbeds could be developed in low-lying floodplain: around the decommissioned settlement ponds in the north-west and in the lowest parts of the flood storage area.

Lowland heath

7.3.15 Lowland heath could be created on the southern embankment where steeper gradients and a sunny aspect would make for suitably warm and dry conditions.

Figure 7.11: Photos of principal habitat types

Neutral unimproved grassland

Species rich hedgerows and hedges on banks

Broadleaved woodland

Wet woodland

Small streams and wet ditches

Scrub habitats

Ponds, scrapes and flushes

Reedbed

Lowland heath

Figure 7.12: Sketch view of wet woodlands

Planting, after-care and management

7.3.16 An agreed management plan would provide the framework for the selection of appropriate plant material, and after-care and management once planted. The exact scope of the plan is still to be determined, but as a minimum it would include:

- species to be used and their location;
- methods for ensuring that plants become properly established; and
- management techniques to ensure that the new habitats thrive in the longer term.

7.3.17 The general intention for all new planting would be to use species that are locally native and consideration would be given to propagation using locally collected plant material, including that from existing habitats on the site that could otherwise be lost. Plant size would be generally small to aid easy establishment. Where possible planting would be undertaken in advance of completion. Grass and wild flower seed mixes would be researched to mimic local conditions and to act as the starting point for the habitats to be created. Plant establishment and subsequent management would be critical and would be undertaken in accordance with the management plan.

7.3.18 Current planting proposals have been informed by a mix of considerations including sensitivity of adjacent landscape, potential activities on adjacent land and location in areas with potentially high levels of use.

7.3.19 Effective management of the outer slopes would ensure that the grassland would not scrub over to such an extent that required safety inspections would be compromised. Management regimes that rely on mowing would neither be affordable nor sustainable so it is anticipated

that the bulk of management would be achieved by grazing. This would generally be undertaken with the primary objective of nature conservation enhancement rather than maximising agricultural returns.

Arable farming

7.3.20 The current strategy envisages arable farming being extended up the embankment on parts of the north and east sides where existing agricultural practices could be least affected by the reservoir, although this is subject to discussion with adjacent farming interests. Slopes suitable for arable farming would have gradients of 1:10 to 1:12 arranged on suitably sized fields, with existing fields and field boundaries in the area extended up the embankment. The technique would not be practical on the west side because of the proposed flood storage areas, nor on the south side because of the proximity of the realigned Hanney to Steventon road and the necessity for steeper embankments.

7.4 RECREATION

Introduction

7.4.1 The new reservoir would have the potential to support a wide range of recreational uses, ranging from low-key quiet activities to major sporting events. However, the selection of an acceptable range of new uses needs to take several factors into account. The Water Industry Act 1991 requires Thames Water to give consideration to the provision of recreation and other leisure facilities for the benefit of the inhabitants of the area provided they do not conflict with the primary purpose of the reservoir to supply water. Local land use policies and the physical constraints of the site would mean that certain uses might be acceptable whereas others would not.

7.4.2 The Stage 2 consultation provides an opportunity to seek views on the acceptability of a range of uses to the local community and other stakeholders, based on the work undertaken to date.

Range of possible uses

7.4.3 In 1998, Thames Water published a draft Scoping Report[14] as part of the previous environmental studies for a proposed new reservoir south-west of Abingdon. Feedback during the consultation undertaken on that Scoping Report was received from a wide range of organisations representing local, regional and national interests, covering social, economic and environmental issues[15]. This feedback has provided the starting point for looking again at the range of possible uses that might be acceptable at the new reservoir.

7.4.4 Thames Water has been assisted in the process of identifying the range of possible uses by the advice received at a 'Visionary Workshop' held in October 2005. The workshop, attended by experts covering a wide range of issues, and building on the earlier local work, helped define a number of principles to guide the identification of acceptable uses:

[14] Planning for Future Water Resources. Environmental Assessment: Draft Scoping Report for Consultation. Report No.3. Prepared by Land Use Consultants and Consultants in Environmental Sciences, Thames Water (June 1998).

[15] Environment Agency. Local Authorities, English Sports Council (Southern Region), Oxford Sailing Club, the British Canoe Union, and the Ramblers Association.

- all uses should be realistically affordable and able to be given consent and provided on the site;
- a site as large as the one identified should be able to accommodate both a wide range of visitor based recreational activities and low-key informal provision;
- the reservoir outer embankment and surrounding area are more important, in considering recreation provision, than the crest and water;
- the reservoir site sits in tranquil countryside, and its design should reflect this;
- the reservoir should be an exemplar for sustainability, with particular emphasis on biodiversity, health and recreation, sustainable access and movement, reduced energy consumption, and positive land management;
- education should feature prominently; and
- the design and operation should be flexible to allow for the future requirements of a changing society.

7.4.5 The range of possible uses is summarised in Figure 7.13. Expressed as a continuum, the uses range from 'do minimum' at the very low scale of use, to 'theme park' at the very high scale of use. This range is wide, reflecting the fact that many different uses, operating at various scales, could be accommodated on a site of this size. The full list is provided in Appendix D.

7.4.6 However, many factors need to be considered in establishing whether the uses would be practicable, acceptable and appropriate on the reservoir site. Figure 7.13 also illustrates what Thames Water considers the acceptable range within which specific potential uses could be identified.

7.4.7 The 'do minimum' part of the continuum in Figure 7.13 was discounted for two principal reasons:

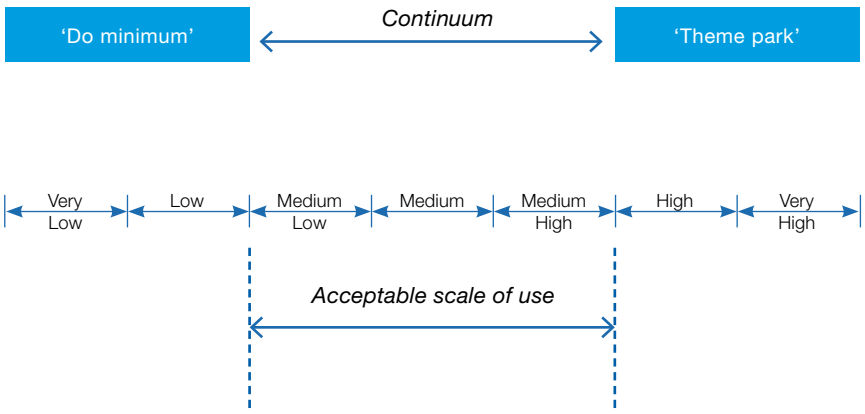
- the requirement in land use planning policy to, as a minimum, replace or compensate for the loss of any current recreational uses on the site; and
- the duty placed on Thames Water by the Water Industry Act to consider making provision for recreation in relation to all its functions.

7.4.8 The 'theme park' end of the range was also considered inappropriate for reasons including the following:

- The type of intensive recreational uses represented by the term 'theme park' would not be consistent with established land use planning policy which seeks to protect the amenity and tranquil character of the area.
- It was also evident from the scoping consultation responses received in 1998 and from the Stage 1 consultation and feedback from the Parish Councils that uses of this sort would not be acceptable in the locality.

7.4.9 Consequently, Figure 7.13 illustrates an acceptable range, from Medium Low to Medium High scale of use.

Figure 7.13: Continuum and acceptable scale of use



7.4.10 The full list of possible uses in Appendix D was then the subject of a further round of consideration, the aim being to establish a shorter list of possible uses that may be acceptable at the reservoir. Each use was assessed against the following criteria:

- compliance with land use planning policy;
- anticipated local need;
- significant environmental and/or social impacts;
- health and safety risk;
- technical feasibility;
- Thames Water's management, operational and aftercare considerations;
- cost; and
- the principles established to guide the identification of acceptable uses.

7.4.11 The results of this exercise are also included in the table in Appendix D, with the second column indicating whether a use could be provided at the reservoir. The comment column explains the reasoning in each case.

7.4.12 The uses that were judged to be acceptable could be split into those that would be suitable at any scale of development (within the acceptable scale of use shown on Figure 7.13), and those whose suitability would vary depending on their scale. For example, activities such as kite flying, picnicking and guided tours are suitable at any scale. However, the suitability of a sailing club would vary depending on its size. A sailing club holding regional regattas would not be suitable at the Medium Low scale of use. This distinction resulted in the shortlist being split into two sections: those activities of varying suitability and those suitable at any scale.
The proposed shortlist is included in Appendix E. For each activity clarification is provided in the appendix on the scale of use within the acceptable range.

7.5 SCENARIOS

7.5.1 While it is possible to comment on the individual uses that have been identified and their likely acceptability, it was considered that some form of spatial representation of their distribution would be required to aid discussions during the Stage 2 consultation. Three scenarios have therefore been produced to illustrate how different uses could be accommodated at the site. It is important to emphasise that these are scenarios to illustrate what might be possible, rather than being the only possible options.

7.5.2 The three scenarios are termed 'Medium Low', 'Medium' and 'Medium High' respectively, and they represent what was judged to be within the acceptable range. The scenarios have been defined in two stages. The first involved the identification of the likely characteristics of different parts of the site once the reservoir has been built, followed by the allocation of possible uses to these areas.

Characteristics of the site

7.5.3 The site was divided into four quadrants for the purposes of describing the likely future characteristics once the reservoir has been built: north-east, south-east, north-west and south-west.

North-east

7.5.4 This quadrant would be the focus of activity in connection with the operational reservoir (pumping station, water treatment works, auxiliary drawdown channel etc). The roads built for construction access would be adapted to give access to these facilities, providing connection to the A34 without passing through existing settlements. This route could also provide access for visitors to the potential recreation facilities.

7.5.5 Road access, plus the relative proximity of Abingdon, and the ability to provide sustainable transport links (cycling, walking and horse riding) using the auxiliary drawdown corridor, make the north-east quadrant the most suited to more intensive forms of activity.

7.5.6 The northern part of the quadrant is, however, more tranquil and contains open (mainly arable) fields bordering the River Ock with Marcham Mill acting as a local landscape focus.

South-east

7.5.7 This quadrant is characterised by mainly arable farming which extends up to the edge of Steventon village. Landscape qualities are diminished to some extent by a considerable number of overhead power lines and a large electricity sub-station. The Hanney to Steventon road is the principal public highway. This would be realigned as part of the reservoir construction, with the potential for the severed portion to be retained in part and used for local access to the base of the reservoir embankment.

7.5.8 The proximity of Steventon village has led to the embankment being located westwards, and also to the introduction of earth (screening) mounds, either as extensions to the embankment or detached from the embankment and closer to Steventon.

South-west

7.5.9 This quadrant contains smaller scale landscapes particularly those around the disused Wilts & Berks Canal where hedges, scrub and localised copses provide a greater degree of enclosure than elsewhere. Hutchins's Copse and the Cuttings Ponds are habitats of locally recognised status and these would be retained. This quadrant would be affected by the proposed realignment of the Hanney to Steventon road and the diversion of the Cow Common Brook around the west side of the reservoir.

7.5.10 The northern part of the quadrant may be required for additional flood compensation. Although the majority of East Hanney lies to the west of the A338 some properties and the village hinterland extend east of the road. The proximity of the village has resulted in the embankment being located eastwards and the adoption of a series of fringing earthworks. The introduction of more intense forms of recreation activity would run counter to this strategy.

