River Thames Scheme

Supplementary Consultation
3 September to 7 October 2024

Ferris Meadow Lake Options Appraisal Report

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Note on this report

As well as this Ferris Meadow Lake Options Appraisal Report, there are seven supporting appendices, each of which provides more detailed information about the appraisal that has been carried out to identify the preferred option at Ferris Meadow Lake. Appendix D includes additional plans in Appendix D Annex 1.

These appendices are referred to frequently in this report to help guide readers who want to find out more detail about particular aspects of the appraisal.

These appendices have been published on the River Thames Scheme website at www.riverthamesscheme.org.uk/supplementary-consultation-ferris-meadow-lake

The seven appendices are as follows:

- Appendix A: Option Drawings
- Appendix B: Technical and Feasibility Appraisal Matrix
- Appendix C: Flood Modelling Option Testing Report
- Appendix D: Environmental Appraisal (includes Annex 1 plans)
- Appendix E: Environmental Design Principles Appraisal
- Appendix F: Water Quality Assessment
- Appendix G: Planning Policy and Legislative Appraisal.

1. Introduction

The River Thames Scheme (the Scheme) will provide flood risk and environmental benefits between Egham Hythe and Teddington. The Scheme consists of a flood relief channel in two sections, additional works to increase the downstream capacity of the River Thames, new green open spaces, as well as areas of new habitat creation.

The alignment of the Spelthorne Channel adopted from the *Lower Thames Strategy* (September 2009) included the use of Ferris Meadow Lake (previously referred to as Ferry Lane Lake) as part of the Scheme before flows discharge to the River Thames. The alignment in the *Lower Thames Strategy* was developed into Option 1, which was presented in January 2024 during the Scheme's statutory consultation, retaining the use of Ferris Meadow Lake. Figure 1 shows an overview of the channels, including the location of Ferris Meadow Lake.

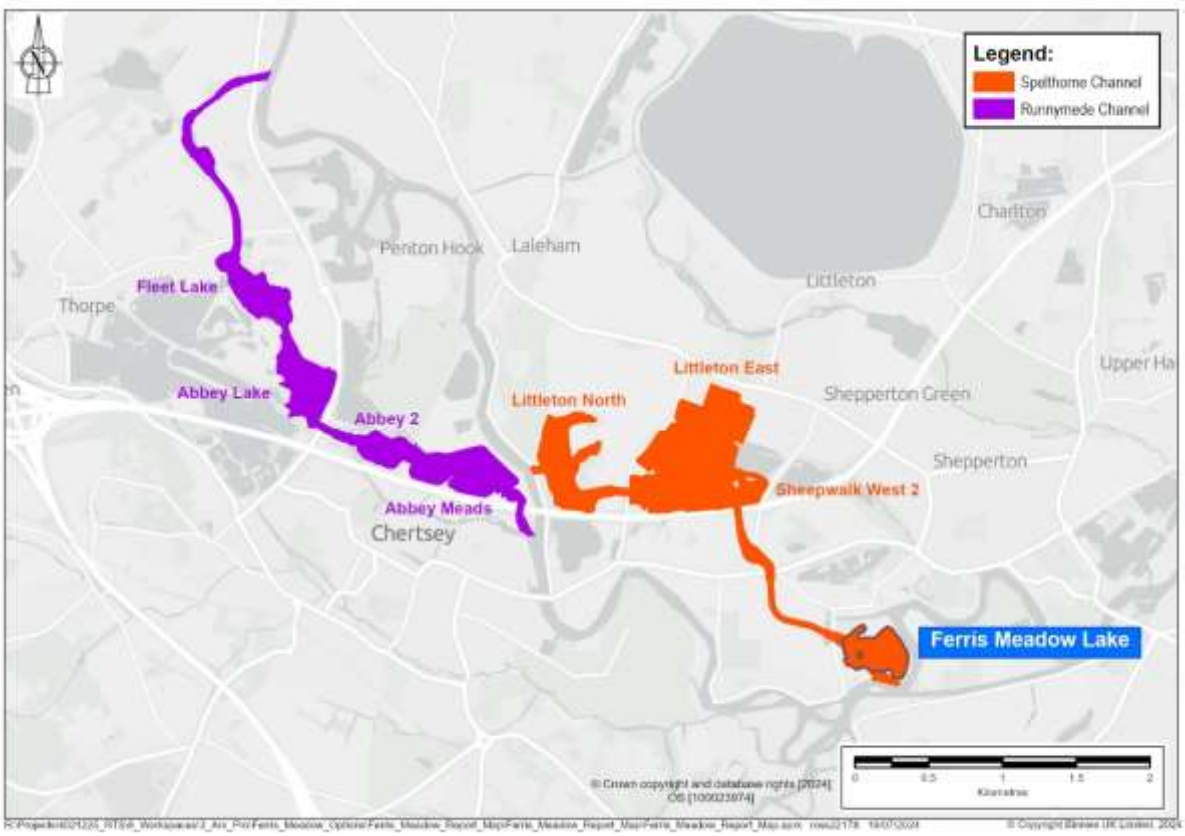

Figure 1 - Ferris Meadow Lake location in relation to the Runnymede and Spelthorne Channels

The route of the proposed channel flow is indicated by the red arrows in Figure 2 below. Option 1, as well as the other options presented during statutory consultation, is explained in Section 2 of this report.

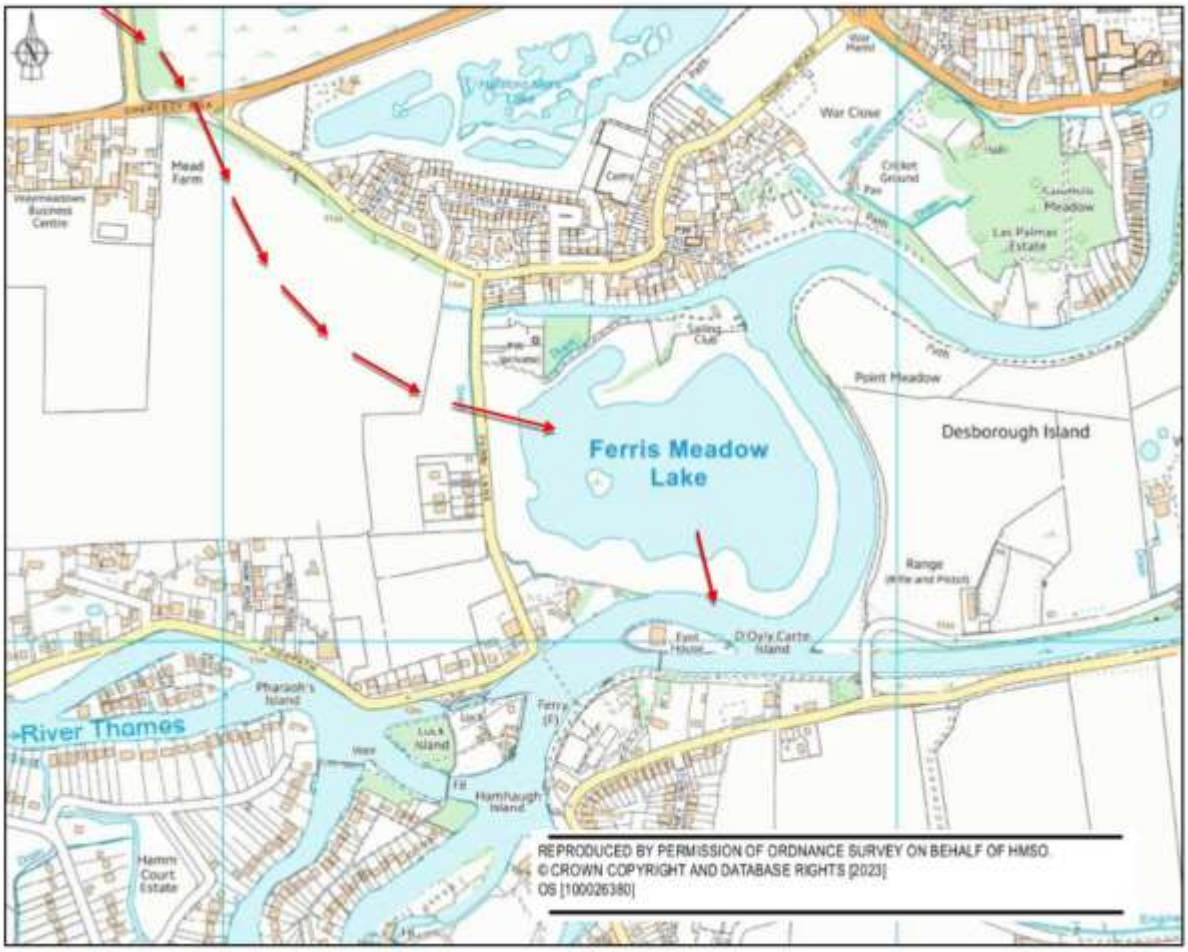

Figure 2 - Plan of Ferris Meadow Lake showing channel flow under Option 1

In non-flood (normal) conditions a small flow of water of between 0.5 to 1.0 m^3/s, called an 'augmented flow', would pass through the flood channel and through Ferris Meadow Lake. The Scheme needs to maintain an augmented flow throughout the Scheme to maintain fish passage, water quality in the channel, and channel water levels.

The lake is privately owned and since 2010 it has been used for the Shepperton Open Water Swim business. The business currently has a temporary planning permission to remain as an open water swimming facility until 29 June 2026, with swimming permitted to take place daily from May to September. The Scheme is expected to be in operation from 2030.

In 2023, the landowner, business owner, and many members of the swimming club expressed concern about the proposal for the Scheme to pass through the lake because of concerns that the water quality would be impacted by the mixing of the Scheme's channel flows with the lake's water. As part of ongoing design development taking place across the Scheme, we devised alternative options for the design in and around Ferris Meadow Lake. The alternative designs involved the channel being routed around the lake instead of through it, meaning there would be

no impact on the lake's water quality from the augmented flow (although some options would see flood condition flows passing through the lake).

As explained in the *Statutory Consultation Brochure*[1], we committed to carrying out a detailed appraisal of the options presented at consultation and, given the popularity of the lake for swimming, there was also a commitment to carry out a water quality assessment to inform the options appraisal process.

To ensure a robust assessment, this appraisal has proceeded on the assumption that the lake remains in use for swimming following the expiry of its current temporary planning permission (i.e. that it obtains new planning permission after the current permission expires).

The following design options were presented in the *Statutory Consultation Brochure* and have been appraised within this report:

- Option 1 - Spelthorne Channel passes through Ferris Meadow Lake.
- Option 2 - Direct the Spelthorne Channel north of Ferris Meadow Lake into the River Thames via the Chap (known locally as 'the Creek').
- Option 3 - Direct the Spelthorne Channel to the west side of Ferris Meadow Lake into the River Thames along a newly constructed route.
- Option 4 - Divide the Spelthorne Channel into two sections with half directed to the north via the Chap and half down the west side of Ferris Meadow Lake along a newly constructed route.
- Option 5 - A tunnel under Ferris Meadow Lake for flood flows with augmented flow diverted into the Chap.
- Option 6 - Flood relief channel alignment through Ferris Meadow Lake but with the augmented flow diverted into the Chap, with sub-options to consider with (6b) and without (6a) a new flow-control structure.

Two further options suitable for appraisal were submitted during statutory consultation. These are summarised as Options 7 and 8 below and have been included in the appraisal process and considered in this report.

- Option 7 - Divide Ferris Meadow Lake into two, creating an area for swimming in the north-east of the lake and a channel for the Scheme (augmented and flood flows) to pass through along the south-west of the lake.
- Option 8 - An open connection created to the River Thames at the southern edge of the lake with a level retention weir to the west of Ferry Lane. Augmented and flood flows would follow the same route through the lake and out to the River Thames via the open connection. This design would allow

[1] https://www.riverthamesscheme.org.uk/__data/assets/pdf_file/0004/363892/River-Thames-Scheme-Statutory-Consultation-Brochure.pdf

(subject to the lake owner obtaining planning consent) a potential future change from a swimming lake to a marina or alternative leisure use.

All these options are described in more detail in Chapter 2 of this report.