North-west

7.5.11 This quadrant is the most rural of the four. It contains no settlements, with the nearest, Garford, being some one kilometre north-west of the A338. There are few dwellings. The land is flat and fairly open and mainly under arable use with scattered copses. The reservoir proposals respect these conditions by proposing shallow slopes to the outer embankments so that arable farming may be extended up much of the slope.

7.5.12 The area to the west of the embankments would be significantly altered to provide for both the Cow Common Brook diversion and the extensive areas of flood compensation required. Temporary settlement ponds required during construction would also be located in this quadrant. These ponds could be retained and subsequently used as the basis of new habitats. The combination of these tranquil qualities and proposed water related functions mean that the introduction of more intense forms of recreation provision would be both difficult and inappropriate.

Distribution of uses

7.5.13 The distribution of uses within the site takes account of the likely characteristics of the four quadrants, as well as the following design principles:

- individual requirements of each use;
- inter-relationship with other uses;
- land use planning policy, notably protecting the amenity of local residents;
- existing and proposed landscape and ecological characteristics; and
- technical requirements of the reservoir itself.

7.5.14 Uses have been allocated to the four quadrants for each of the three scenarios, as shown in Figures 7.14, 7.15 and 7.16 (see Volume 2). The various uses have been grouped into six broad categories for ease of reference: educational, nature and landscape, sport, access and recreation, art and culture and miscellaneous. The colour coding in the figures illustrates the groupings. Uses that are considered common to all three scenarios are shown on the right of each figure.

7.5.15 Inevitably there were some instances where locational requirements would be contradictory and compromise solutions are therefore required. The location of sailing facilities is an example. In strict sailing terms this facility could be expected to be in the south-west quadrant

to take advantage of prevailing winds. However, such a location would be likely to generate unacceptable traffic impacts, so the facility has been shown in the north-east quadrant where road access would be already available from the A34 via the A415.

7.5.16 Figures 7.17, 7.18 and 7.19 (see Volume 2) are sketch plans showing the potential locations of activities for each of the scenarios. They are illustrative only and aim to convey the character of the scenarios and likely broad location of facilities and activities, as the basis for discussion in Stage 2. Figures 7.21, 7.22 and 7.23 show the north-east quadrant in more detail for each scenario.

7.5.17 Landscape, nature conservation and access features are incorporated into all three scenarios:

- Beaches, coves and associated promontories. These could be located near to East Hanney, Steventon and Drayton. Access to the water's edge would be mainly at the beaches and coves with selected access elsewhere by paths through the riprap. Swimming would not be permitted for health and safety reasons.
- Areas of specific habitat creation. Habitat creation, notably wetland and damp meadows to the west of the site would be linked to the flood storage area. The relative tranquillity of the western edge of the site would be retained in all three scenarios. The size of the site makes it possible to retain intimate and tranquil areas within all scenarios.
- An extensive network of new bridleways, footpaths and cycle paths.

7.5.18 The characteristics specific to each of the illustrative scenarios are summarised below.

The new network of access routes would be extended to connect with existing routes outside the area affected by the works and, where appropriate, improvements would be made to existing routes to link the area with the surrounding settlements. Some routes would be designed as cycle paths or shared pedestrian/cycle paths. The six kilometre crest top route could form part of the Oxfordshire cycle network as an alternative to using a dedicated cycle path beside the realigned Hanney to Steventon road. Access to the crest would be via a variety of routes and gradients, providing access for all.

Medium Low scenario

7.5.19 The Medium Low scenario is depicted in Figure 7.17 (Volume 2) and Figure 7.21. The uses at this scale could be spread fairly evenly across the entire site, with three areas of local parking provision in the vicinity of the three coves. The range of uses is the smallest of the three scenarios with the overriding themes of tranquillity, provision of facilities at the local level, restriction of built development, and low levels of expected traffic generation.

7.5.20 At this scale, the provision of associated facilities on-site could involve the erection of information boards, including details about the site (its construction, operation and layout) and some educational information, angling, and potentially some land art. No water sports would occur on the reservoir itself. Car parks would be provided in three locations to support these facilities, each containing spaces for 20 to 50 vehicles.

7.5.21 The scale of facilities would be generally sufficient to act as a local or sub-district resource for local people.

Medium scenario

7.5.22 Figures 7.18 (Volume 2) and 7.22 depict the range and scale of activities and facilities that could be provided at the Medium scenario scale. The activities at this scale would be more focussed within certain areas, although some uses would still be well spaced throughout the site e.g. walking and cycling.

7.5.23 The focus of built development would be primarily in the north-east corner of the site, and could incorporate a visitor centre, local events area and water gardens, together with angling, a water sports clubhouse and an area for boat storage (see Figure 7.22). Certain water sports could be permitted on the reservoir at this scale of use (although not motor boats due to water and noise pollution). Car parking would be provided in two areas in the north-east corner; 75 spaces (plus 400 overflow) would be located near the events area, with 225 spaces provided near the visitor centre. In addition, there would be spaces for 300 boats to be parked on-site.

7.5.24 The other two areas of built development considered suitable at this scale of use would be in the south-west and north-west corner of the site, and could include a school study centre and pony trekking centre respectively. Both could be based in existing buildings or incorporated into buildings required for reservoir construction purposes. Parking in the two locations for approximately 20 vehicles in each (plus two coaches at the study centre) would support these facilities.

7.5.25 The scale of facilities would generally be sufficient to act as a district to county resource for people in Oxfordshire.

Medium High scenario

7.5.26 The Medium High scenario is depicted in Figure 7.19 (Volume 2) and Figure 7.23. The range of activities and facilities would not differ widely from those provided at the Medium scale. It is the scale of the uses that mainly differentiates between the two scenarios.

7.5.27 Facilities in the north-east corner could include a visitor centre, including retail and refreshments, and facilities for educational visits to the site. In addition, the north-east corner could incorporate a heritage/archaeological centre, a larger events area, water gardens, an outdoor educational science park and facilities for both angling and water sports. The pony trekking centre located in the north-west in the Medium scenario could be expanded into an equestrian centre and located instead at the north-east. Car parking would be provided in two areas in the north-east corner; 300 spaces (plus 500 overflow) would be located between the events area and the water gardens, with 300 spaces provided near the visitor centre. In addition, there would be space for 500 boats to be parked on-site.

7.5.28 **The area of built development focussed in the south of the site could provide facilities for** pre-booked educational visits, nature study and research, and 'artists' huts, together with associated parking facilities. Parking for 40 vehicles (plus four coaches) at the enlarged study centre would support these facilities.

7.5.29 **The scale of facilities would generally be sufficient to act as a resource for Oxfordshire and** surrounding counties.

Figure 7.20: View of outer face arable farming

Figure 7.21: Medium Low scenario north-east quadrant

Red text indicates facilities/activities proposed under the conservation, access and recreation scenarios.
Blue text indicates broad habitats proposed by the illustrative habitat plan.
Black text indicates facilities required for the operation of the reservoir.

Figure 7.22: Medium scenario north-east quadrant

Red text indicates facilities/activities proposed under the conservation, access and recreation scenarios.
Blue text indicates broad habitats proposed by the illustrative habitat plan.
Black text indicates facilities required for the operation of the reservoir.

Figure 7.23: Medium High scenario north-east quadrant

Red text indicates facilities/activities proposed under the conservation, access and recreation scenarios.
Blue text indicates broad habitats proposed by the illustrative habitat plan.
Black text indicates facilities required for the operation of the reservoir.

7.6 DESIGN OF STRUCTURES AND BUILDINGS

7.6.1 Several structures and buildings would be required to support the function of the reservoir for water supply purposes and other ancillary operations, as well as recreational uses on the site. A set of architectural principles has been identified to guide the design of these structures and to ensure a cohesive approach to the various building elements.

Structures and buildings

7.6.2 Primary structures and buildings would be required:

- Water treatment works
- Pumping station
- Intake-outfall structure
- Inlet-outlet towers

7.6.3 Recreational buildings to accommodate the uses being considered as part of this Stage 2 consultation and as a minimum would probably include:

- Visitor centre
- Watersports clubhouse
- Classroom facility

7.6.4 Secondary buildings to support ancillary operations for the proposed reservoir would be required:

- Boathouse for operation and maintenance
- Landscape maintenance depot
- Caretaker's lodging

Design vision

7.6.5 The design of the buildings associated with the reservoir would be important as it presents a further opportunity to enhance the overall landscape as an integral part of the reservoir proposal. High quality design should be evident throughout the buildings and the spaces around them. All buildings should contribute to sustainable development including the creation of an environment where everyone can access and benefit from the recreational activities that the reservoir proposal might present. To deliver this vision Thames Water has identified a number of architectural principles which would be achieved through the design, as identified below.

Architectural principles

7.6.6 Incorporation of the following principles in the design of buildings and structures would assist in meeting the overall design vision:

- visitor appeal: to provide buildings and related spaces where people would want to visit and spend time; and to promote the regional and inter-regional significance of Thames Water's proposal;

- educational appeal: to provide opportunity to learn about water provision, the functioning of the reservoir and related wildlife conservation;
- economic stimulus for the local area: to integrate the buildings with the new water environment, recreational opportunity and biodiversity improvement, and thereby increase attraction to visitors and benefits to the local economy;
- ease of maintenance and operation: to ensure all buildings, as well as being visually attractive, are (as importantly) fit for purpose and allow for flexibility in layout and expansion if needed;
- innovation: to incorporate innovative design where appropriate in the context of the other principles;
- high quality design: to reflect high quality of design through the architectural finish, details and materials used;
- appropriateness to context: to integrate with both the new and existing landscape (including the River Thames setting);
- sustainability: where possible, to minimise carbon emissions, maximise energy efficiency, explore use of passive design and alternative energy sources (e.g. solar orientation), maximise water efficiency, use renewable building materials, provide for flexibility, and be responsive to climate change;
- access for all: to provide equal and convenient physical access to buildings and associated spaces for all; and
- response to community engagement in design: to respond to ideas and suggestions put forward by the local community both in terms of the function of the building (particularly those associated with recreation), and in the architectural design.

7.6.7 For the purposes of the Stage 2 consultation, a range of possible options for addressing the treatment of the design have been explored and are presented to illustrate what could be achieved (see Figures 7.24 to 7.28). Several themes have been explored including:

- concealing or making prominent;
- creating small-scale clusters of buildings or unified volumes; and
- using water as a theme.

7.6.8 The comments received on the architectural principles and the illustrative designs will help to develop the concept design of the buildings as the project progresses. If the main consent for the project were granted, then the detailed design of the buildings would be finalised through the planning process with the Local Planning Authority.

Figure 7.24: Sample design range for intake-outfall

(a) (b)

Figure 7.25: Farmoor Water Treatment Works

Figure 7.26: Sample design range for the water treatment works

(a)

(b)

(c)

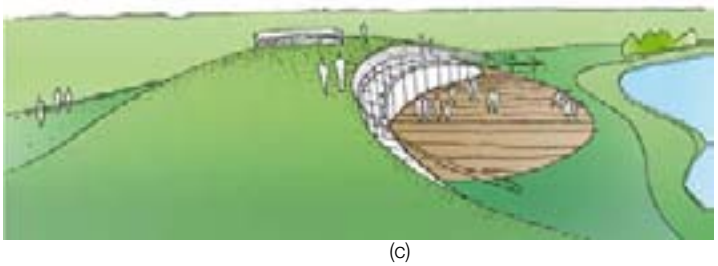
Figure 7.27: Sample design range for inlet-outlet towers

(a) (b) (c)

Figure 7.28: Sample design range for optional visitor centre

(a)

(b)



(c)

Questions on Part B: Landscape, Conservation, Recreation and Building Design

On the basis of the information provided in Part B, it would be useful to provide feedback to Thames Water on the initial proposals put forward for landscape, conservation, recreation and building design.