In addition to Options 7 and 8 noted above, several suggested variations to the options presented at consultation were received during statutory consultation. For example, a variation on Option 2 was submitted, which included a more naturalised bank to the south side of the Chap, with a 1-in-3 side slope requiring a wider channel. There was also the incorporation of an overflow swale (a shallow, broad and vegetated channel) in the southern bank. That variation to Option 2, as well as the other variations received, were similar enough to the options appraised in this report that they did not require their own appraisal.

This report summarises the process undertaken to appraise the options against a series of criteria. The report also presents the findings of the appraisal against those criteria, an overview of consultation responses received at statutory consultation in the context of that appraisal, and an explanation as to how we came to identify the preferred option.

This report also contains more detailed information in support of the appraisal process in its appendices.

2. Options Considered

This section describes the options identified for appraisal. All the options presented below would provide sufficient relief during flood conditions to ensure the effectiveness of the Spelthorne Channel. Each would maintain an augmented flow during non-flood conditions to ensure fish passage and water quality across the Scheme. In some of the options, flood flow and augmented flow would follow the same route and in others they would take a separate route.

In addition, the proposed active travel route (a publicly accessible route used for recreation and commuting by walkers and cyclists) would take the same route in each of the options to the south of Ferris Meadow Lake and then east along a new bridge over the River Thames to Desborough Island.

2.1 Option 1

Option 1 involves the Spelthorne Channel passing through Ferris Meadow Lake before discharging to the River Thames. This option consists of a bridge over the Scheme's channel at Ferry Lane (LA12) with a footbridge to one side for landowner use (FBR8), excavation to direct channel flow into the north-west corner of the lake, and a level retention structure and outfall structure (FCS19) at the southern edge of the lake. A further footbridge crossing the outfall structure is required (FBR7) to maintain access around the lake and for the active travel route. Both the augmented flow and flow in flood conditions would pass along the proposed Spelthorne Channel through the lake. See Figure 3 below for an illustration of Option 1, while a more detailed drawing can be found in Appendix A of this report.

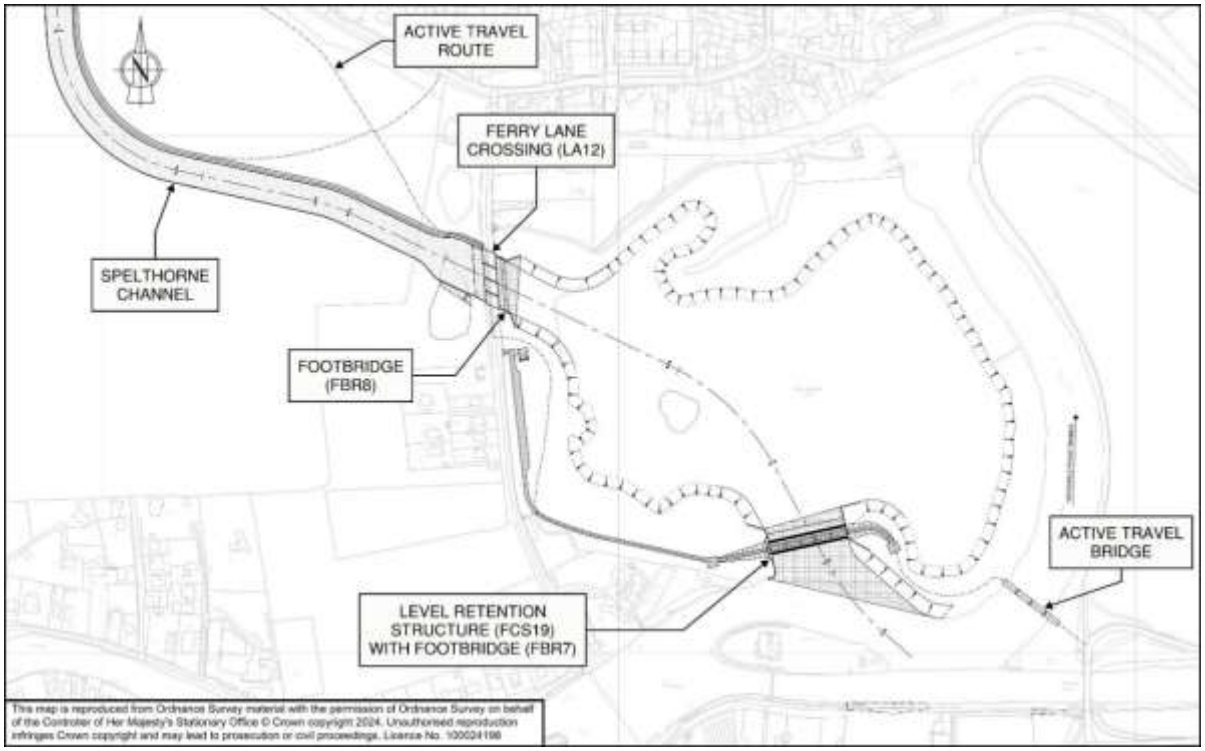

Figure 3 - Option 1, with the Spelthorne Channel passing through Ferris Meadow Lake

2.2 Option 2

An existing backwater called the Chap, located immediately north of Ferris Meadow Lake, would be widened to create a 30m-wide channel for the Scheme. This would carry both the augmented flow and flow in flood conditions directly into the River Thames without any connection to the lake. The edge of the Chap's north bank would remain unchanged in alignment (to avoid land take on this side of the Chap), with the south bank being extended further south where sheet piling is expected to be needed. Excavation of the Chap would be required to ensure it was deep enough and to create a trapezoidal shape on its northern side. Due to the expected high speed of the water flow, bed and bank scour protection in the form of rip rap (a layer of large stones) would also need to be added to prevent erosion. A more natural-shaped channel edge on the south bank could be used (i.e. trapezoidal) but this would require further land take involving several parcels of land under different ownerships and has not been considered further in this appraisal. From a hydraulic perspective, a rectangular channel (requiring a narrower channel of 25m) would also be effective, but due to the challenges of working so close to the properties on the north bank of the Chap this has not been taken forward into the appraisal.

A level retention weir (FCS19) would be located in the field to the west of Ferry Lane. This weir would be needed to prevent the groundwater level being drained down through the flood channel in non-flood conditions. The Ferry Lane crossing (LA12) needs to be in line with the Chap in order for the Scheme's flow to discharge via the

Chap to the River Thames. The sailing clubhouse would need to be relocated, with its access track realigned. Both augmented and flood flows would pass along the Chap. Figure 4 below shows an illustration of Option 2, while a more detailed drawing can be found in Appendix A.

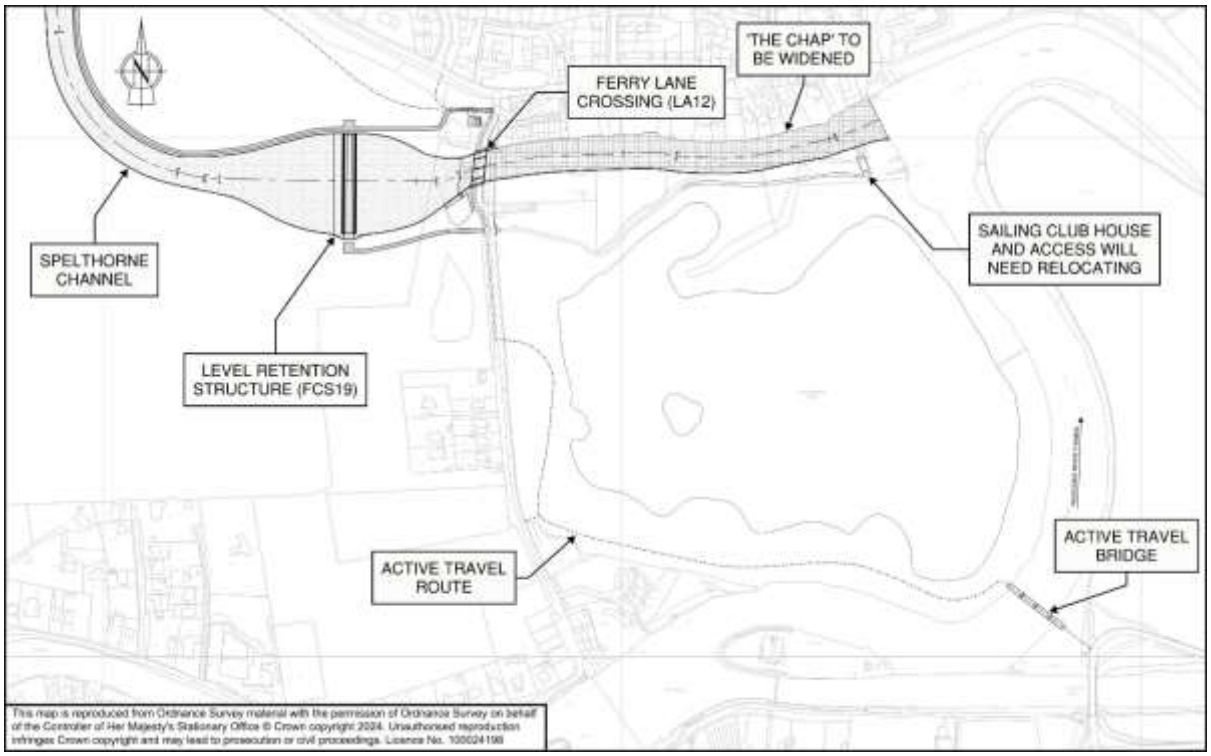

Figure 4 - Option 2, with the Spelthorne Channel passing along the widened Chap

2.3 Option 3

For this option, a new section of channel would be excavated along the western side of Ferris Meadow Lake. The channel would be 30m wide allowing the channel to pass from the Ferry Lane bridge to the River Thames at the south of the lake, but without any connection to the lake. This option includes a bridge over the flood channel at Ferry Lane (LA12), with a footbridge to one side for landowner use (FBR8).

A level retention weir (FCS19) would be located in the field to the west of Ferry Lane for the same reasons as in Option 2. The new channel is expected to require sheet piling on both sides due to the lack of space in this location. Bed scour protection in the form of rip rap would be included along the length of the channel due to the predicted flow speed during flood conditions. The Ferris Meadow Lake edge would need to be realigned in places to create the required channel width and to have sufficient space for the active travel route. To maintain access around the lake, and for active travel, a footbridge over the channel would be required (FBR7). Both the augmented flow and flow in flood conditions would pass along the new channel proposed in this option and the lake would be avoided completely. See Figure 5

below for an illustration of Option 3, while a more detailed drawing can be found in Appendix A.

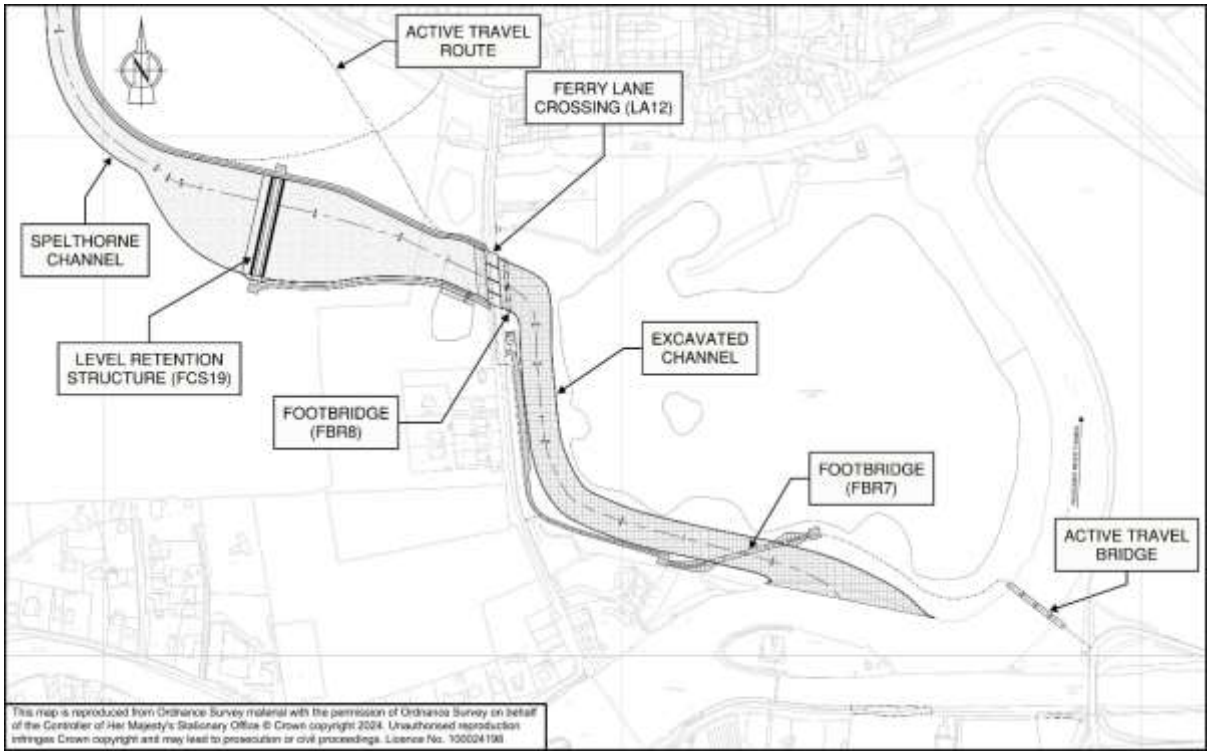

Figure 5 - Option 3, with the Spelthorne Channel passing to the west of Ferris Meadow Lake

2.4 Option 4

The flood relief channel would be divided into two and split between the Chap and a new channel on the western side of Ferris Meadow Lake. The same elements apply as Option 2 and 3 but with the width of channel to the west of the lake reduced to 15m wide, and to 20m wide for the Chap. Excavation of the Chap would be required to ensure it was deep enough and to create a trapezoidal shape on its northern side. Due to the expected high speed of the water flow, bed and bank scour protection in the form of rip rap would need to be added to prevent erosion. Some widening is expected to be necessary on the south bank and sheet piles installed to avoid erosion and minimise land take. An access bridge for the sailing club would also be required over the western channel. A footbridge would also be needed at the southern end of this channel to maintain access around the lake (FBR7). Both augmented and flood flows would be split broadly equally between the two channels, with the lake being avoided completely. Figure 6 below shows an illustration of Option 4, while a more detailed drawing can be found in Appendix A.

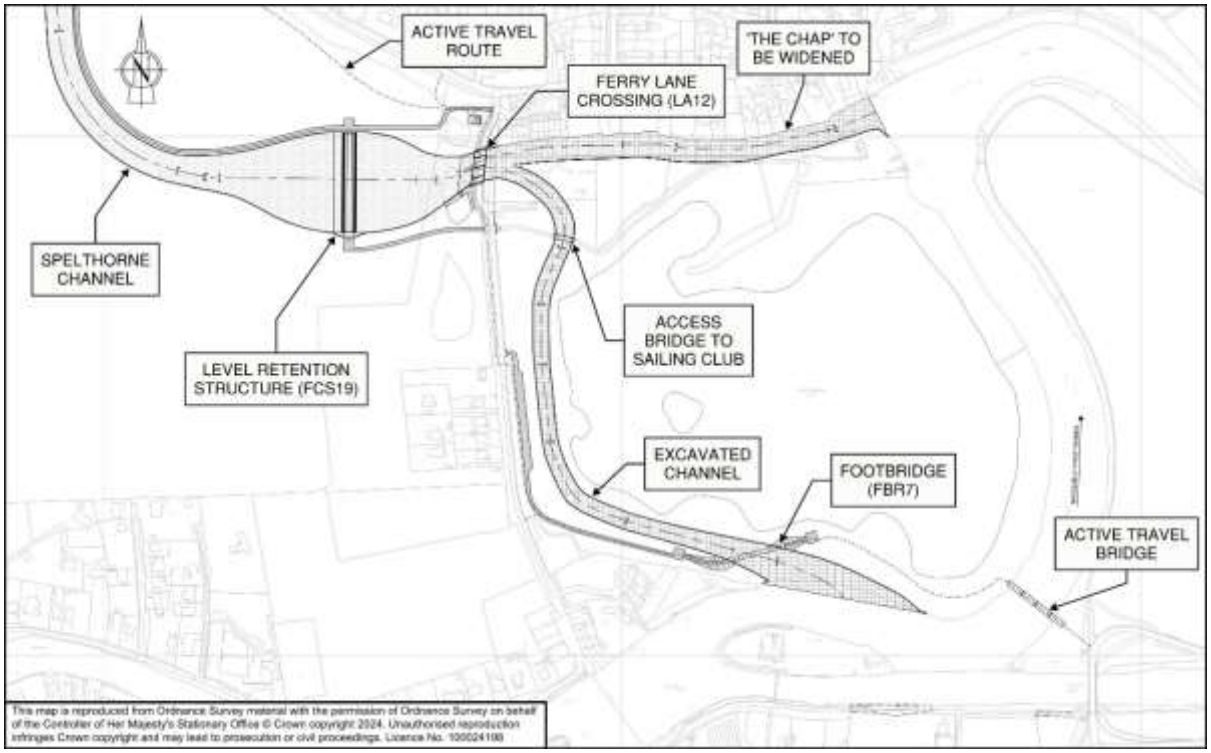

Figure 6 - Option 4, with the Spelthorne Channel split between a new channel to the west of Ferris Meadow Lake and the widened Chap to the north

2.5 Option 5

Option 5 would require a tunnel underneath the lake with a diameter of 12.5m. The tunnel would need to be built deep enough to be sufficiently into London clay as the clay provides a stable and safe environment for tunnelling. London clay typically starts at a depth of 9m in this area, which would mean the base of the tunnel would likely be 20m deep. Large inlet and outlet structures would be required, as well as two shafts. The tunnel inlet would be in the field west of Ferry Lane, and the outlet on Desborough Island. A level retention weir (FCS19) would be located in the field to the west of the tunnel inlet shaft to control water levels upstream of the tunnel inlet.

The tunnel would act as an inverted syphon in flood conditions, which means the tunnel would completely fill and flow under pressure. There would need to be a separate channel for augmented flow and fish passage as the tunnel would not be suitable to carry these. The augmented flow would be directed into the Chap via an existing culvert under Ferry Lane which connects into the Chap. It is assumed the channel connecting to the Chap would require sheet piling either side with a concrete base due to being constructed in landfill material. Both augmented and flood flows would avoid the lake completely. Figure 7 below shows an illustration of Option 5, while a more detailed drawing can be found in Appendix A.

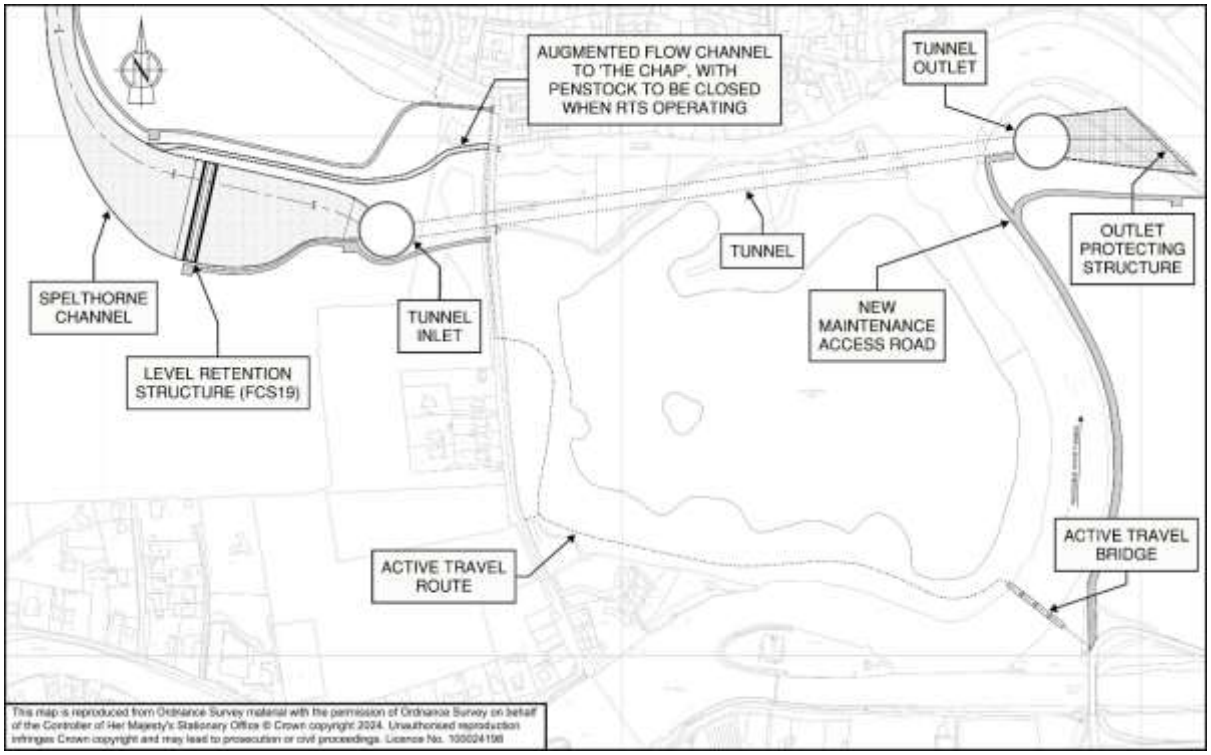

Figure 7 - Option 5, with a tunnel under Ferris Meadow Lake

2.6 Option 6a

Option 6a includes the Option 1 channel alignment through Ferris Meadow Lake for flood flows, but with an augmented flow diversion into the Chap. This option would require a penstock (sluice gate) where the Spelthorne Channel joins the Chap. During normal conditions, the penstock would be open to allow for the augmented flow, but would be closed to flow when the Spelthorne Channel is in operation during floods. The small augmented-flow channel would be sheet piled on each side and with a concrete base, due to being constructed in landfill. Augmented flow would pass to the River Thames via the Chap but in flood conditions the lake would be used as in Option 1 to pass flows to the River Thames. Option 6a (unlike Option 6b described below) does not include a flow-control structure across the full width of the Spelthorne Channel, therefore complete isolation of the Scheme's flow from the lake during normal conditions would not be guaranteed. Figure 8 below shows an illustration of Option 6a, while a more detailed drawing can be found in Appendix A.

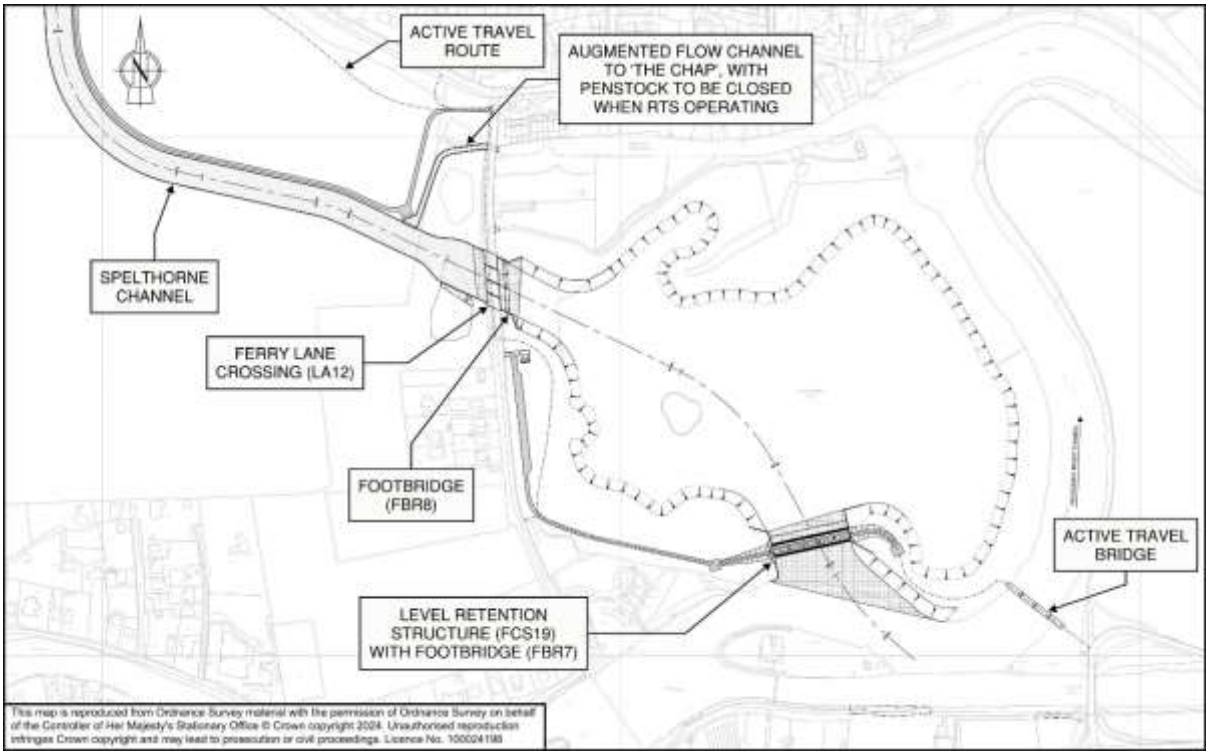

Figure 8 - Option 6a, with augmented flow passing along the Chap (without a flow-control structure) and flood flow passing through Ferris Meadow Lake

2.7 Option 6b

This option is similar to Option 6a but, unlike Option 6a, it includes a flow-control gate structure across the full width of the Spelthorne Channel on the west side of Ferry Lane alongside the bridge. This structure would allow the Spelthorne Channel to be fully closed, preventing any augmented flow passing into the lake. However, the structure would require operational compounds, including provision for crane access.