These comments will help Thames Water as it takes forward the design proposals.

There are four main questions.

Landscape, Conservation and Building Design:

- ***Which aspects of the initial proposals for landscape, nature conservation and building design do you particularly like or dislike?***

You can use the table provided in the feedback form to identify preferences among the initial proposals.

- ***Thinking about the aspects identified in the previous question, please select up to four, including any others you think are relevant. Please let us know any ideas you have of where Thames Water could make improvements to the initial proposals.***

There is space on the feedback form for your descriptions.

Recreation:

- ***Which of the recreational activities do you consider most important, and at which scale would you like the provision to be made?***

We have described in Part B of the Report three possible scenarios as starting points for developing ideas on recreational provision. We have listed in the feedback form the main activities considered important in the Stage 1 consultation. Your views on the importance of activities and the different scale of provision will help us in the next stage of the design process.

- ***Thinking about the activities identified in the previous question, please select up to four, including any others you think are relevant. Please give us suggestions on how you would like these activities to be taken forward in the next stage of the work.***

These suggestions will help us to develop the reservior proposals. In particular, they will be used as a basis for discussion in the workshops and at the local panel.

Next Steps

8 Next steps: what involvement is possible?

8.1 CURRENT STAGE

8.1.1 Thames Water has made progress in developing the proposals for the reservoir and its associated works (tunnels, pumping station etc) including construction, and has begun to clarify the opportunities available in terms of landscape, conservation, recreation provision and building design.

8.1.2 The aims of the consultation at this stage are to enable Government departments and agencies, local authorities, local parish and town councils, the local community and other stakeholders to:

- raise issues in relation to the technical proposals as far as they have been developed and described in Part A of this report; and
- put forward ideas and suggestions, and participate in developing proposals and options on landscape, conservation, recreation and building design. The first suggestions for which are described in Part B.

8.1.3 The Strategy for Community and Stakeholder Involvement (available on the Thames Water website) outlines the means available for involvement during this consultation period (January – March 2007):

- An exhibition will be open for visitors in January 2007 at the venues and times listed in Table 8.1. The exhibition presents the main aspects of the proposals so far and there are staff available at all times to answer questions. Further copies of this report (including in CD format) are available at the exhibition together with a summary version.
- Feedback forms are available separately to provide opportunity to make specific comments on Part A and put forward ideas and suggestions related to Part B. The forms can be filled in at the exhibition or sent in by 3 March 2007.
- There are also copies of this report, summary and feedback forms available at selected venues including the District Council's Local Service Points (Abbey House, Abingdon; Grove Street, Wantage and the Area Office at Faringdon) and at local libraries, throughout the consultation period. Other background documents are available on the website and at local libraries.
- Workshops will be held over the weekend of 3-4 February 2007 led by an independent facilitator to develop proposals and options based on the scenarios presented in Part B of the report, and the ideas and suggestions being received during the consultation. Participants will be selected from those expressing interest in Stage 1 to ensure as wide a range of views and interests as possible.
- A local panel is also being established to act as a sounding board for the entirety of the project from this stage through preparation and assessment of a design proposal to construction and use of the facilities. Participants will be selected from those volunteering in Stage 1 in order to reflect the breadth of views in the local area.
- Statutory and technical stakeholders will continue to have meetings with Thames Water to cover specific issues.

Table 8.1: Exhibition opening times Stage 2

Venue	Date - 2007	Times open to public
Guildhall, Abingdon	Saturday 6 January	9am – 9pm
	Thursday 25 January	9am – 9pm
	Friday 26 January	9am – 9pm
	Monday 29 January	9am – 4pm
	Tuesday 30 January	9am – 5.30pm
Village Hall, Steventon	Monday 8 January	9am – 9pm
	Tuesday 9 January	9am – 6pm
	Friday 12 January	9am – 6pm
	Saturday 13 January	9am – 9pm
Memorial Hall, East Hanney	Monday 15 January	9am – 9pm
	Tuesday 16 January	9am – 9pm
	Thursday 18 January	9am – 9pm
Civic Hall, Wantage	Friday 19 January	9am – 6pm
	Saturday 20 January	9am – 9pm
Drayton Hall, Drayton	Tuesday 23 January	9am – 6pm
	Wednesday 24 January	9am – 6pm
Marcham Primary School, Marcham	Saturday 27 January	9am – 9pm

8.1.4 A Report on Stage 2 Involvement will be prepared to summarise the ideas and suggestions received and how these are being addressed and developed as we develop the project.

8.2 FUTURE INVOLVEMENT

Stage 3

8.2.1 In Stage 3 (mid 2007 to mid 2008), Thames Water will develop the ideas from Stages 1 and 2 into a detailed design of the reservoir. The process will involve continual testing and amendment in response to the Environmental Impact Assessment and Sustainability Appraisal both of which will be undertaken in parallel to the design process.

8.2.2 The Environmental Impact Assessment will require preparation of a Scoping Report and consultation with specific bodies to ensure that the appropriate issues will be addressed. Related work on a Sustainability Appraisal, Transport Assessment and an Economic Impact Report, and the development of an Environmental Management Plan will also take place at this time, involving specific stakeholders to assess issues and potential solutions.

8.2.3 Newsletters and the website will keep local people and organisations informed of progress through to formal submission. The local panel will meet two or three times during this period to assist in testing the development of the detailed proposals.

Stage 4

8.2.4 The formal submission of proposals in Stage 4 is currently expected to take place by mid 2008. Notice will be given via leaflets, the newsletter and the website of the date for formal submission of the proposals at least two months before the due date so that individuals and organisations can plan ahead. A further exhibition will be provided to explain the proposals and clarify outstanding issues, so that respondents can be fully aware of the material submitted prior to making formal comments.

8.2.5 The Strategy for Community and Stakeholder Involvement, available on the website, provides more information on these later stages.

Appendices

Appendix A
Programme of Schemes

PROGRAMME OF SCHEMES: PROGRESS

The preferred programme of schemes identified in the Stage 1 Needs and Alternatives Report combines a number of demand and supply side options to maintain security of supply over the 25-year water resource planning period. On the demand side the programme comprises a rollout of metering on change of occupancy across the London and Swindon and Oxfordshire resource zones; an enhanced water efficiency campaign to include the distribution of cistern displacement devices and the undertaking of water audits for domestic and commercial customers; a programme of active leakage control, and an allowance for the potential savings achievable from new building regulations and guidance. The London area will see a continuation of the mains replacement programme at a rate of 250 km of mains replaced a year.

In terms of additional supply options, in the medium-term the London water resource zone requires the development of an artificial recharge scheme located in South London, a small desalination plant and a reuse scheme. The Swindon and Oxfordshire areas require the development of a groundwater scheme and an aquifer storage and recovery scheme in the medium-term. The London and Swindon and Oxfordshire water resource zones are both reliant on the development of a dual function reservoir near Abingdon in the long-term.

The implementation of the medium to long-term options for maintaining the supply demand balance for water supplies, as set out in the Stage 1 Report, will be subject to scrutiny by both Ofwat and the Environment Agency when submitted to them in 2008 as part of the five-yearly regulatory business plan cycle. If the schemes within the next five-year Asset Management Plan (AMP) period receive funding, Thames Water will be able to promote them through the revenue generated from customers' bills. The next stages of work in the development of these schemes can then be progressed. Funding in that AMP period may also be required for any preparatory studies of schemes that may be needed in the following AMP period starting 2015.

Each scheme's development and timing is dependent not only on the five-year AMP period in which the funding will be allocated, but also on the individual project lead times. For example, it will be necessary to undertake pre-planning application studies, (e.g. Environmental Impact Assessment), submit a planning application and obtain planning permission before project construction. All these factors have been considered in devising the water resource programme.

Looking at the medium-term resource schemes in particular, their development will be based on activities taking place during the current AMP period. The proposed effluent reuse scheme can only be developed following the results of the feasibility trials and the testing of a pilot plant over the next few years. Added to this it is expected that a public consultation exercise will be undertaken to understand public acceptability of effluent reuse as a water resource option.

The demand side measures included in the programmes (e.g. additional metering) are set to commence at the beginning of the next AMP period, starting in 2010 and will build on the work already started during this AMP period. The promotion of all the schemes, demand management and resource development, will be dependent on the necessary permissions (e.g. planning permission and/or abstraction licences) being obtained.

Appendix B
Options Assessment Methodology for the Preferred Scheme and Design Options Report

1. INTRODUCTION

For many parts of the UTMRD project a number of potential options are available and decisions are needed to be reached as to which option would be preferred depending on matters like sustainability and cost. In order to reach these decisions an options assessment methodology was developed.

This Appendix aims to provide an outline of the complete options assessment methodology, detailing its purpose and describing it in full. Section 5 of the main report discusses how the options assessment methodology has been applied, where relevant, to the UTMRD project.

2. PURPOSE OF THE ASSESSMENT

For each element of the scheme there are choices e.g. height, shape, location etc. The options assessment methodology was developed to provide a robust method for identifying a preferred option from these choices.

The overarching purpose of the methodology is to maintain consistency and a logical approach to decision making, whilst ensuring that the principles of sustainability are central to the process.

The main consideration when developing the methodology was to produce a method that is as simple and transparent as possible, in order to achieve a sufficient degree of distinction between options and allow a decision on which to choose.

In tune with established practice, it was considered preferable to base the assessment on quantitative data, where these can be obtained, to remove one element of subjectivity. Where judgements have been made, these are discussed and recorded to allow the reader to follow the thinking behind the decisions made.

3. PRINCIPLES OF THE ASSESSMENT

The options assessment methodology is based on two methods already used by Thames Water*, which have been combined and simplified, based on the following guiding principles:

- the objectives of the option assessment should be made clear and the reasons for choosing particular assessment criteria should be given;
- the assessment procedure used should be set out clearly and the steps involved should be presented in a logical order;
- criteria should be assessed quantitatively wherever possible, or otherwise qualitatively using a simple rating system;
- the results should be presented in terms of the raw data obtained, since data transformations tend to reduce the transparency of the assessment;
- the results should be presented graphically where possible, to aid in interpretation; and
- the provisionally preferred option should be identified by discussion of the results.

* A multi-criteria analysis (MCA) used for water resource planning, and a value management technique routinely used for assessing capital schemes within Thames Water's Engineering Department.

The process can be summarised as:

1. Sustainability assessment and shortlisting of options.
2. Cost, risk and opportunities assessment of shortlisted options.
3. Consideration of the results of sustainability, risk/opportunity and cost assessments.
4. Identification of a preferred option.

4 STEPS IN THE ASSESSMENT

The options assessment methodology comprises ten steps. The individual steps involved and the outputs from each step are shown in the form of a flow diagram in Figure B1.

Each of these steps is described in turn below.

Step 1 sets out the main objectives of the options assessment. It also identifies any engineering, planning, environmental and social criteria that are regarded as being of more importance to that particular option assessment than the other criteria – these are the key assessment criteria, which may be used to help decide between options that perform similarly against the range of assessment criteria.

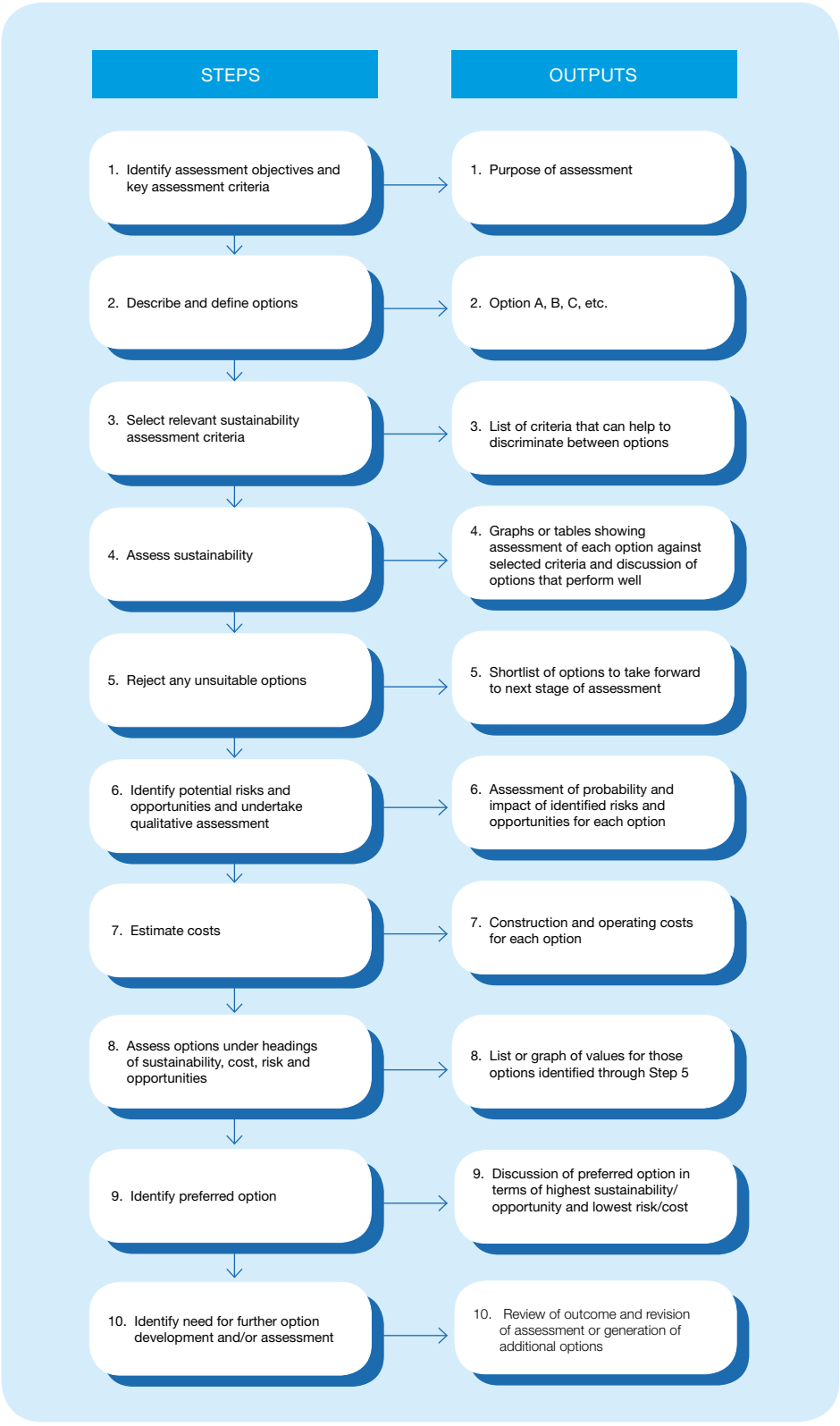
Step 2 provides a definition and description of the options to be assessed, including a location map or maps.

Step 3 involves the selection of relevant sustainability criteria from a master list, as shown in Table B1. A master list is used to ensure that a wide range of criteria is considered for each option assessment and that particular topics are not overlooked or omitted.

The master list comprises environmental protection, engineering, planning and social criteria. The engineering criteria cover issues such as resource use and energy consumption, while the planning criteria reflect land use policies designed to protect and enhance the environment. The environmental and social criteria indicate potential adverse and beneficial impacts on the natural and human environment.

Some criteria within the master list are not relevant to a particular option assessment and these are thus rejected, with a short explanation of the reasoning recorded in the table (examples are shown in Table B1). One reason for rejecting a criterion from the list could be that it would not help to discriminate between the options being assessed, e.g. all options may need the same length of access road, therefore the 'construction access requirements' criterion would not help to choose between the options being considered.

Figure B1 Flow chart of option assessment methodolgy



The acceptance or rejection of sustainability criteria from the master list produces a shortlist of criteria that are used to assess each option within a particular option assessment. The aim of the assessment is to quantify the impacts of the options, for example, the area of permanent habitat loss (m^2) or the loss of flood storage volume (m^3).

The shortlist details the objective for selecting each criterion, together with the measures that will be used to quantify the impacts, as shown in Table B2.

Table B1: Master list of possible sustainability criteria, with two examples of how they can be rejected for each option assessment

Heading	Assessment criteria	Relevance	Selected?
Engineering	Resource use and energy consumption for construction		
	Resource use and energy consumption for operation		
	Quantity of materials imported to site		
	Construction duration		
	Construction access requirements		
Planning	Green Belt		
	Land use allocations	Similar for all options	✘
Environmental	Hydrodynamics (water movement) and water quality		
	Fluvial geomorphology		
	Floodplain		
	Fisheries		
	Ecology		
	Contaminated Land		
	Hydrogeology (groundwater movement)		
	Noise and vibration	Potential impacts captured under "community" criterion below	✘
	Air quality		
	Cultural heritage		
	Landscape		
	Agriculture and land use		
	Waste management		
Social	Transport		
	Community		
	Socio-economics		
	Recreation, access and amenity		
	Visual amenity		
	Navigation		

Table B2: Example short-list of sustainability criteria, with illustrative measurement parameters and units

Heading	Assessment criteria	Objective for selecting criterion	Measurement parameters and units
Engineering	Resource use and energy consumption for construction	To minimise the amount of energy required during construction (used by machinery for constructing the pipeline), because this will reduce the use of natural resources and carbon dioxide emissions.	Length of pipeline (m).
	Quantity of materials imported to site	To minimise the amount of construction material that has to be imported into the site, in order to reduce the use of natural resources, energy consumption and pollution from transporting materials.	Volume of material required during pipeline construction (m^3)
Planning	Green Belt	To minimise the permanent loss of Green Belt land to development and make the scheme more acceptable in planning terms.	Area of Green Belt lost to the development (m^2)
Environmental	Terrestrial Ecology	To minimise the permanent loss of habitats of high nature conservation value.	Area of permanent habitat loss (m^2)
	Cultural heritage (archaeology)	To reduce the chance of destroying or damaging areas of ground known to contain significant archaeological deposits.	Loss of known archaeological sites (no.)
	Landscape (visual appreciation)	To protect the appearance of the landscape by minimising the loss of landscape features (e.g. trees, hedgerows).	Features lost: no. of trees, length of hedgerow (m)
Social	Community	To keep construction activities as far away from nearby houses as possible, in order to cause least nuisance to residents (noise, dust, etc.)	Distance of construction works and access routes from nearby houses (m)
	Recreation, access and amenity	To minimise disruption to existing public access routes (footpaths, cycle routes, bridleways), so that people can continue to enjoy them.	Length of public access routes (footpaths, cycle routes, bridleways) disrupted / diverted by the scheme (m)
	Visual amenity	To protect the views of open countryside that people currently enjoy and value.	Length of public access routes (footpaths, cycle routes, bridleways) from which the scheme would be visible (m) Number of houses from which the scheme would be visible (no.)

Step 4 of the process is the collation and discussion of the measurements made. The results of the measurements are presented in both table format (Table B3 provides an example) and graphically. These data are then considered in terms of both the magnitude and significance of the differences observed between the options, i.e. by how much they differ and whether the difference is important. The results and considerations are reported in detail to ensure that the reasons for decisions are clear. Step 4 finishes with a summary table of the best and worst options for each criterion.

Table B3: Example of the type of raw data collated for the sustainability assessment of three options, as part of Step 4

Criteria	Options			Assumptions / Comments
	A	B	C	
ENGINEERING				
Volume of material required for construction (m^3)	18,500	17,000	21,000	Sand and gravel are the main construction materials required.
ENVIRONMENTAL				
Loss of known archaeological sites (no.)	2	3	0	Known sites were identified using the County Statutory Management Requirements (SMR) data only.
Area of permanent habitat loss (m^2)	24,850	17,420	10,760	Development footprint based on engineering data.

By considering the results of **Step 4** (including the summary table of the best and worst options for each criterion), **Step 5** rejects any options that are unsuitable. For example, an option may consistently perform the worst against a number of the criteria and is therefore rejected at this stage. The remaining options are carried forward to **Step 6**: the identification of potential risks and opportunities. Step 6 contains a list of risk and opportunity criteria (this list is not exhaustive and can be changed if necessary). Potential risks in the list range from unfavourable tunnelling conditions; opportunities might include operational flexibility and resilience to climate change. Those criteria in the risk/opportunities longlist that are relevant to the options assessment are considered further, a process reported through a written commentary.

Following an assessment of the options' sustainability, their associated risks and potential opportunities, **Step 7** considers cost (for both the construction and operation phases). **Step 8** provides an overall review of the options carried forward from Step 5, comparing the sustainability, risk, opportunities and cost assessments. From the overall options assessment **Step 9** identifies the preferred option, using the key assessment criteria where necessary to distinguish between options that are similar in the assessment overall.

During the last few Steps of the option assessment process it may become clear that a combination of the best parts of two or more options may provide the best scheme. This opportunity can be taken in **Step 10** of the options assessment methodology. Where a new option is developed, it will undergo the same assessment process outlined above, and in due course will be compared against the previously preferred option identified in Step 9. The outcome of Step 10 is the identification of the preferred option to be incorporated into the overall UTMRD preferred scheme.

5. USE OF THE ASSESSMENT

Section 5 of the main report describes how the options assessment methodology has been applied, where relevant, to the UTMRD project, providing a systematic decision making process to identify a preferred option on sustainability, opportunity, risk and cost grounds.

Appendix C
River Regulation

RIVER REGULATION

The years 1976/1977 are shown here to illustrate the conditions of river regulation during the most recent prolonged drought.