The flow control gates would be opened in flood conditions, and the augmented flow channel closed. In normal conditions, augmented flow would pass into the River Thames via the Chap, but in flood conditions the lake would be used (as in Option 1). The inclusion of a flow control structure provides complete isolation of the Scheme's flows from the lake during normal conditions. Figure 9 below shows an illustration of Option 6b, while a more detailed drawing can be found in Appendix A.

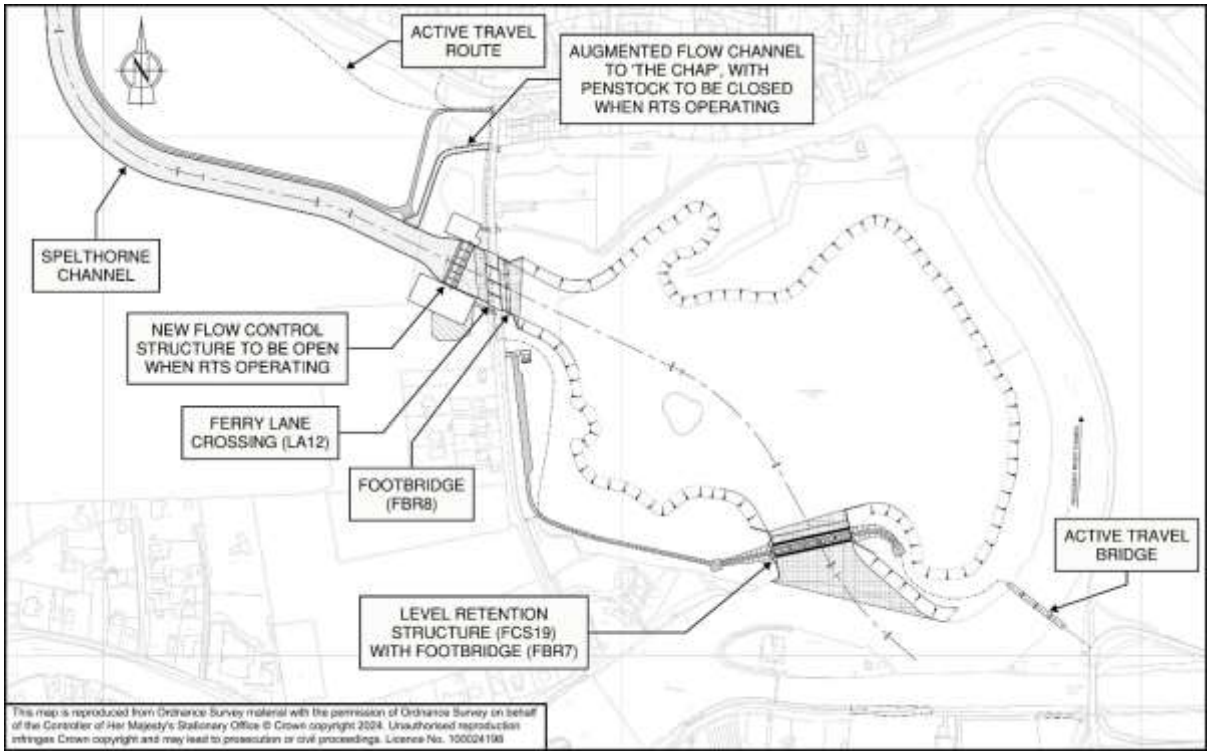

Figure 9 - Option 6b, with the augmented flow passing along the Chap, including a flow-control structure to isolate Ferris Meadow Lake, with flood flows passing through the lake

2.8 Option 7

Option 7 is similar to Option 1 with the channel passing through Ferris Meadow Lake, but in this design the lake would be divided into two separate areas, with the north-east area isolated from the Scheme in order to be used for swimming. The Spelthorne Channel would pass under Ferry Lane (at the same location as Option 1), through the south-western area of the lake and would discharge to the River Thames at the southern edge of the lake, where there would be a level retention structure and outfall structure (FCS19) (as in Option 1). Both flood flows from the Scheme's channel and augmented flow in normal conditions would take the same route.

The lake would be divided by installing a bund across it. This could be constructed by installing two lines of sheet piles into the clay bed (typically at 9m below ground), 5m apart, tied together. Fill material would be placed between the sheet piles. The bund height would be similar to the ground level at the edge of the lake.

The bund could be used by the lake owner for access across the lake if required and it is assumed that safety fencing (wooden post and rail fencing, or similar, to be visually sensitive to the location) would be required along the edges. Some minor planting could be included along the edges to soften the impact of the sheet piles. Figure 10 below shows an illustration of Option 7, while a more detailed drawing can be found in Appendix A.

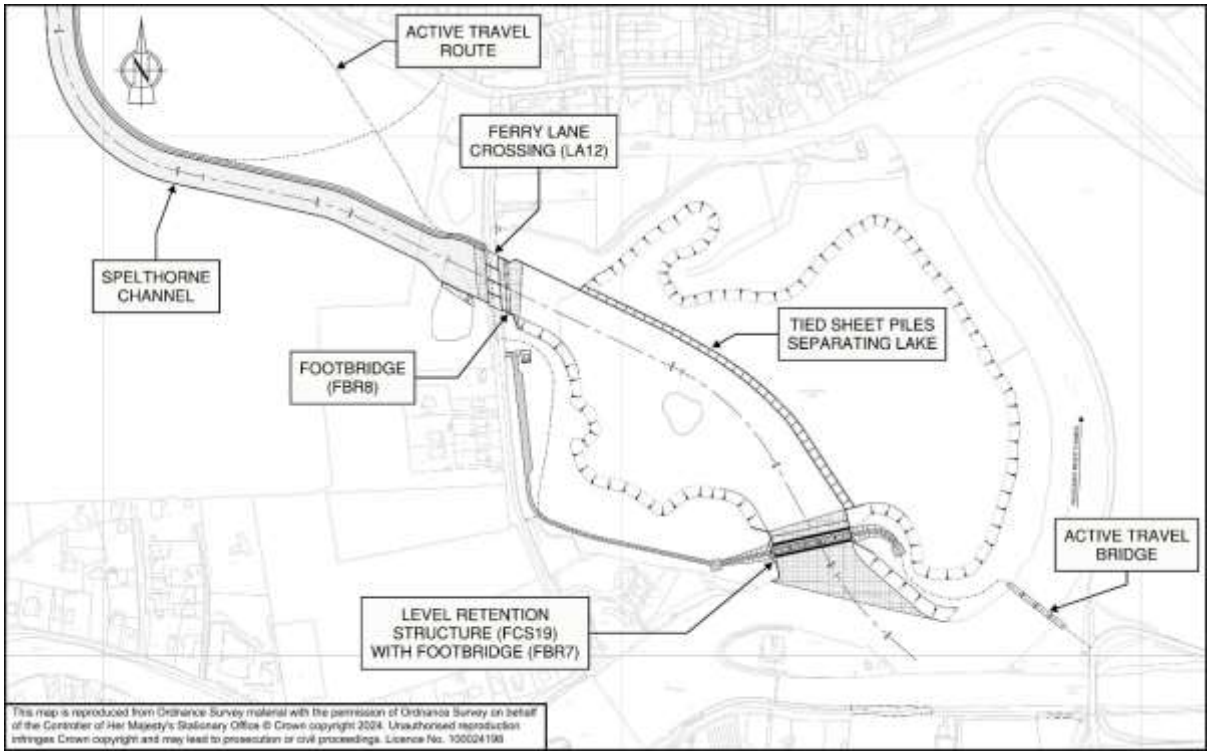

Figure 10 - Option 7, with the lake divided in two to allow separation of the Spelthorne Channel and the rest of the lake

2.9 Option 8

Option 8 would involve the creation of an open connection to the River Thames at the southern edge of the lake. The edges of the opening would be sheet piled to prevent erosion. Both flood flows from the Scheme's channel and augmented flow would take the same route through the lake. For Option 8, a level retention weir would be provided in the field to the west of Ferry Lane. This weir would be needed to prevent the groundwater level being drained down through the flood channel in non-flood conditions.

The development and obtaining of permissions to change the recreational use lake would not be carried out by the Scheme and would need to be undertaken subsequently by the landowner. Therefore, the option appraisal considers the works needed for the flood channel to connect directly with the River Thames, but not any works required to change the recreational use of the lake. Figure 11 below shows an illustration of Option 8, while a more detailed drawing can be found in Appendix A.

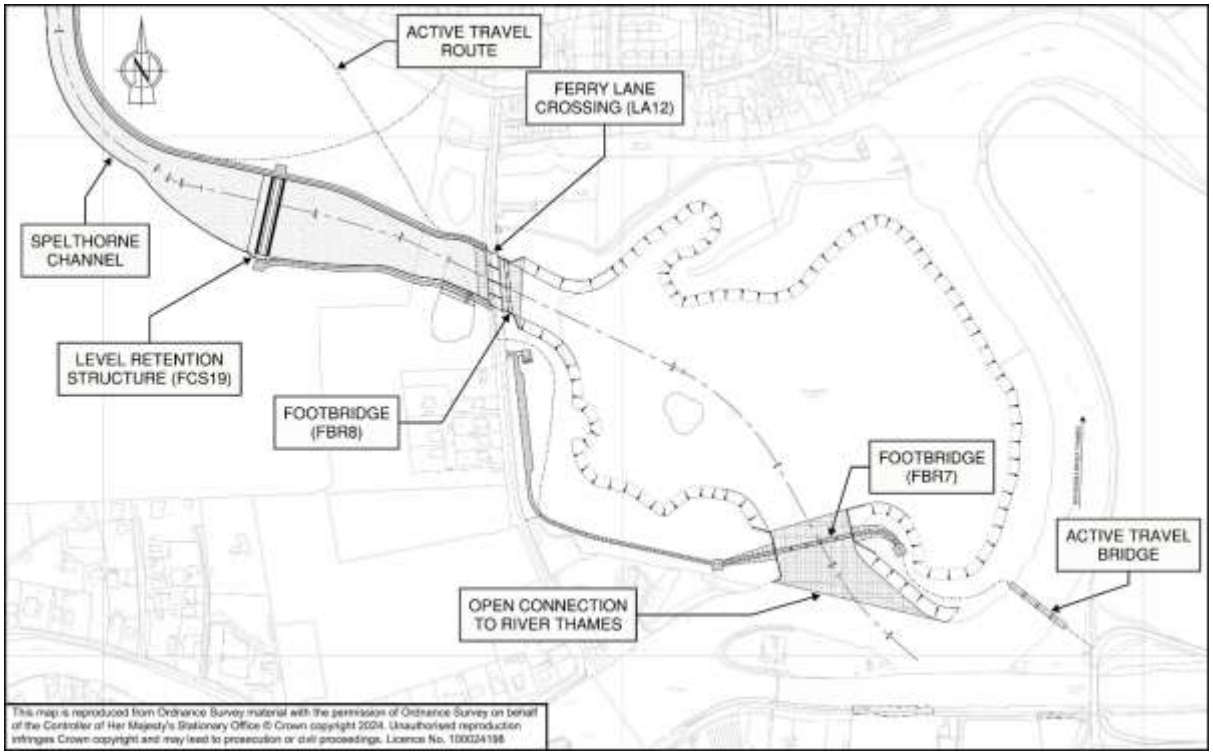

Figure 11 - Option 8, with an open connection to the River Thames in the south of the lake

3. Considerations for Option Appraisal

To be able to appraise the Ferris Meadow Lake options it was important to understand the flood conveyance of the Scheme by hydraulic (flood) modelling to enable options to be sized sufficiently. It was also necessary to understand the water environment of the lake and surrounding water bodies to set the context for which the impacts of the different options could be understood. This section discusses each of these in turn.