Figure C1: Comparison of river flows in summer with and without the reservoir

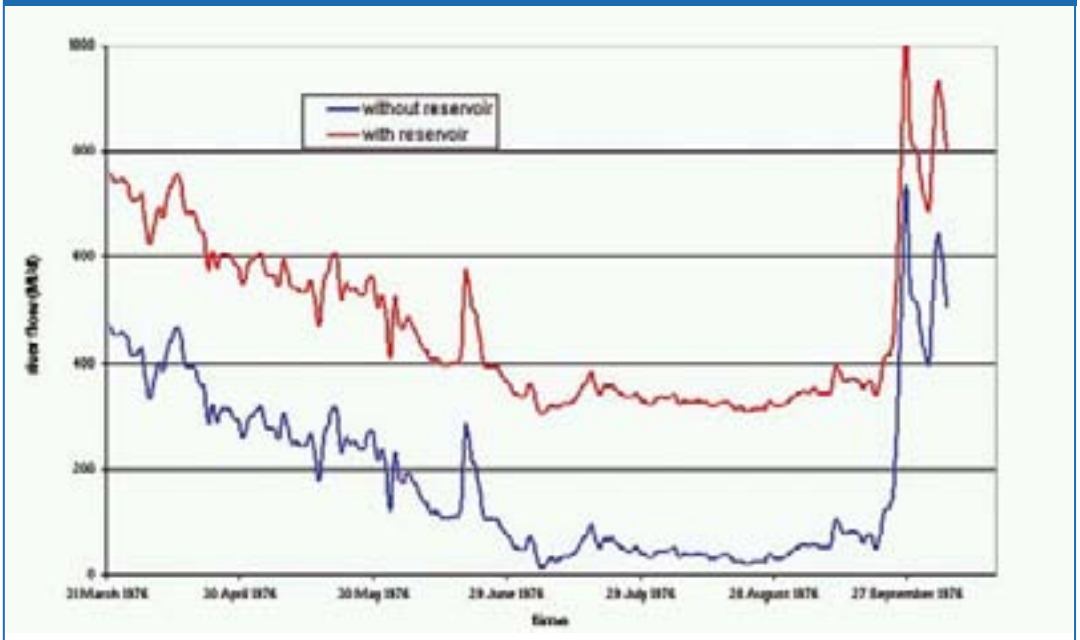
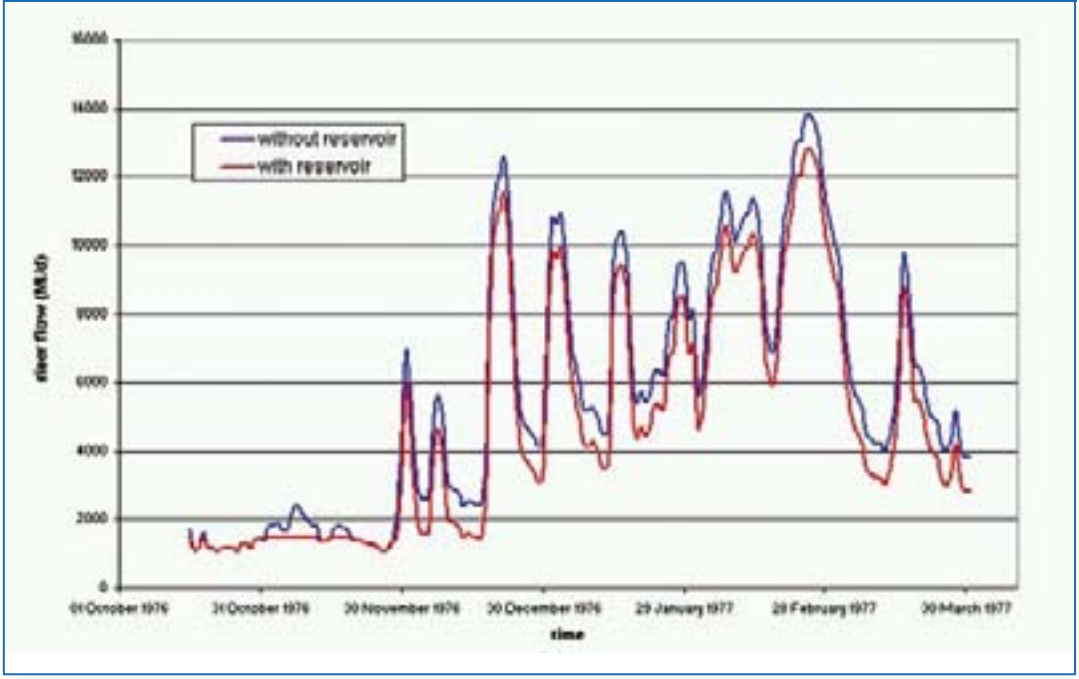


Figure C2: Comparison of river flows in winter with and without the reservoir



Appendix D
Longlist of Use Options

Use		Carried forward to shortlist? - See Appendix E	Comment
Activities identified in Visionary Workshop			
1	Visitor centre	Yes (1)	
2	Outdoor sport and recreation facilities	No	This generic use has not been taken forward to the shortlist of uses because specific outdoor sport and recreation facilities are covered by a number of uses below.
3	Education	Yes (2)	
4	Research	Yes (3)	
5	Access to the hinterland – modified to 'Improved connectivity and existing rights of way'	Yes (35)	It was decided by the Mitigation Working Group (MWG) that 'Improved connectivity and existing rights of way' best captured this option.
6	Woodland	Yes (27)	
7	Country park – modified to 'Car park provision for informal recreation'	Yes (14)	It was decided by the MWG that car park provision for informal recreation (e.g. County Parks) will be constrained by the scale of use.
8	World class bio-reserve – modified to 'Bio-reserve'	Yes (26)	It was decided by the MWG that this use should be modified to 'Bio-reserve' to allow the suggestion to fit into a range of scales of use.
9	New railway station	No	An existing site for a new railway station on Wantage Road, Grove, is to be safeguarded by planning policy in the Vale of White Horse DC **Local Plan** 2011. This site is being progressed by OCC and is better related to the community which it would serve than the reservoir site. It is also understood that potential technical constraints to a new station on the Great Western Mainline have been identified. Given this context the option of a railway station at the reservoir is not considered appropriate.
10	"Capability Brown" landscape (with no house) – modified to 'informal parkland'	Yes (28)	It was decided by the MWG that 'informal parkland' best captured this option.
11	Outdoor educational science park	Yes (4)	It was considered appropriate that this type of education resource should be linked to the reservoir; possibly a water based facility, relating to the hydrological cycle.
12	Organic farmland	Yes (48)	Space could be provided for agricultural uses.
13	Rare breeds farm	Yes (48)	Space could be provided for agricultural uses.
14	Fish farm	Yes (49)	Space could be provided for aquaculture.
15	Major water garden – modified to 'water garden'	Yes (7)	With restrictions on any associated retail elements, as these could be contrary to planning policy (policies at national, regional and local levels generally require retail development that may attract a large number of people, to be located in or next to towns). It was decided by the MWG that this use should be modified to 'water garden' to allow the suggestion to fit into a range of scales of use.
16	Vineyard	Yes (48)	Space could be provided for agricultural uses.

Use	Carried forward to shortlist? - See Appendix E	Comment
17 Golf course	No	TW Policy will not allow this use*; golf courses are intensive water users. The land take of a golf course would not leave enough land for required mitigation measures. Drayton Park Golf Club is within 2km of the UTMRD site, so there is no local need for a future golf course.
18 Sculpture park – modified to 'Sculpture'	Yes (23)	It was decided by the MWG that 'sculpture' best captured this option, thereby including a wider range of facility.
19 Artists' studio	Yes (24)	Space could be provided for artist's or cultural education studios
20 Events area/ amphitheatre	Yes (16)	
21 Greater integration of restored canal	Yes (36)	Thames Water are safeguarding a route for the Wilts & Berks Canal to replace the historic alignment
22 Houses/buildings on stilts	No	Houses within the site were ruled out on planning policy grounds (national, regional and local policy states that housing development should be focused on existing towns and identified local service centres), as well as the potential environmental impact.
23 A railway station next to the water	No	An existing site for a new railway station on Wantage Road, Grove, is to be safeguarded by planning policy in the Vale of White Horse DC Local Plan 2011. This site is being progressed by OCC and is better related to the community which it would serve than the reservoir site. It is also understood that potential technical constraints to a new station on the Great Western Mainline have been identified. Given this context the option of a railway station at the reservoir is not considered appropriate.
24 A major tourist facility for Oxfordshire (i.e. an Eden Project)	No	A major tourist facility was ruled out by a consensus between all consultations held to date and the Visionary Workshop. In addition, a major tourist facility may conflict with planning policy (policies at national, regional and local levels generally require that major leisure developments that attract a large number of people, are focused in existing centres), and would potentially lead to a significant negative environmental impact through traffic generation. However, a small tourist facility will be suitable at the site – this has been incorporated in the shortlist of use options under both a visitor centre (1) and education (2).
25 Another Glyndebourne (indoor opera house)	No	Rejected due to a perceived lack of demand for a development of this type, linked to the risk of operational failure. In addition the use would potentially lead to a significant negative environmental impact through traffic generation*.
26 Locks to link the water to the Wilts & Berks Canal	No	Not practical as canal boats cannot travel on the reservoir due to the wave action.
27 Conservation and community facilities through purchase of additional land	Yes (47)	The purchase of additional land would be possible where it is justified for mitigation or compensation measures.

* Over and above that generated by the visitor centre and other more frequently desired after uses.

Use	Carried forward to shortlist? - See Appendix E	Comment
28 Scuba diving to a sunken "wreck"	No	Swimming in the reservoir would not be allowed for health and safety reasons.
29 Waterfall feature – modified to 'water feature'	Yes (8)	It was decided by the MWG that 'water feature' best captured this option.
30 Creation of specialist habitats such as heathlands, chalk grasslands etc	Yes (29)	
31 Butterfly bank – an area of land managed for butterflies	Yes (30)	
32 Organic picnics	Yes (37)	Space could be provided for picnic areas.
33 'Fish and pick your food for the pot'	Yes (49)	Space could be provided for aquaculture.
34 Views over the water, possibly from the Steventon to Hannay road	No	This is not technically feasible because the road diversion needs to be completed before the reservoir embankments are constructed. Re-diversion of the road following construction of the embankments would not be desirable due to the risks associated with allowing public vehicle access to the water's edge.
35 Break up water surface and hard edge with breakwaters	No	This has been integrated within the design.
36 Renewable energy generation, hydro power or wind e.g. wind turbines or photovoltaic cells	No	This suggestion is not a conservation, access or recreation use, but is important for the project and is being addressed.
TW 2004 Scoping Report Potential After Uses		
37 Passenger ferry	Yes (17)	Facilities for electric only craft could be provided.
38 Water sports clubhouse	Yes (9)	
39 Sailing	Yes (10)	
40 Wind-surfing	Yes (11)	
41 Canoeing	Yes (12)	
42 Rowing course	No	Rejected due to a lack of demand for a development of this type, given the proximity of the site to rowing courses on the River Thames, at Eton, Reading and Oxford. In addition, rowing courses require motorised support craft; these will not be allowed on the reservoir for water quality reasons.
43 Coarse game fishing and angling	Yes (18)	The settling ponds could be stocked for coarse game fishing and angling, but the reservoir would not be stocked on water quality grounds.
44 Jet skiing	No	Motorised craft would not be permitted on water quality grounds.
45 Model boats	No	This use is not practical on a reservoir.
46 Snorkelling and free-diving	No	Swimming in the reservoir would not be permitted for health and safety reasons.
47 Visitor centre and facilities	Yes (1)	
48 Campsite	Yes (50)	

Use	Carried forward to shortlist? - See Appendix E	Comment
49 Camping cabins	No	Cabins were ruled out to restrict built development at the site.
50 Swimming pool	No	This use would be contrary to planning policy (policies at national, regional and local levels require development of this nature to be situated in existing centres); such uses are most practicable and best suited to urban areas.
51 Promenade	Yes (51)	
52 Pier	No	A pier would be unsuitable due to the level of water draw down. However, a ramp down the inner slope would be provided for operational, and possibly sailing/wind surfing/canoeing, purposes.
53 BBQ/picnic area	Yes (37)	Space could be provided for picnic areas; however barbeques would only be permitted outside the Thames Water operational site due to company policy.
54 Viewing areas	Yes (38)	
55 Lookout tower	Yes (39)	
56 Heritage museum or centre	Yes (5)	
57 Marina on the reservoir	No	This is technically unfeasible due to reservoir drawdown.
58 Marina / canal basin on the Wilts & Berks Canal	No	Thames Water are safeguarding a route for the Wilts & Berks Canal to replace the historic alignment.
59 Sandy beach areas	Yes (52)	
60 Areas for dogs	No	Dogs and their owners would be allowed access to the majority of the site. Areas incompatible with dogs - for example a toddler's play area - would be fenced off.
61 Market area/regular markets	No	This use would be contrary to planning policy (policies at national, regional and local levels require development of this nature to be situated in existing centres); such uses are most practicable and best suited to urban areas.
62 Adventure playground/assault course	Yes (53)	Land for facilities could be provided.
63 Cycle hire	Yes (19)	
64 Bridleways	Yes (20)	Facilities (bridleways and parking) for hacking could be provided.
65 Pony trekking, guided horse tours	Yes (21)	Land for facilities (a trekking centre and horse hire) could be provided.
66 Equestrian centre	Yes (22)	Land for facilities (an equestrian centre) could be provided.
67 Toddler play area	Yes (40)	

Use	Carried forward to shortlist? - See Appendix E	Comment
68 Water park (giant water slides)	No	Rejected due to planning policy (policies at national, regional and local levels generally require large leisure development that attracts a large number of people to be focused in existing centres) and the potential environment impact of such a development (both in traffic generation and landscape terms).
69 Petting zoo	Yes (48)	Space could be provided for agricultural uses.
70 Rifle club	No	The use of live firearms would conflict with other users of the site, therefore it will not be allowed for health and safety reasons.
71 Formal sports pitches (i.e. a cricket ground or tennis courts)	Yes (13)	Space for land based outdoor sports could be provided if there is local demand for such facilities. As such, it was decided by the MWG that 'land based formal outdoor sports' best captured these use options.
72 Climbing wall	Yes (13)	
73 Abseiling	Yes (13)	
74 Sports field and organised sports	Yes (13)	
75 Bungee jumping	Yes (13)	
76 Water-fowl hunting	No	This use would not be permitted under Thames Water policy* or for environmental impact reasons.
77 Dry ski slope on embankment	No	The angles of the embankment would not be steep enough for this type of activity to be practicable.
78 Kite flying	Yes (54)	
79 Guide tours	Yes (55)	
80 Fruit farm	Yes (48)	Space could be provided for agricultural uses.
81 Wetland creation on margins and surrounding land	Yes (31)	
82 Wildlife centre and school study centre	Yes (6)	
83 Animal refuge	Yes (48)	Space could be provided for agricultural uses.
84 Floating islands	No	This use is not technically practicable, and would be very expensive both in terms of construction and operation costs.
85 Rafts for breeding birds	Yes (33)	
86 Arboretum	Yes (32)	
87 Land art	Yes (46)	
88 Underwater world/aquarium	No	Rejected due to planning policy (policies at national, regional and local levels generally require leisure development that attracts a large number of people to be focused in existing centres) and the potential environment impact of such a development (both in traffic generation and landscape terms).

* TW Policy objective CR07: "Protect biodiversity both on our landholdings and where our activities may have an impact".

Use	Carried forward to shortlist? - See Appendix E	Comment
89 Community centre	No	This use would be contrary to planning policy (policies at national, regional and local levels require development of this nature to be situated in existing centres); such uses are most practicable and best suited to urban areas.
90 Housing development	No	Houses within the site were ruled out on planning policy grounds (national, regional and local policy states that housing development should be focused on existing towns and identified local service centres), as well as the potential environmental impact.
Environmental Assessment Draft Scoping Report (LUC and CES) 1998		
91 Walking around the crest of the reservoir	Yes (41)	
92 Cycling around the crest of the reservoir	Yes (42)	
93 Fishing from banks and boats	Yes (18)	The settling ponds could be stocked for coarse game fishing and angling, but the reservoir would not be stocked on water quality grounds.
94 Nature study	Yes (25)	
95 Bird watching	Yes (43)	
96 Quiet contemplation	Yes (44)	
97 Non-motorised water sports	No	This generic use has not been taken forward to the shortlist of uses as specific non-motorised water sports are covered by other uses within this longlist.
98 Horse riding/trekking	Yes (20-22)	See longlist uses 64, 65 and 66 for comments.
99 Education	Yes (2)	
100 Full range of sporting activities to competition standard	No	This implies large facilities and therefore would be contrary to planning policy (policies at national, regional and local levels generally require development that attracts a large number of people to be focused in existing centres) and inappropriate development in the countryside.
101 Indoor sports complex/health club	No	This use would be contrary to planning policy (policies at national, regional and local levels require development of this nature to be situated in existing centres); such uses are most practicable and best suited to urban areas.
102 White water canoe course	No	Rejected due to a perceived lack of demand for a development of this type, linked to the risk of operational failure.
103 Indoor leisure facilities	No	This use would be contrary to planning policy (policies at national, regional and local levels require development of this nature to be situated in existing centres); such uses are most practicable and best suited to urban areas.

Use	Carried forward to shortlist? - See Appendix E	Comment
Conservation, access and recreation suggestions from mitigation forms		
104 Do not make the facilities provided at the reservoir too noisy	No	This is not an after use of the reservoir (therefore the suggestion has not been carried through to the shortlist), but the sentiment that noisy facilities are not welcome is expressed within the Conservation, Access and Recreation Report.
105 Provide access to the site from the A34	Yes (45)	The Highways Agency will not permit direct access to and from the A34. However, as direct as possible access to the A34 would be provided via the A415 Marcham Road.
106 Allow the restored Wilts & Berks Canal to go through the reservoir	No	Not practical as canal boats cannot travel on the reservoir due to the wave action.
107 Concern was expressed about the amount of visitor traffic which the site could attract	No	This is not a use of the reservoir (therefore the suggestion has not been carried through to the short-list), but the sentiment that facilities that create large volumes of traffic are not welcome is expressed within the Conservation, Access and Recreation Report.
108 A major sporting/recreation facility	No	This implies large facilities and therefore would be contrary to planning policy (policies at national, regional and local levels generally require development that attracts a large number of people, to be focused in existing centres) and inappropriate development in the countryside.
109 Provision of employment	No	This is not a use of the reservoir (therefore the suggestion has not been carried through to the short-list), but the facilities provided through conservation, access and recreation may lead to the creation of some long-term employment opportunities.
110 A nature facility for local schools	Yes (6)	
111 Use of islands to break up the surface area and expanse of water	No	This use is not technically practicable, and would be very expensive both in terms of construction and operation costs.
112 Music festival site	No	This use would be contrary to planning policy and would potentially lead to a significant negative environmental impact through noise and traffic generation.
113 Use seed on new banks to encourage wildlife	Yes (34)	
114 Free passes for residents to facilities	No	This is not a use of the reservoir therefore the suggestion has not been carried through to the short-list. However, the request will be documented through the mitigation forms and addressed at a later point in the project.
115 Dry ski slope on embankment	No	The angles of the embankment would not be steep enough for this type of activity to be practicable.

Appendix E
Shortlist of Activities

Definition of use/facility	Description, location, construction & operation	Scale		
		Medium Low	Medium	Medium High
Education				
1. Visitor Centre Provision would range from simple information boards at the Medium Low scale to built facilities for Medium and Medium High. Built facilities would include toilets, meeting space, retail and potential refreshments together with limited administrative functions. At the Medium scale, certain functions could be provided by means of specialist rooms within the building, whilst at the Medium High scenario these functions could be catered for in separate buildings. The scale of facilities is proportional to their perceived catchment area as noted in the table. The Medium High facility is likely to be broadly similar in scale to Severn Trent's visitor centre at Carsington, with the Medium scenario having a reduced scale of provision.	Description	Information boards	A district/county facility	A sub-regional facility
	Location	All	NE	NE
	Construction & operation	Required for compliance Thames Water could build and run	Thames Water could build and run	Thames Water could build and run
2. Education The site and its operation have considerable educational potential. At the Medium Low scale this is assumed to be through a series of information boards at car parks and selected locations around the reservoir. For Medium and Medium High more formal provision is anticipated with this acting as a resource for both informal visits and prearranged school visits. For Medium an educational display is assumed as part of the visitor centre; for Medium High a l arger display together with dedicated room.	Description	Local educational information boards	Educational display and room associated with a district/county visitor centre	Large educational display and rooms, possibly with a conference facility.
	Location	All	NE	NE
	Construction & operation	Required for compliance Thames Water could build and run	Thames Water could build and run OR Thames Water could build and franchise	Thames Water could build and franchise OR Thames Water could allocate land and franchise

Definition of use/facility	Description, location, construction & operation	Scale		
		Medium Low	Medium	Medium High
3. Research Research can vary from field measurements and observations requiring no built structures, to a facilitated building space for research purposes e.g. a laboratory.	Description	Field observations	Hut (or huts) to store field monitoring equipment. 20 car park spaces	More extensive built facilities, with potential for simple laboratories. 40 car park spaces plus 4 coach spaces
	Location	S/SW/NW	S/SW/NW	S
	Construction & operation	Thames Water could allocate land and franchise	Thames Water could build and franchise	Thames Water could allocate land and franchise OR Thames Water could allocate land for potential future use
4. Outdoor educational water science park (relating to the hydrological cycle (cloud to tap and back), demonstrating how the reservoir works). It is conceived that this use would illustrate the hydrological cycle and demonstrate how the reservoir works. As such it could range from part of an exhibition within the area of the visitor centre, to a separate outdoor interactive science park.	Description	Not appropriate	Part of an exhibition within the visitor centre	Outdoor educational water science park
	Location		NE	NE
	Construction & operation		Thames Water could build and run	Thames Water could build and franchise

Definition of use/facility	Description, location, construction & operation	Scale		
		Medium Low	Medium	Medium High
5. Heritage/archaeological centre A heritage or archaeological centre could range from the provision of information boards, to more detailed information either within the visitor centre or as a separate visitor facility, the latter including an exhibition area. Information would focus on the heritage of the site particularly finds and in the case of the larger facility a possible re-creation of the medieval and older field patterns characteristic of the site.	Description	Information boards	Part of an exhibition within the visitor centre	Separate facility
	Location	All	NE	NE
	Construction & operation	Required for compliance Thames Water could build and run	Required for ompliance Thames Water could build and run	Thames Water could allocate land for potential future use
6. Wildlife and nature, local school study centre It is assumed that this use would include a classroom, toilets, parking, a store, and a wet weather cover, all for prearranged school visits. These could operate in conjunction with 'Research' (use no.3). It is anticipated that the study centre would utilise buildings constructed as part of the sidings.	Description	Not appropriate	Facilities suitable for one class	Facilities suitable for 2 or more classes
	Location		S	S
	Construction & operation		Thames Water could build and run	Thames Water could build and run
Nature and landscape				
7. Water garden A combination of mainly still water, landform and landscape with possible small scale retail at the Medium High scale.	Description	Not appropriate	Free entry, low key	Entry payment with possible limited retail
	Location		NE	NE
	Construction & operation		Thames Water could build and run	Thames Water could build and run
8. Water feature A water feature, depending on the size and associated facilities, could fit into all three scenarios, assuming that the reservoir itself is a water feature.	Description	Reservoir itself	Reservoir itself + small cascade down outer slope	Reservoir itself + major fountain
	Location	N/A	NE	NE (within reservoir)
	Construction & operation	N/A	Thames Water could build and run	Thames Water could build and run