3.1 Hydraulic Modelling

3.1.1 Overview of the modelling

Hydraulic modelling is the process of using computer simulation to assess the flood risk associated with different design options being considered. Computer models are developed using rainfall and river data collected over many years to create a representation of a river system in its current state to which design options can be added and analysed.

The nine options for Ferris Meadow Lake have been analysed using hydraulic modelling and developed to ensure that they each provide an equivalent flood conveyance capability to Option 1. The comparison was made to Option 1 because it has formed the basis of the Scheme before statutory consultation and meets the important requirements of causing no increase in river flood risk and providing a reduced flood risk from Windsor to Teddington. For full details of the modelling undertaken and the results, refer to Appendix C of this report.

The 5% (1 in 20) annual chance flood was used for option comparison. Again, this is consistent with the approach used in previous phases of the design development. The 5% annual chance flood is the magnitude where the flood channel is most effective, so provides the clearest comparison point.

Options 6a and 6b were not tested in the model because, in flood conditions, they are effectively the same as Option 1. For more information about this, see Appendix C.

3.1.2 Results

To achieve the same hydraulic efficiency and flood levels of Option 1 (the same flood level in the River Thames at the Spelthorne Channel offtake and flood levels within ±0.05m along the Spelthorne Channel as for Option 1), the options were sized using the model.

The flood levels achieved were similar across all the options (as channels were sized to suit as described above), with some minor differences:

- Flood levels in the River Thames are marginally lower than for Option 1 for all the options. These changes in flood levels are very small (within ±0.03m).

- Option 2, with the flood channel outlet into the Chap, gives a slightly worse performance in the Desborough Loop but slightly better performance in the Desborough Cut compared to Option 1. However, the differences are small (up to 0.03m) and water levels remain lower than existing conditions.
- Flood levels in the flood channel upstream of Ferris Meadow Lake are generally similar to that of Option 1. There are some differences, but these are small (±0.05m) and have no practical impact on the Scheme's performance.

Peak flows in a 5% (1 in 20) annual chance flood have been assessed at locations close to Ferris Meadow Lake for the different options. This has shown that:

- For all options, there is close to an even split in peak flows between the Desborough Cut and the Desborough Loop around Desborough Island with around 240m^3/s on each side of the island of the 480m^3/s total reaching Walton Bridge. There is some variation between the options, but it is small (±10m^3/s).
- The peak flow reaching Walton Bridge is very similar for all options.

The full hydraulic modelling results, including flood levels and flows along with the location of the modelling comparison points, can be found in Appendix C of this report.

3.2 Water Environment

Ferris Meadow Lake is an offline, still, water body that is hydraulically connected to the River Thames through groundwater (the Chobham and Bagshot Beds WFD groundwater body). It is not designated in its own right as a water body under the Water Framework Directive (WFD). Although it is maintained and used for swimming, it is not a designated Bathing Water (although an application for Bathing Water status has been made by the lake owners). Microbiological monitoring for bathing water quality has been carried out on the lake, as part of the collection of baseline information for the Scheme, although the results have not been formally reported to the Environment Agency. Based on this monitoring, the lake would theoretically be classified as 'Excellent', when compared with the standards set out in the Bathing Water Regulations[2]. Other recreational uses of the lake include boating.

Lake condition assessment (which is an assessment as to how close to natural conditions a lake is based on its physical, hydrological, chemical and biological characteristics) has determined a fairly good condition for the Ferris Meadow Lake bed, bank and vegetated margins. Although the vast majority of the lake edge is shaded by overhanging trees, which limits development of marginal vegetation, one

[2] Bathing Water Regulations https://environment.data.gov.uk/bwq/profiles/help-understanding-data.html

stretch has been cleared and supports a diverse range of aquatic and wetland plants.

The benthic invertebrate species found in the lake is indicative of an enriched, heavily sedimented water body.

The Ferris Meadow Lake Water Quality Assessment sets out in detail the current water quality of Ferris Meadow Lake. In summary, nutrients such as Total Nitrogen and Total Phosphorous (P) are present in the lake at low levels. Biochemical Oxygen Demand (BOD) and Dissolved Oxygen (DO) levels also indicate that the lake has good water quality[3] and the presence of chemical pollutants is also low. For more information about this assessment, refer to Appendix F.

Ferris Meadow Lake can currently become flooded during moderate fluvial flood events within the River Thames. This typically occurs for a flood event with a 50% (1 in 2) annual chance flood.

Ferris Meadow Lake lies on bedrock geology of Claygate member formation and superficial geology of Shepperton gravel member. This forms part of the WFD groundwater body Chobham and Bagshot beds which does not have as good water quality as Ferris Meadow Lake. Lake level interaction with groundwater is based on Scheme surveys, which concluded that the lake appears to be in good hydraulic connection with the gravel aquifer. However, there are large areas of landfill to the north and west which could be reducing groundwater flows in this direction.

The water quality data available for the lake indicates that the lake water quality is good despite being influenced by the ingress of groundwater from the Chobham and Bagshot Beds, which is of poorer chemical quality. In addition, infrequent ingress of flood water from the River Thames (albeit mainly outside of the summer season) could also be adversely contributing to the present water quality of Ferris Meadow Lake because water quality monitoring and analysis suggest comparatively poorer levels of P in the River Thames, although the impacts of such ingress do not appear to be adversely affecting the current levels of total phosphorus in the lake.

The lake is known to support the South West London Waterbodies Special Protection Area (SPA) and Ramsar site by providing an open water habitat for two key species of migratory birds (Gadwall, *Anas strepera* and Shoveler, *Anas clypeata*). Aquatic Invasive Non-native Species (INNS), Himalayan (Balsam *Impatiens glandulifera)* and Canadian waterweed *(Elodea canadensis)* are present within the lake.

As with other lakes in the area, Ferris Meadow Lake is within the Lower Thames Drinking Water Protected Area and Safeguard Zone (Cookham-Egham-Teddington). Drinking Water Safeguard Zones (Surface Water) are catchment areas that influence the water quality for their respective Drinking Water Protected Area (Surface Water).

[3] This assessment of ‘good’ is the considered view of the project’s water environment experts and is based on different criteria from the Bathing Water Regulations, which are referenced elsewhere in this report.

They are identified where the protected area has been assigned as being “at risk“ of failing the drinking water protection objectives of the Water Environment (Water Framework Directive) (England & Wales) Regulations 2017.

The different options being considered would have potential to cause changes to the water environment and this is discussed in Section 5.2.1.

4. Appraisal Methodology

The Ferris Meadow Lake Options Appraisal has been carried out in five parts with the findings drawn together in the Conclusion section of this report. The six parts of the appraisal are:

- Technical and Feasibility Appraisal
- Environmental Appraisal
- Environmental Design Principles (EDP) Appraisal
- Planning Policy and Legislative Appraisal
- Construction Costs
- Land Costs

Each part of the appraisal is explained below.

4.1 Technical and Feasibility Appraisal

The purpose of the Technical and Feasibility Appraisal was to consider each option against a set of criteria that covered the design, construction and future requirements of each option. The appraisal has been carried out with input from the Scheme's design leads in channel and engineering, utilities, materials management, carbon, landscape and suitably qualified construction experts.

The assessment has considered the following criteria for each option:

- Impact on Existing Structures – This considered which structures in the location of Ferris Meadow Lake would likely need to be modified or removed, such as buildings, culverts and roads.
- Buildability – This considered how complicated the option would be to build.
- Operation and Maintenance – This considered the operational requirements such as the need for regular inspections and maintenance.
- Impact on Utilities – This investigated which utilities were in the area and determined the diversions that would be required, which would have cost and programme implications.
- Materials Management - In light of the waste hierarchy, this has focused on the amount of materials and waste extracted for each option, which the Scheme would then need to appropriately manage.
- Carbon Impact – This assessed the significant carbon-contributing materials (steel, concrete and rip rap) that would be required to implement each option.

A Technical and Feasibility Appraisal Matrix has been prepared considering the potential impacts of each of the options against the criteria, and this can be found in Appendix B of this report.

As well as describing the issues and impacts of the proposed options they were given a Red Amber Green (RAG) rating.

The RAG rating definitions for all criteria are shown in Table 1 below.

Table 1 - RAG rating definitions for the Technical and Feasibility Appraisal criteria

Appraisal criteria	RAG	Appraisal rating definitions
Existing Structures	Red	Significant changes to existing structures required
Existing Structures	Amber	Some changes to existing structures required
Existing Structures	Green	No changes to existing structures required
Buildability	Red	High risk to programme/high level buildability issues
Buildability	Amber	Moderate risk to programme/ buildability issues
Buildability	Green	Low risk to programme/ buildability issues
Operation & Maintenance	Red	Significant operation and maintenance requirements
Operation & Maintenance	Amber	Moderate operation and maintenance requirements
Operation & Maintenance	Green	Low operation and maintenance requirements
Impacts on Utilities	Red	Significant impacts on utilities
Impacts on Utilities	Amber	Moderate impacts on utilities

Appraisal criteria	RAG	Appraisal rating definitions
Impacts on Utilities	Green	Minimal impacts on utilities
Materials Management	Red	Significant amount of materials and waste excavated
Materials Management	Amber	Moderate amount of materials and waste excavated
Materials Management	Green	Minimal amount of materials and waste excavated
Carbon Impact	Red	Significant carbon footprint with limited carbon mitigation measures available
Carbon Impact	Amber	Moderate carbon footprint with some mitigation measures available
Carbon Impact	Green	Minimal carbon footprint

4.2 Environmental Appraisal

A Scheme-specific methodology has been developed for Environmental Appraisal of the options. For further details on this methodology, refer to Appendix D of this report. The methodology uses data from the Scheme's ongoing Environmental Impact Assessment (EIA), evaluating each option against its effects on the following topics:

- Air quality
- Biodiversity
- Climate change mitigation and adaptation
- Cultural heritage
- Flood risk
- Health
- Landscape and visual amenity
- Materials and waste

- Noise and vibration
- Socio-economics
- Soils and land
- Traffic and transport
- Water environment.

The assessment has been carried out by the Scheme's EIA topic leads.

A Red Amber Green (RAG) rating methodology was used to appraise the risks of each option, as described in Table 2 below.

Table 2 - RAG rating definitions for the Environmental Appraisal

Risk status	Appraisal rating definitions
High risk	Potential for high environmental impact and difficulty in achieving acceptable mitigation
Medium risk	Potential for a medium environmental impact and requires bespoke mitigation
Low risk	Potential for a minor or positive environmental impact, and mitigation is likely to be achieved through standard practice

4.3 Environmental Design Principles Appraisal

Environmental Design Principles (EDP) have been adopted by the Scheme to inform the development of environmental aspects of the Scheme design. These EDP were shared at the recent Statutory Consultation. They build on the Scheme Goals, while also drawing on the Environment Agency's and partners' priorities, the United Nations' Sustainable Development Goals, and collaborative work that has been undertaken with Surrey County Council (SCC) during the Scheme design phase.

The EDP are grouped under the three pillars of sustainability: Environmental Connections, Community Connections and Economic Connections

A review of the options against the EDP was carried out using a scoring process and a Red Amber Green (RAG) rating. The scoring is based on a multi-criteria appraisal matrix, built up from the EDP. The matrix gives a score for each EDP, organised under the three categories of Environmental Connections, Community Connections and Economic Connections. Each of these is divided into subcategories as follows:

Environmental Connections

- Climate Challenge
- Biodiversity

- Resource Use and Carbon Management
- Landscape and Visual Connections

Community Connections

- Health and Well-being
- Connecting Communities
- Recreation
- Safe, Accessible and Inclusive Spaces

Economic Connections

- Resilience
- Natural capital
- Funding and grants

Within each of these subcategories is a set of principles against which each option was assessed. The rating for each of these was determined on whether they are achievable, have potential to be achieved, or unlikely to be achievable. This rating was then combined into a percentage score, firstly for individual categories and then for the three categories combined.