Definition of use/facility	Description, location, construction & operation	Scale		
		Medium Low	Medium	Medium High
Sport				
9. Water sports clubhouse Built facilities and other infrastructure required to support sailing, windsurfing and canoeing. A simple boat slip and jetty would be provided in all scenarios to enable launching of Thames Water boats to undertake necessary inspections and maintenance. This would be accessed via a simple track up the outer embankment. At the Medium scale, it is anticipated that sailing, windsurfing and canoeing would share one clubhouse; at the Medium High scale, it is anticipated that there would be two or more clubhouses dedicated to water sporting activity. The clubhouse and water sport activities are located in the north-east so that inevitable traffic generation can use the access road and connection to A415 rather than placing traffic on the local highway network. The consequence of this is the need to provide a substantially enhanced floating jetty and breakwater to compensate for the sub-optimal aspect in relation to prevailing winds.	Description	No additional facilities above boat slip and jetty.	A local/district facility. Small clubhouse with associated boat storage and enhanced boat launching facilities. Suitable for club regattas.	A district/county facility. Larger clubhouse with associated boat storage, repair and enhanced boat launching facilities. Suitable for county/sub-regional regattas.
	Location	NE	NE	NE
	Construction & operation	Required for compliance Thames Water could build and run	Thames Water could build and franchise	Thames Water could build and franchise OR Thames Water could allocate land and franchise

Definition of use/facility	Description, location, construction & operation	Scale		
		Medium Low	Medium	Medium High
10. Sailing Sailing is considered inappropriate at the Medium Low scale. Other scales envisage sailing of different intensities across the whole reservoir. Neither the Medium or Medium High scale foresees any seasonal limits on sailing, although zoning would be used to prevent disturbance to other uses e.g. wintering wildfowl. Both scales envisage training as important activities with Medium High providing commensurately greater facilities.	Description	No sailing	General club use with some club regattas.	Higher intensity of general club use, with some county/sub-regional regattas.
	Location		NE	NE
	Construction & operation		Thames Water could build and franchise	Thames Water could allocate land and franchise
11. Wind-surfing Wind-surfing is considered inappropriate at the Medium Low scale. Other scales envisage wind-surfing of different intensities across the whole reservoir. Neither the Medium or Medium High scale foresees any seasonal limits on wind-surfing. Both scales envisage training as important activities with Medium High providing commensurately greater facilities.	Description	No wind-surfing	General club use with some club regattas.	Higher intensity of general club use, with some county/sub-regional regattas.
	Location		NE	NE
	Construction & operation		Thames Water could build and franchise	Thames Water could allocate land and franchise
12. Canoeing Canoeing is considered inappropriate at the Medium Low scale. Other scales envisage canoeing of different intensities across the whole reservoir. Neither the Medium or Medium High scale foresees any seasonal limits on canoeing. Both scales envisage training as important activities with Medium High providing commensurately greater facilities.	Description	No canoeing	General club use with some club events.	Higher intensity of general club use, with some county/ sub-regional events.
	Location		NE	NE
	Construction & operation.		Thames Water could build and franchise	Thames Water could allocate land and franchise

Definition of use/facility	Description, location, construction & operation	Scale		
		Medium Low	Medium	Medium High
13. Land based formal outdoor sports This use covers the allocation of land for formal land based outdoor sports facilities such as pitches and facilities for sports such as climbing. They would be situated near existing communities, with provision based on demand expressed through consultation.	Description	No provision	Limited provision	More extensive provision
	Location		NE/SE/SW	NE/SE/SW
	Construction & operation		Thames Water could build and franchise OR Thames Water could allocate land for potential future use	Thames Water could build and franchise OR Thames Water could allocate land for potential future use
Access and recreation				
14. Car park provision for informal recreation Parking provision for general local access for informal recreation/ country park activities (i.e. excludes parking related to proposed built facilities and/or other forms of recreation). The strategy envisages small local facilities near to existing communities with direct access from the public highway or newly constructed access road.	Description	Three car parks with capacities of 20 - 50 each	Two car parks with capacities of 20 – 50 each in SW and SE; with parking for informal recreation to share with that provided for proposed facilities in use no. 15 below.	Two car parks with capacities of 20 – 50 each in SW and SE; with parking for informal recreation to share with that provided for proposed facilities in use no. 15 below.
	Location	SW, SE and NE	SW, SE and NE	SW, SE and NE
	Construction & operation	Required for compliance Thames Water could build and run	Thames Water could build and run	Thames Water could build and run
15. Parking to support built/ other facilities In contrast to parking for informal recreation (as covered by use 14 above), this range of parking would provide access to formal uses including: visitor centre, education, outdoor educational science park, water garden, heritage centre, water sports, and events.	Description	Not appropriate as all parking for the Medium Low scale of use is covered above under 14: Car park provision for information recreation	Assumes parking for: visitor centre, water garden, water sports, and events. 300 car spaces (+ 400 overflow grass parking), coach spaces and space for 300 boats	Assumes parking for: visitor centre, outdoor educational science park, heritage centre, water garden, water sports, and events. 600 car spaces (+ 500 overflow grass parking), coach spaces and space for 500 boats
	Location		NE for larger facilities	NE for larger facilities
	Construction & operation		Thames Water could build and run	Thames Water could build and run

Definition of use/facility	Description, location, construction & operation	Scale		
		Medium Low	Medium	Medium High
16. Events area The intensity of this use would depend on the numbers of users it was designed for. A small area set aside for infrequent events involving few people could be consistent with the Medium scenario, whereas an area designed for larger numbers of people, and/or more regular events such as local concerts or festivals would represent a more Medium High scale of use.	Description	Not appropriate	Local event	District/county event
	Location		NE	NE
	Construction & operation		Thames Water could build and run	Thames Water could build and run
17. Passenger ferry A passenger ferry could represent a transportation or recreational use at the Medium High scale during the peak holiday season; however it must be powered by electricity for water quality purposes.	Description	Not appropriate	Not appropriate	Would share water sports jetty
	Location			NE
	Construction & operation.			Thames Water could build and franchise
18. Coarse game fishing and angling (settling ponds or reservoir – latter not stocked) Angling could take place at all levels of after use. Angling in a Medium Low after use scenario would require no separate facilities, in contrast to angling at the Medium High scale which could include an anglers' hut, a bait shop and parking.	Description	Stocked settling ponds	Stocked settling ponds, with anglers' hut	Stocked settling ponds, with anglers' hut, parking and bait shop
	Location	NE	NE	NE + NW
	Construction & operation	Thames Water could build and franchise	Thames Water could build and franchise	Thames Water could build and franchise
19. Cycle hire Cycling at the Medium Low scale would involve the provision of cycle paths only. Cycle hire would only be suitable at the Medium and Medium High scales; the former as the provision of space for a container in which to store cycles for hire, the latter involving the provision of space for construction of a building with associated facilities.	Description	Provision of cycle paths	Provision of space for a structure to store cycles for hire	Provide space for facilities for cycle hire
	Location	All	All, structure NE	All, cycle hire NE
	Construction & operation	Required for compliance Thames Water could build and run	Required for compliance Thames Water could build and run OR Thames Water could allocate land and franchise	Required for compliance Thames Water could build and run OR Thames Water could allocate land and franchise

Definition of use/facility	Description, location, construction & operation	Scale		
		Medium Low	Medium	Medium High
20. Bridleways Bridleways exist through the site, and therefore Thames Water are required to provide replacement bridleways. Bridleways must be designed into the project at all scales, but can be extended for the Medium and Medium High scales of use.	Description	Provision of replacement bridleways	Provision of extended bridleway network	Provision of extensive bridleway network
	Location	All	All	All
	Construction & operation	Required for compliance Thames Water could build and run	Thames Water could build and run	Thames Water could build and run
21. Pony trekking Land for facilities (a trekking centre and horse hire) would be compatible at both the Medium and Medium High scales. Includes limited parking. A smaller scale operational base could be satisfactorily incorporated into the NW. A larger facility as envisaged at the Medium High scale would require a NE location to mitigate traffic impacts.	Description	Not appropriate	Horse hire for trekking, local level	Horse hire for trekking, district level
	Location		NW	NE
	Construction & operation		Thames Water could allocate land and franchise	Thames Water could allocate land and franchise
22. Equestrian Centre Land for facilities (an equestrian centre) can be provided at both the Medium and Medium High scales. Including permanent and overflow parking sufficient for events. A smaller scale operational base could be satisfactorily incorporated into the NW. A larger facility as envisaged at the Medium High scale would require a NE location to mitigate traffic impacts.	Description	Not appropriate	Stables and outdoor facilities, 20 stables, formal lessons only. 20 car park spaces, car parking to be provided by that for proposed facilities in use no. 15 above.	Stables and outdoor facilities, 40 stables, formal lessons only, possibly formal events
	Location		NW	NE
	Construction & operation		Required for ompliance Thames Water could build and run OR Thames Water could allocate land and franchise	Thames Water could allocate land and franchise

Definition of use/facility	Description, location, construction & operation	Scale		
		Medium Low	Medium	Medium High
Art and Culture				
23. Sculpture Provision could range from single, one-off pieces to a small or more extensive sculpture trail. A permanent sculpture trail could be accommodated at the Medium scale of use, with a larger trail, possibly incorporating visiting exhibition events, suitable at the Medium High scale.	Description	Limited number of pieces	Permanent sculpture trail, potentially around crest	Permanent sculpture trail, potentially around crest, with possible visiting exhibition events
	Location	Anywhere	Anywhere	S/NE
	Construction & operation	Thames Water could allocate land and franchise	Thames Water could allocate land and franchise	Thames Water could allocate land and franchise
24. Artists' studio Artists' studios (a number of small serviced huts) are only suitable at the Medium High scale of use.	Description	Not appropriate	In association with the sculpture trail and nature study centre, very limited small scale serviced huts, prearranged access only	In association with the sculpture trail and visitor centre, limited number of studios with public access and retail opportunities
	Location		S	NE or S
	Construction & operation		Thames Water could build and franchise	Thames Water could build and franchise

A number of uses are not included within the above list. They were omitted because they either have a small landtake and/or can be added to all of the scenarios. As such, the following uses can be added to any scenario depending on the results of public consultation:

- **Education**
  - 25. Nature study
  - 55. Guided tours
- **Nature and landscape**
  - 26. Bio-reserve
  - 27. Woodland
  - 28. Informal parkland

29. Creation of specialist habitats such as heathlands, chalk grasslands etc
30. Butterfly bank – an area of land managed for butterflies
31. Wetland creation on surrounding land
32. Arboretum
33. Rafts for breeding birds
34. Use seed on new banks to encourage wildlife

- **Access and recreation**

35. Improved rights of way network
36. Integration of the restored canal alignment
37. Picnic areas
38. Viewing areas
39. Lookout tower
40. Toddler play area
41. Walking around the crest of the reservoir embankment
42. Cycling around the crest of the embankment
43. Bird watching
44. Quiet contemplation
45. Provide access to the site from the A34*
50. Campsite
51. Promenade
53. Adventure playground/assault course
54. Kite flying

- **Art and culture**

46. Land Art

- **Miscellaneous**

47. Conservation and community facilities through purchase of additional land
48. Provision of space for agriculture
49. Provision of space for aquaculture
52. Sandy beach areas

* The Highways Agency will not permit direct access to and from the A34. However, access to the A34 would be provided via the A415 Marcham Road. As such, this use option is not included on Figures 7.14 to 7.16.