For more information, refer to Appendix E where the EDP Appraisal is presented in detail.

4.4 Planning Policy and Legislative Appraisal

An appraisal of the options' compliance with relevant national planning policy, along with Spelthorne Borough Council and Elmbridge Borough Council's local development plan policies has been carried out, as well as identifying significant legislative compliance concerns. This appraisal is set out in Appendix G.

The following key themes were considered in this assessment:

- Landscape (trees)
- Cultural heritage
- Flood risk
- Climate resilience and adaptation
- Green Infrastructure connectivity
- Landscape character and visual impact
- Biodiversity
- Recreational use and socio-economic impact

- Materials and waste.

4.5 Construction Costs

Estimated construction costs have been calculated by suitably qualified construction experts based on the current level of design shown on the option drawings in Appendix A.

The cost estimates for each option considered the materials required, such as sheet piles and concrete; the labour and staff needed to carry out the work; plus the use of construction machinery and vehicles for each option.

The figures also include costs for dealing with excavated materials, which has assumed that 30% of this material would need to be taken off site for disposal (5% hazardous and 25% non-hazardous), while the remainder would be processed for re-use elsewhere within the Scheme. It has also been assumed that material excavated elsewhere, such as from areas considered to be natural ground, can be re-used without processing.

The appraisal involved a comparison of the combined construction costs for each option, with the lower-cost options being considered more suitable.

4.6 Land Costs

Land costs have been estimated by the Land Agent working for the Scheme. These cover the standard Compensation Code heads of claim, including the value of the land taken, severance and injurious affection, disturbance and professional fees. The values presented in Section 5.6 are estimates only, based on market conditions and the option designs at the time of writing, being indicative figures based upon desktop investigations. Options with lower land costs were considered more suitable.

5. Appraisal Findings and Outcomes

5.1 Technical and Feasibility Appraisal Results

This section sets out the findings of the Technical and Feasibility Appraisal of all of the options. The appraisal has been undertaken to consider the viability of each option. As noted in Section 4, each option has been considered against the six criteria and the results presented in a a set of RAG ratings applied for each option. For the detailed results of the Technical and Feasibility Appraisal, refer to Appendix B of this report. A summary from each criterion assessed is set out in Sections 5.1.1 to 6 below. The summary table of RAG ratings is provided in Table 3 below.

Table 3 - Technical and Feasibility Appraisal summary table

Appraisal criteria	Option 1	Option 2	Option 3	Option 4	Option 5	Option 6a	Option 6b	Option 7	Option 8
Impact on Existing Structures	Green	Red	Green	Amber	Green	Green	Green	Green	Green
Buildability	Green	Red	Amber	Red	Red	Amber	Amber	Amber	Amber
Operation and Maintenance	Green	Amber	Amber	Amber	Red	Amber	Red	Amber	Amber
Impacts on Utilities	Amber	Red	Amber	Red	Amber	Red	Red	Amber	Amber
Materials Management	Green	Amber	Red	Amber	Red	Green	Green	Green	Amber
Carbon Impact	Green	Amber	Red	Red	Red	Green	Amber	Amber	Amber

5.1.1 Impacts on Existing Structures

Options 1, 3, 5, 6a, 6b, 7 and 8 would not result in any impacts on existing structures and as such have been given a green RAG rating.

One of the structures that would be affected by Options 2 and 4 is the existing culvert under Ferry Lane which connects into the Chap. The culvert would need to be removed for both these options and a new bridge constructed to accommodate

the flood channel. Ferry Lane would also need realigning to the west to enable construction of this proposed bridge due to the proximity to properties in Desborough Close.

Option 2 would also require the relocation of the sailing club building and access road due to the widening of the Chap to the south and hence given a red RAG rating. Option 4 is not likely to require this same relocation and has been given an amber RAG rating.

5.1.2 Buildability

The options have been assessed considering the risks to the Scheme's programme and high-level buildability issues.

Option 1 would be the easiest to build because it requires the least amount of excavation in landfill to the west of Ferry Lane. Construction does, however, require a large cofferdam into the River Thames and Ferris Meadow Lake to enable the construction of the level retention structure at the south of the lake. A green RAG rating was given to Option 1.

The next easiest options to build would be Options 3, 6a, 6b, 7 and 8, which are all amber RAG rated because, although the buildability issues are not the same, they can all be classified as moderately complex.

Option 6a requires a small increase of excavation in landfill and the additional sheet pilling work on the new augmented flow channel (compared with Option 1).

Option 6b requires the addition of a further gated structure and operational compound, which is also within the landfill and as such is more complex to build than Option 6a.

Option 3 has the benefits of no channel connection into the lake and therefore does not need any cofferdams into the River Thames and Ferris Meadow Lake. However, there is additional excavation through landfill (compared with Options 1, 6a and 7) and substantial lengths of sheet piling. Option 3 also requires excavation in natural ground, which could pose an archaeological risk at the south of the lake, and this could add construction complexity and programme delay.

Option 8 requires additional excavation through landfill (compared with Options 1, 6a and 7) and construction of a large cofferdam into the River Thames.

Option 7 requires the division of Ferris Meadow Lake. Due to the significant depth of the lake, the bund providing the separation in the lake would be formed using sheet piles. Piling would have to be carried out from within the lake which is more complex than piling carried out from the land. Material to fill in between the piles would have to be sourced and, again, the placement and compaction would be more complex because of its location within the lake. This option needs construction in the landfill to the west of Ferry Lane and would require a large cofferdam into the River Thames and lake (as per Option 1).

The most complex options to build are Options 2, 4 and 5, which are all red RAG rated.

Option 2 (similarly to Option 3) has no connection into the lake so would not need a cofferdam for construction. However, the many residences affected by the works on the Chap present a significant risk to the programme and create construction complexity with work needed in individual gardens to the south of the Chap and alongside frontages to the north of the Chap. As with Option 3, additional excavation in landfill and excavation in the Chap are required, and there would need to be engineering of the Chap's banks and a need to place erosion protection. It is likely moorings would need to be temporarily removed ahead of construction and re-instated on completion. Option 2 also requires works at the sailing club, demolishing the existing building and constructing a replacement. The location of Ferry Lane crossing (LA12) further to the north presents further issues, as although the crossing may be smaller in length, additional utility diversions are required, and construction would be close to properties on the north bank of the Chap. It would therefore be necessary to realign Ferry Lane to the west at this location. All of this would add cost and time to the programme. For these reasons Option 2 is considered more complex to build than Options 3, 6a, 6b, 7 and 8.

Option 4 is more complex than Options 2 and 3 because it requires the elements of both (i.e. excavation and construction in the Chap and a new channel to the south and west of Ferris Meadow Lake), with all the construction challenges highlighted above for those options.

The option that is considered to present the highest risk to programme and with the most complex construction issues is Option 5. There is uncertainty on the feasibility of this tunnel option due to underlying aquifers and ground conditions which would need to be confirmed by geotechnical investigation. It also requires large volumes of excavation in both landfill and natural soil. Option 5 would also require complex logistics to mobilise the tunnelling machinery, creating large areas of temporary hardstanding, and needing large cranes to support the tunnelling operation.

5.1.3 Operation and Maintenance

The option which would have the least operation and maintenance requirements is Option 1, which has been given a green RAG rating. Option 1 would have the smallest length of sheet piles to inspect and maintain, and there would be no operational requirements because Option 1 only includes passive structures.

Options 2, 3, 4, 6a, 7 and 8 require additional maintenance compared with Option 1 and have been amber RAG rated.

For Options 2, 3, 4 and 8, additional maintenance and inspections would be required due to the lengths of sheet piles alongside the channels.

For Option 6a there is a small section of new channel to inspect and maintain, and the existing culvert under Ferry Lane would need maintaining. The penstock to close off the augmented flow channel would also need to be operated and maintained.

Option 7 would require inspection and maintenance as per Option 1 but with the additional requirement of the sheet piled bund to inspect and maintain.

Options 2, 3, 4, and 8 would also have the increased maintenance of the larger structure FCS19 when compared with Options 1, 6a and 7.

Options 5 and 6b have more significant operation and maintenance requirements and have been given a red RAG rating.

With Option 6b, the large gated structure would have significant operational requirements to ensure that the gates are opened and closed in line with the rest of the Scheme. It would also be a major structure to maintain and would require a large operational compound allowing crane access. It would also have the maintenance requirements of Option 1.

The option with the most operation and maintenance requirements would be Option 5. The tunnel would need to be regularly inspected. Due to the confined space containing water, this would have to be done by a specialist team, and would probably require expensive bespoke equipment, such as a remote vehicle. Any repairs needed would be difficult and expensive requiring large-scale equipment to be brought into the area.

5.1.4 Impact on Utilities

Options 1, 3, 5, 7 and 8 require a moderate amount of utility diversions and have been given an amber RAG rating.

Options 1, 3, 7 and 8 would require diversion of an existing 500mm diameter water main that runs from the west of Ferry Lane and travels east on the northern edge of Ferris Meadow Lake. The Ferry Lane Crossing (LA12) would require temporary diversions of a further water main, communication cables, foul water drainage, low and high voltage electrical cables, low pressure gas pipes and street lighting. The construction of a pumping station to the south of Ferry Lane Crossing (LA12) would be necessary to enable the foul water gravity main to cross the channel and feed to the existing River Thames water pumping station to the north.

For Option 5, due to the tunnelling under Ferry Lane (where there are a significant number of services) the services in the lane would be able to remain without diversion. However, engagement with utility owners would be needed to confirm this. A gas main and foul water main are visible inside the existing Ferry Lane culvert and due to the increased flow through the culvert (for the augmented flow), there is an increased risk of blockage from debris, and potential for damage to the pipes. This is likely to require a diversion of the pipes and this has been assumed for this appraisal. There may also be a need for a pumping station for the foul water main (assumed to be required for appraisal purposes). Otherwise, the diversions are similar to Options 1, 3, 7 and 8.

Options 2, 4, 6a and 6b require significant utility diversions and have been given a red RAG rating.

Option 2 would require similar diversions of services to the options above. However, with the construction of Ferry Lane Crossing (LA12) being further north towards the Chap, there are several additional electricity cables present which would require diversion. One benefit is the 500mm water main running in an east-west direction would not require such an extensive diversion. However, there are likely to be additional diversions further east towards the sailing club for their services (assumed for the purpose of the appraisal). The construction of a pumping station to the north of the Ferry Lane bridge (LA12) (rather than to the south in Options 1, 3, 7 and 8) would be necessary to enable the foul water gravity main to cross the channel and feed to the existing River Thames water pumping. This could also enable the foul water main visible inside Ferry Lane culvert to be diverted. The gas main visible inside the Ferry Lane culvert would also require diverting.

Option 4 would require similar service diversions as Option 2 but the 500mm water main, electricity and communications services running towards the sailing club would need to be diverted to cross a new bridge providing access to the sailing club over the channel to the west of the lake. The construction of a pumping station north of Ferry Lane Crossing (LA12) would be necessary to enable the foul water gravity main to cross the channel and feed to the River Thames water pumping station to the south.

For Options 6a and 6b, the utility diversions would be the same as for Options 1, 3, 7 and 8 but, as with Option 5, the gas main and foul water main inside the existing Ferry Lane culvert may need diversions and potentially a second pumping station for the foul water main to the north.

5.1.5 Materials management

Materials management of the Scheme follows the waste hierarchy concept of reduce, re-use, recover and dispose. In light of this waste hierarchy, the appraisal has focused on the volume of arisings generated for each option that would then need to be dealt with by the Scheme. The land to the west of Ferry Lane that the Spelthorne Channel passes through is known to be landfill and this makes excavation in this area more complex because arisings would require processing, possible treatment and may have to be disposed of offsite. Land to the east of Ferry Lane is generally thought to be naturally occurring so its excavation and material future use is less complex.

A summary of the estimated excavation quantities associated with each option, along with the assigned RAG ratings are provided in

Table 4 below. Typically, options with lower quantities of arisings would be considered preferable to those with higher quantities.

Table 4 - Excavation quantities for each option (in thousands of m^3) and RAG rating

All quantities in thousands of m^3	Option 1	Option 2	Option 3	Option 4	Option 5	Option 6a	Option 6b	Option 7	Option 8
West of Ferry Lane (landfill waste - landfill)	27.5	70	85.5	70	108.5	31.5	31.5	27.5	70
East of Ferry Lane (assumed natural material)	28	35	58.5	55	109	28	28	28	28
Total estimated arisings	55.5	105	144	125	217.5	59.5	59.5	55.5	98
RAG rating	Green	Amber	Red	Amber	Red	Green	Green	Green	Amber

Options 1, 6a, 6b and 7 would have the least total volume of arisings to be excavated compared with all other options and also the lowest amount of arisings from landfill. These options perform the most favourably against the waste hierarchy as they use an existing water body rather than excavating material. A green RAG rating was given to all these options.

Options 2, 4 and 8 have greater volumes of arisings from excavation and have been given an amber RAG rating. These options would all have large volumes of arisings from excavation in the landfill area to the west of Ferry Lane for the construction of a large weir structure, along with the excavation of either a new section of channel or widening of the Chap.

Red RAG ratings were given to Options 3 and 5 because they would have the greatest total volume of material to be excavated compared with all other options and the greatest amount of excavation in landfill.

Option 3 would have significant quantities of excavation required for the new channel to both the west and south of Ferris Meadow Lake and the large weir structure in the landfill area to the west of Ferry Lane. Option 5 would have greatest total volume of arisings of all the options. This would include very large quantities from both landfill and non-landfill to be processed for recovery and re-use on site or disposed of offsite. There would be probable opportunity for re-use of excavated London Clay from tunnelling which could be of benefit to the Scheme because there will be a need for naturally occurring, impermeable material for other parts of the Scheme.

Carbon Impact

The high-level carbon impact appraisal focused on estimating for each option the quantities of sheet piles, concrete and rip rap for bed protection. This is because these materials are the largest contributors of carbon for each option, with sheet

piles having much more of an impact than concrete generally and with rip rap making a smaller but not insignificant contribution.

Options 1 and 6a would have the lowest use of sheet piles, concrete and rip rap, hence these options having the smallest estimated carbon footprint and green RAG ratings.

Option 1 would have the lowest carbon footprint of all the options. Option 6a would have a larger carbon footprint than Option 1, due to the need for sheet piles along both sides of the new channel to pass the augmented flow but not significantly so.

Options 2, 6b, 7 and 8 would have a moderate carbon footprint and have been given an amber RAG rating.

Option 2 would have a carbon footprint twice that of Option 1. This is based on the expectation that sheet piles would be required on the south bank of the Chap and rip rap needed for bed protection and on the north bank. There would also be more extensive requirements for sheet piling and concrete to the west of Ferry Lane because this option would include a larger weir structure.

Option 6b is similar to Option 6a from the carbon impact of sheet piles and concrete but due to the addition of a large, gated structure with associated compounds it has a larger carbon footprint.

Option 7 would contain the same amount of concrete as Option 1, but would require two rows of sheet piles to form a separation bund and hence an increase in carbon footprint compared with it.

Option 8 would have a higher carbon footprint than Options 1 and 6a. For this option, the carbon impact is due to extensive requirements for sheet piling and concrete to the west of Ferry Lane because this option would include a large weir structure in landfill (also required for Options 2, 3, 4 and 5). To the east of Ferry Lane, there is only a small requirement for sheet piles and hence minimal carbon impact on this side of the Lane.

Options 3, 4 and 5 would have a significant carbon footprint and have been given a red RAG rating.

Both Options 3 and 4 would, due to the proximity of the lake edge and limited land, require sheet piling on both sides of the channel excavated to the west and south of the lake, as well as bed protection. They would also contain the large weir structure to the west of Ferry Lane in landfill with more extensive requirements for sheet piling and concrete.

For Option 5, the amount of concrete required to line the inlet and outlet shafts and the underground structure would be significant. There would also be a large quantity of sheet piles required in the flood level retaining structure and the augmented flow channel. Overall, this option would have the largest carbon footprint.

5.1.6 Summary of Technical and Feasibility Appraisal

For a summary of the RAG ratings for each option, see Table 3 at the start of Section 5.1 above.

This appraisal has shown that there are two options that perform significantly worse than others. These are Option 4 (the two-channel approach) which was given three red RAG ratings and three amber ratings, and Option 5 (the tunnel), which was given four red RAG ratings and one amber RAG rating, plus one green RAG rating.

For Option 5, there are concerns about the challenges to construction of such a large diameter tunnel in this location and there is currently uncertainty as to the technical feasibility of this tunnelling option due to underlying aquifers and ground conditions. As such, it is difficult to accurately estimate the construction cost for Option 5, but is estimated to be over £140million.

Option 4 requires construction in two separate sections and hence has a significant carbon impact, a high amount of material arisings, construction complexities, with the majority of the issues of Option 2 and 3 combined together.

As a result of this appraisal, it has been concluded that neither Options 4 nor 5 would be suitable options for the Scheme. As such, they are not taken further for appraisal in this report, although these options are included for information in the appendices.

The Technical and Feasibility Appraisal shows that the best-performing option from this perspective, with five green RAG ratings, is Option 1. This is closely followed by Option 7, with two greens and four ambers). Neither of these options have any red RAG ratings. Option 6a is also close to Option 7 in third position, as it received three green RAG ratings, two amber RAG ratings but also a received a red RAG rating as a result of issues with utilities.

5.2 Environmental Appraisal Results

This section sets out a summary of the findings of the Environmental Appraisal. Section 5.2.1 provides a summary of the Water Quality Assessment (provided in full in Appendix F), and a summary of key environmental risks identified for each option is provided in Section 5.2.2. The full Environmental Appraisal is presented in Appendix D.

Table 5 - RAG ratings for each option for each of the environmental topics appraised

Environmental Appraisal Topic	Option 1	Option 2	Option 3	Option 6a	Option 6b	Option 7	Option 8
Air quality	Amber	Amber	Amber	Amber	Amber	Amber	Amber
Biodiversity	Amber	Red	Red	Amber	Amber	Red	Red
Climate change	Green	Green	Green	Green	Green	Green	Green
Cultural heritage	Amber	Amber	Amber	Amber	Amber	Amber	Amber
Flood risk	Green	Green	Green	Green	Amber	Green	Green
Health	Amber	Green	Amber	Amber	Green	Green	Red
Landscape and visual	Green	Red	Amber	Green	Amber	Green	Green
Materials and waste	Green	Amber	Amber	Green	Green	Green	Amber
Noise and vibration	Amber	Amber	Amber	Amber	Amber	Amber	Amber
Socio-economics	Amber	Amber	Green	Amber	Green	Green	Red
Soils and land	Green	Red	Red	Amber	Amber	Green	Red
Traffic and transport	Green	Amber	Red	Green	Green	Green	Amber
Water environment	Amber	Amber	Green	Amber	Amber	Green	Red

5.2.1 Water Quality Assessment

A Water Quality Assessment has been carried out to consider the effects of the different options on the water quality in Ferris Meadow Lake, Ferry Lane West Lakes 1, 2 and 3 (located to the west of Ferry Lane) and the Chap. A summary of this assessment is provided below, with more detail provided in Appendix F of this report. The Environmental Appraisal in Appendix D provides more information about the wider water environment impacts of the options at Ferris Meadow Lake.

Construction effects on water quality

Construction impacts would be minimised through the use of construction standard practice. During construction of the channels upstream of Ferris Meadow Lake, excavation through areas of historic landfill may mobilise contaminants in groundwater with a risk of their transferral to downstream receptors including Ferris Meadow Lake. However, these impacts on controlled waters (which include Ferris Meadow Lake) are considered to be low to moderate. This would be validated prior to construction through a hydrogeological risk assessment that would highlight any risks to contamination of groundwaters and surface waters from construction.

The project would seek to minimise the impacts on water quality during the Scheme's construction period through the use of standard practice construction methods. This would be the case no matter which option were implemented. As such, there are not expected to be significant impacts on water quality in Ferris Meadow Lake during the construction period from any of the options. For more information about the construction effects on water quality, see Appendix F.

Operational effects on water quality

The predicted operational effects of the Scheme on water quality at Ferris Meadow Lake would vary according to whether the option selected would allow augmented flow to pass through Ferris Meadow Lake.

Ferris Meadow Lake is currently subject to periodic flooding from the River Thames and, with the Scheme in place, would still receive flood waters from the River Thames at a similar frequency to existing conditions, which would include the input of nutrients, microbes, and pollutants.

As such, the focus of the Water Quality Assessment below relates to the potential impacts of the augmented flow on water quality with reference to flood flows where applicable.

During augmented flow conditions, Options 1, 6a, 7 and 8 are likely to lead to the greatest negative effects to Ferris Meadow Lake from mixing of river water with the lake water because the augmented flow passes through the lake. It is notable that the operational effects for Option 7 are less than the others because half of the existing lake would be separated by a bund and would therefore not receive the augmented flow or flood flows.

Under Option 6a, as the augmented flow would mainly pass through the Chap (noting that there would be no additional control structure to fully prevent some of the augmented flow entering Ferris Meadow Lake as in Option 6b) in comparison to Option 1, flow and circulation through Ferris Meadow Lake would be less, increasing the residence time of the lake and enabling sediments and nutrients to settle in the lake, between flood events. There is a risk that the increased residence time and continual input of nutrients would increase the risk of eutrophication in the lake. Overall, the level of risk to Ferris Meadow Lake would be similar to Option 1 (while the exact magnitude of any difference cannot be calculated between Option 1 and 6a, Option 1 has a shorter residence time and increased nutrient loading and Option 6a has a longer residence time and lower nutrient loading).

For water quality, the increased fluvial input (for Options 1, 6a, 6b, 7 and 8) would result in increased nutrients, in addition to contaminants from the River Thames, connected lakes upstream and from landfill (e.g. through providing a pathway for pollutants to enter the lake). The increase in nutrients would increase the risk of algal blooms occurring over and above existing occurrences. However, algal blooms are related to residence times (i.e. the longer the residence time, the longer the length of time water stays in the lake without being replaced through circulation and therefore the higher the risk of algal blooms occurring) and since the augmented flow would help reduce residence times in the lake this would help to mitigate the risk of such algal blooms. However, it cannot be guaranteed that this would reduce algal blooms over and above existing levels. For further information and evidence, see the Ferris Meadow Lake Water Quality Assessment in Appendix F.

For Options 1, 6a, 7 and 8, microbial ingress into Ferris Meadow Lake could potentially increase as a result of River Thames water entering the lake. However, this is not expected to have a significant impact on bathing water quality and therefore the lake would remain safe for recreation.

During normal conditions, when no flooding has taken place, water quality in Ferris Meadow Lake under these options would remain healthy for humans because the microbes that have the potential to cause ill health would decay during the time it takes the water carrying them to leave the River Thames at Laleham and pass along the Spelthorne Channel to Ferris Meadow Lake. Modelling shows that, during normal conditions, this water would take around 45 days to complete its journey, while 90% of the microbes monitored in relation to water quality would have died within 20 days.

As such, this indicates that during augmented flow conditions, these microbes are unlikely to reach Ferris Meadow Lake from the River Thames in a viable state or in sufficient numbers to cause a risk to human health.

Therefore, Ferris Meadow Lake would be expected to support a classification of at least ‘Good’ under the Bathing Water Regulations classification. This would be a reduction from its current level of ‘Excellent’, but these predicted water quality impacts would not prevent the use of the lake for recreational purposes.

For surface water dependent biodiversity, the altered flow regime and water quality has the potential to affect macrophyte, invertebrate, fish and marginal habitats. These effects represent changes, although these may not necessarily be negative and may have positive effects, for example potential increased growth of macrophytes may enhance the available habitats for the migratory birds.

Reduced residence times, increased flow and greater turnover of sediment through the lake, have the potential to offset the increased nutrient concentrations which risk generating algal blooms. However, this is not necessarily to a greater level than would otherwise be occurring without the Scheme in place.