Appendix F
Glossary

Abstraction licences		Authorisation granted by the Environment Agency to allow removal of water from a source.[i]
Biodiversity		The whole variety of life encompassing all genetics, species and ecosystem variations, including plants and animals.
Biodiversity Action Plan	BAP	A strategy prepared for a local area aimed at conserving and enhancing biological diversity.
Biomass		Living matter within an environmental area, for example, plant material, vegetation, or agricultural waste used as a fuel or energy source.
Combined Heat and Power	CHP	On-site generation of electricity, heat and/or cooling for the public and private sector.
Borrow pit		An excavation dug to provide material (borrow) for fill elsewhere.
Bottom Operating Water Level		Water level (in metres above sea level) when the reservoir is at its lowest operating level.
Brown electricity and gas		Electricity or gas generated from fossil fuels.
Capital investment		Spending by firms on capital equipment. This includes spending on machinery, equipment and buildings.
Carbon neutrality		Emitting no net additional carbon dioxide into the atmosphere.
Combined Heat and Power	CHP	On-site generation of electricity, heat and/or cooling for the public and private sector.
Compulsory Works Order	CWO	An Order made by the Secretary of State under Section 167 Water Industry Act 1991 on an application by a Water Undertaker to carry out any engineering or building operations; or to discharge water into any inland waters or underground strata.
Deficit		The supply/ demand balance of water can be either in surplus (where supply exceeds demand) or deficit (where supply cannot meet demand).[ii]
Demand Management		The implementation of policies or measures that serve to control or influence the consumption or waste of water. [iii]
Direct supply reservoir		A reservoir from which water is treated and piped directly to customers.
Discharge consent		A statutory authorisation document issued by the Environment Agency, which defines the legal limits and conditions on the discharge of an effluent into controlled waters. [iv]

Drawdown		The reduction in water level resulting from release of water.
Embodied energy		Energy used in extracting or making the materials imported to build the reservoir, including their transport to the site.
Enabling works		Works required before reservoir embankment construction can commence.
Environment Agency	EA	The government agency's main statutory body with responsibility for advising on environmental and flood risk management policy, and setting and enforcing environmental standards in England and Wales.
Environmental Impact Assessment	EIA	Requirement under Directive 85/377 EEC (as amended by Directive 97/11/EC) to carry out an assessment of the likely significant effects of a proposed development on the environment before consent is granted. EIA must be carried out in accordance with the Town and Country Planning (Environmental Impact Assessment) (England and Wales) Regulations 1999.
Environmental Management Plan		The environmental management plan explains how the measures identified through the environmental impact assessment (EIA) process would be implemented once construction of the reservoir begins, for example, the measures to minimise noise of the construction vehicles.
Environmental Statement	ES	The Environmental Statement explains the environmental issues identified as being important to a particular project under consideration, as well as what the environment is like now, and how it might change as a result of the project. Consideration must be given to the alternatives that have been looked at and the ways in which the significant effects the project is likely to have on the environment may be avoided, reduced or addressed.
Flood compensation		EA requirement for provision of compensation flood storage.
Floodplain		An area of land over which river or sea water flows or is stored in times of flood. A floodplain can extend beyond the land immediately adjacent to a watercourse.
Flood storage area		Area identified for compensation flood storage.
Fluvial geomorphology		The shaping of a watercourse due to water flow.

Full Storage Level	FSL	Water level (in metres above sea level) when the reservoir is at its maximum water level.
Geomorphology		The study of landforms including their origin and evolution and the processes that shape them.
Green Belt		A designation for land around certain cities and large built-up areas, which aims to keep this land permanently open or largely undeveloped.[v]
Green electricity		Electricity generated from renewable resources.
Green energy		Energy generated from renewable resources.
Greenfield site		Land (or a defined site) usually farmland that has not previously been developed.
Groundwater		An important part of the natural water cycle present underground, within strata known as aquifers.[vi]
Inlet-outlet towers		Towers to allow filling (inlet) and release (outlet) of water from the reservoir.
Intake-outfall		Structure through which water would be abstracted from the river and through which stored water would be released.
Landform		Natural features of a land surface.
Leakage control		Control of the sum of distribution losses (on trunk mains, service reservoirs, distribution mains and communication pipes), and underground supply pipe losses (between the point of delivery at a property and the point of consumption).[vii]
Local panel		A group of stakeholders brought together to function over a prolonged period so as to influence the development of solutions.[viii]
Local Plan		Development plan prepared by district and other local planning authorities.
Local Planning Authority	LPA	Authority with responsibility for planning regulation and development control.
Megalitres per day	Ml/d	One megalitre = one million litres (1000 cubic metres) per day.[ix]
Mitigation		The alteration of proposals to address specific concerns in order to achieve environmental, social or economic improvement.[x]
Morphological diversity		The range and extent of forms and structures of organisms.

Multi Criteria Analysis	MCA	MCA involves a variety of decision-making techniques that incorporate different criteria on which to base a decision, rather than techniques based solely on, for example, financial analysis. Its main role is to deal with large amounts of complex information in a consistent way, which can otherwise create difficulties for decision-makers.[xi]
Open stone asphalt		A layer of material similar to normal road construction.
Operating costs		Operating costs comprising day-to-day (planned and unplanned) routine expenses, which have no effect on the decline in service potential.
Planning Policy Guidance 16	PPG16	PPG16 Archaeology and Planning sets out the government's policy on archaeological remains on land and how they should be preserved or recorded both in an urban setting and in the countryside.[xii]
Planning Policy Guidance 25	PPG25	PPG25 Development and Flood Risk explains how flood risk should be considered at all stages of the planning and development process. It sets out the importance of the management and reduction of flood risk in planning, acting on a precautionary basis and taking account of climate change.[xiii]
Planning Policy Statement 1	PPS1	PPS1 Delivering Sustainable Development sets out the Government's overarching planning policies on the delivery of sustainable development through the planning system.[xiv]
Planning Policy Statement 9	PPS9	PPS9 Biodiversity and Geological Conservation sets out planning policies on protection of biodiversity and geological conservation through the planning system.[xv]
Planning Policy Statement 25	PPS25	PPS25 Development and Flood Risk - the intention is that PPS25, together with an accompanying Practice Guide, should replace Planning Policy Guidance Note 25 (PPG25): Development and Flood Risk published in July 2001.[xvi]
Programme		A group of activities or measures directed towards achieving defined objectives and targets.
Resource Zone		The largest possible zone in which all resources, including external transfers, can be shared and hence the zone in which all customers experience the same risk of supply failure from a resource shortfall.[xvii]

Riprap		Riprap (also known as rip rap or shot rock) is loose rock or other material used for wave protection and soil stabilisation.
River Regulation		Supporting river flow by releasing from reservoirs during periods of low flow.
Settlement Pond		Pond to allow settlement of clay particles before discharge of water to a watercourse.
Stage 1 Needs and Alternatives	Stage 1	UTMRD work on future needs for water and alternative measures available to meet the deficit.
Stage 2 Preferred Scheme and Design Options	Stage 2	UTMRD work on the preferred reservoir scheme and design options available.
Stilling basin		Basin to dissipate the energy in the water discharged from the siphons.
Storage Reservoir		A reservoir stores surplus river water during wet periods so that it is available for use during dry periods.
Stakeholder		Any body, organisation or person with a particular interest or responsibility in the area affected by a proposal, or in the provision or regulation of aspects of provision of the proposal.[xviii]
Strategic Environmental Assessment	SEA	A process designed to ensure that significant environmental effects arising from proposed plans and programmes and reasonable alternatives are identified, assessed, subjected to public participation, taken into account by decision-makers, and monitored. SEA sets the framework for future assessment of development projects some of which require Environmental Impact Assessment (EIA).[xix]
Sustainability		Sustainability is essentially about protecting and enhancing the environment, and careful use of natural resources whilst considering today's needs and those of future generations.
Sustainability Appraisal		A single appraisal tool which provides for the systematic identification and evaluation of the economic, social and environmental impacts of a proposal.
Sustainability criteria		A range of attributes against which to measure performance and which indicate the level of sustainability.
Sustainability Statement		Part of final consent application.
Swindon and Oxfordshire resource zone	SWOX	See: resource zone.
Upper Thames Major Resource Development	UTMRD	Term specific to this study.

Water Industry Sustainability Indicators		A set of parameters defined by the water industry for monitoring performance in terms of environmental, economic and social perspectives.
Water Resources Plan	WRP	Water Companies' plans for supplying water to meet demand over a 25 year period.
Wastewater treatment plant		Plant where wastewater is treated to a standard suitable for discharge.
Water resource zones	WRZ	The largest possible zone in which all resources, including external transfers, can be shared and hence the zone in which all customers experience the same risk of supply failure from a resource shortfall. [xx]
Water treatment works	WTW	Plant where raw water is treated to a standard suitable for drinking.
Workshop		A group of stakeholders brought together to consider specific issues in depth at a crucial stage in the development of solutions.[xxi]

[i] Definitions of Key Terms for Water Resources Practitioners, UKWIR/Environment Agency, Report Ref. No. 97/WR/14/1, 1997

[ii] Environment Agency (2005) Regional Spatial Strategy: South West (RSS 10) Housing Growth and Water Supply in the South West of England 2005 to 2030, http://www.swenvo.org.uk/publications/Water_supply_housing_growth_2005_2030.pdf

[iii] Definitions of Key Terms for Water Resources Practitioners, UKWIR/Environment Agency, Report Ref. No. 97/WR/14/1, 1997

[iv] Environment Agency, The Test and Itchen Catchment Abstraction Management Strategy, http://www.environment-agency.gov.uk/commondata/acrobat/consult_p5872_1176767.pdf

[v] Planning Portal, http://www.planningportal.gov.uk

[vi] Planning Portal, http://www.planningportal.gov.uk

[vii] Definitions of Key Terms for Water Resources Practitioners, UKWIR/Environment Agency, Report Ref. No. 97/WR/14/1, 1997

[viii] UTMRD Strategy for Community and Stakeholder Involvement, Thames Water, 14 September 2006

[ix] Definitions of Key Terms for Water Resources Practitioners, UKWIR/Environment Agency, Report Ref. No. 97/WR/14/1, 1997

[x] UTMRD Strategy for Community and Stakeholder Involvement, Thames Water, 14 September 2006

[xi] Ofwat, Glossary of Terms, http://www.ofwat.gov.uk/aptrix/ofwat/publish.nsf/AttachmentsByTitle/lrmc_report_glossary.pdf/$File/lrmc_report_glossary.pdf

[xii] Planning Portal, http://www.planningportal.gov.uk/england/professionals

[xiii] Planning Portal, http://www.planningportal.gov.uk/england/professionals

[xiv] Planning Portal, http://www.planningportal.gov.uk/england/professionals

[xv] Planning Portal, http://www.planningportal.gov.uk/england/professionals

[xvi] Communities and Local Government, http://www.communities.gov.uk

[xvii] Definitions of Key Terms for Water Resources Practitioners, UKWIR/Environment Agency, Report Ref. No. 97/WR/14/1, 1997

[xviii] UTMRD Strategy for Community and Stakeholder Involvement, Thames Water, 14 September 2006

[xix] Environment Agency, http://www.environment-agency.gov.uk

[xx] Tripartite Group (2000) Leakage Target Setting for Water Companies in England and Wales- summary report, http://www.ofwat.gov.uk/aptrix/ofwat/publish.nsf/AttachmentsByTitle/tripartite_summary.pdf/$FILE/tripartite_summary.pdf

[xxi] UTMRD Strategy for Community and Stakeholder Involvement, Thames Water, 14 September 2006