As set out above, Options 2 and 3 would not result in augmented flow passing into Ferris Meadow Lake, so there would be no impact on the water quality of the lake for bathing.

During augmented flow conditions, there would also be no impact on water quality in the lake for Option 6b. However, unlike Options 2 and 3, during flood conditions, River Thames water would enter the lake under Option 6b. As a result, during flood, additional nutrients would be added to the lake. Because the augmented flow would be through the Chap, those nutrients that do enter the lake during flood conditions would take longer to flush through, staying in the lake for longer.

For more information relating to changes to water quality in the lake under each option, see Appendix F of this report.

Water quality in the Chap

Water quality impacts to the Chap from Options 1, 3, 7 and 8 would likely be insignificant because the Scheme would not interact with the Chap.

Impacts to the Chap as a result of implementing Options 2, 6a and 6b would likely be greater because of the passing of augmented flow from the Spelthorne Channel passing into the Chap. For more information about this, see Appendix F.

5.2.2 Environmental Appraisal

This section summarises the key environmental impacts identified for each option, focusing on those that were categorised as ‘high risk’. There is a summary of the Environmental Appraisal results in Table 5 above. While the options considered generate different environmental impacts for some topics, there is relatively little difference in impacts between options for others. This is the case for air quality (medium), climate change (low), cultural heritage (medium), and noise and vibration (medium). Therefore, while these environmental topics are important considerations requiring assessment and mitigation, they are not determining factors in the environmental appraisal of the options and are not discussed further below.

A summary of the environmental appraisals for Options 4 and 5 has not been included in this section because of their poor performance in the Technical and Feasibility Appraisal. They are included in the full Environmental Appraisal, which can be found in Appendix D of this report.

Option 1

There were no high risks to the environment associated with Option 1. Mixing river water with lake water is anticipated to increase nutrient conditions, and other contaminants in Ferris Meadow Lake. However, these effects would be mitigated by the continuous augmented flow, reducing the amount of time the nutrients would be in the lake and reducing the risk of algal blooms and eutrophication. Therefore, it is unlikely to cause a change to the distribution of macrophytes, invertebrate, fish communities and marginal habitats of the lake.

The potential negative permanent changes to Ferris Meadow Lake water quality and hydromorphology from the presence of the augmented flow is considered a medium risk for water, health and socio-economics. The reduction in water quality is not anticipated to present a risk to human health. However, there may be a perceived risk to health, which could discourage t swimmers from using the lake, and lead to potential physical and mental health impacts for regular swimmers. This could have an impact on the Shepperton Open Water Swim business and the lake as a recreational facility, although this effect may reduce over time as effects are understood.

With regards to landscape and visual amenity, trees in the location of the proposed and widened access track to the west of Ferris Meadow Lake are the subject of a Tree Preservation Order, although further consideration of the route of the track would minimise loss of trees, resulting in a predicted low visual impact.

Option 2

Option 2 is considered high risk for biodiversity due to the loss of a backwater habitat in the Chap, with acceptable mitigation for this habitat loss being difficult to achieve.

With regards to landscape and visual, Option 2 would have the greatest effect on the amenity of residents of the Chap because private land to the south of the Chap would be lost. There would also be partial loss of the existing picturesque waterside setting and their view would be changed with the relocation of the sailing club boathouse. The widening of the Chap on the south side could also impact trees that are subject to a Tree Preservation Order in gardens of properties and mitigation would need to be agreed for loss, which may be difficult to achieve.

Option 2 is considered high risk for soils and land as the construction of a large water control structure and wider flood channel within an area of historic landfill to the west of Ferris Meadow Lake could lead to additional potential effects from the creation of new pollutant pathways and risk of landfill gas and leachate release.

Option 3

Option 3 is considered high risk for biodiversity due to the permanent terrestrial habitat loss within and outside of Ferris Meadows Site of Nature Conservation Interest (SNCI), including grassland and woodland. Compensatory planting would be required to mitigate the effect, but there would still be a permanent loss of terrestrial habitat.

With regards to landscape and visual, there are groups of trees in this area that are the subject of a Tree Preservation Order, both adjacent to Ferry Lane and along the lake edge, as well as other individual protected trees in the southern area of the lake. It is likely that many trees would be lost due to the channel being constructed in this location, with a predicted 'medium' visual impact.

Option 3 is considered high risk for soils and land. This is because of the construction of a larger water control structure and wider flood channel within an area of historic landfill. This could lead to additional effects from new pollutant pathways being created and a greater risk of landfill gas and leachate release.

Option 3 generates the second-highest volume of excavated material of all of the options. The HGV traffic (and associated air quality emissions) generated by transporting the excavated material is likely to be high and would be difficult to manage with standard mitigation. It is likely that the construction programme would need be extended to reduce hourly HGV movements to manageable levels.

Option 6a

Option 6a is considered medium risk to biodiversity because flood flows would enter the lake adding additional nutrients. However, because the augmented flow would be predominately through the Chap, rather than the lake, those nutrients that do enter the lake would take some time to flush through and would stay in the lake for longer. As such, this could increase the risk of eutrophication in the lake. Monitoring and mitigation would be required to reduce the severity of this effect to a level where there is no impact on the Ferris Meadow Lake's aquatic ecology. All other effects on biodiversity receptors can be mitigated with bespoke mitigation measures.

As some of the augmented flow would still enter Ferris Meadow Lake, there are potential negative permanent changes to the lake's water quality and hydro-morphology, which is considered a medium risk for health and socio-economics. While the reduction in water quality is not anticipated to be sufficient to affect human health, there may be a perceived risk to health, which could discourage swimmers from using the lake, and as such have an impact on mental and physical health. This could have an p impact on the Shepperton Open Water Swim business and the lake as a recreational facility, although this effect may reduce over time as effects are understood.

With regards to landscape and visual impacts, trees in the location of the proposed access track to the west of Ferris Meadow Lake are the subject of a Tree Preservation Order. It is expected that further consideration of the route of the track would minimise loss of trees, resulting in a predicted low visual impact.

Option 6b

No high-risk categories were identified for this option. Option 6b is considered medium risk for biodiversity for the same reasons as Option 6a described above.

With regards to landscape and visual, as with Option 6a above, trees in the location of the proposed access track to the west of Ferris Meadow Lake are the subject of a Tree Preservation Order, although further consideration of the route of the track would minimise loss resulting in a low visual impact.

The diversion of all of the augmented flow through the Chap under Option 6b (in contrast with Option 6a) would reduce the likelihood of water quality effects to Ferris Meadow Lake, meaning there would be a low impact on health, recreation and Shepperton Open Water Swim. However, it should be noted that, like Option 6a, additional nutrients from River Thames water would enter the lake during flood conditions under Option 6b. Because the augmented flow would be through the Chap, those nutrients that do enter the lake during flood conditions would take longer to flush through, staying in the lake for longer than in Option 6a. Therefore, this could increase the risk of eutrophication in Ferris Meadow Lake.

While Option 6b meets the flood risk performance required of the Scheme, it requires a major structure with future maintenance and management risk, which makes it less resilient and was therefore assessed as medium impact from a climate resilience perspective.

Option 7

Option 7 is the highest risk for biodiversity of all the options because splitting of Ferris Meadow Lake into two parts is considered likely to reduce the lake's function as a supporting waterbody to the South West London Waterbodies SPA and Ramsar site. This is because there may be a reduction in foraging area and an increase in susceptibility to disturbance. There is a risk that the splitting of the lake could be assessed as causing an adverse effect on the integrity of the SPA and Ramsar site. Evidence to show that there are no "alternative solutions" to Option 7 is likely to be required if this option were selected, which would be difficult to achieve given the consideration of a range of options that would have a reduced impact on the SPA and Ramsar site.

Option 7 would lead to large permanent changes to Ferris Meadow Lake, affecting water quality and hydromorphology, but only on the western side of the lake, with the eastern side of the lake effectively becoming a separate water body experiencing minimal impacts on water quality and hydromorphology. As Shepperton Open Water Swim only uses the eastern half of Ferris Meadow Lake for swimming, the separation of the Scheme's channel from this part of the lake would mean the area used by Shepperton Open Water Swim would be unaffected, meaning there would be low risk to health and socio-economics for Option 7.

There are also low impacts on landscape and visual receptors.

Option 8

Option 8 is considered high risk for biodiversity due to changes in water quality as a result of its open connection with the River Thames. There is the potential that this option could lead to a biodiversity opportunity through the creation a backwater for

fish as there would be free access into and out of the lake. Option 8 could result in operational disturbance to the interest features of South West London Waterbodies SPA and Ramsar Site due to the new access being created and more craft entering the lake.

Option 8 is also considered highest risk for water environment, health and socio-economics as it would lead to large permanent changes to Ferris Meadow Lake, affecting water quality and hydromorphology. The unrestricted flow of River Thames water directly into Ferris Meadow Lake (as compared to journeying down the Spelthorne channel) could result in permanent impacts to Shepperton Open Water Swim facility. This has the potential to affect the physical and mental health of regular users. While this option provides the potential for alternative businesses to establish, such as a marina, there is no guarantee this would be achieved.

Option 8 is considered high risk for soils and land as the construction of a larger water control structure and wider flood channel within an area of historic landfill could lead to additional potential effects from the creation of new pollutant pathways and greater risk of landfill gas and leachate release.

Impacts on landscape and visual receptors are predicted to be low.

5.2.3 Summary of the Environmental Appraisal

The summary of RAG ratings is provided in Table 5 above. Note that as Options 4 and 5 performed poorly in the Technical and Feasibility Appraisal, their results have not been highlighted in this section, although they were considered as part of the Environmental Appraisal and the findings about those options can be found in Appendix D.

The appraisal has demonstrated that Options 1 and 7 are the best-performing options overall environmentally. The key difference between them is that the appraisal of Option 1 identifies potential human health and socio-economic impacts from perceived risks to swimming, while the appraisal of Option 7 identifies a high risk to biodiversity, which could lead to non-compliance with the Habitats Regulations in respect of the South West London Waterbodies SPA and Ramsar site.

This analysis needs to be seen in the context that the Environmental Appraisal shows that in non-flood conditions, water quality in the lake for Option 1 is predicted to be ‘Good’ (equivalent bathing water standard) once the Scheme is operational. This would be a reduction in quality from the current level, which is ‘Excellent’, but Option 1 would allow for continued safe swimming in the lake.

5.3 Environmental Design Principles Appraisal

A review of options against the Environmental Design Principles (EDP) was carried out. A detailed appraisal matrix outlining the outcomes of this appraisal is provided in Appendix E of this report, with a summary of the findings provided below.

The options have been given a percentage score that relates to their ability to achieve the Scheme goals. The higher the score, the more successful the option, with these scores summarised in Table 6 below. Options 4 and 5 have been omitted here because of their poor performance in the Technical and Feasibility Appraisal, although they are included in Appendix E.

The EDP Appraisal found that all the options have the potential to satisfy the Scheme goals, according to these appraisal criteria. As such, the EDP scores did not play a significant role in selecting the preferred option for Ferris Meadow Lake.

Table 6 - Environmental Design Principles score summary

	Option 1	Option 2	Option 3	Option 6a	Option 6b	Option 7	Option 8
Environmental Connections	88%	79%	73%	85%	79%	83%	78%
Community Connections	84%	87%	82%	84%	86%	86%	83%
Economic Connections	83%	76%	73%	83%	83%	83%	83%
Score for achieving Scheme goals	**85%**	**81%**	**76%**	**84%**	**83%**	**84%**	**81%**

5.3.1 Environmental Connections

In terms of scoring against Environmental Connections, all options fall within a range of scores between 73% and 88%. Option 1 scores slightly higher mix of ‘potential to achieve’ and ‘achievable’. Option 3 scores lower than all others predominantly due to its high carbon impact and excavation quantities. Option 3, however, was still classed as having potential to achieve or achievable against the principles assessed.

5.3.2 Community Connections

For Community Connections, all options score very closely with a mix of ‘potential to achieve’ and ‘achievable’.

Most options offer opportunities for Natural Green Open Spaces, plus habitat creation, providing new spaces to enhance local health and well-being, with potential for new travel connections via the active travel routes with only subtle variations between them.

5.3.3 Economic Connections

All options were deemed to have the potential to promote ‘green’ tourism and other recreational opportunities to encourage a boost to local economy.

5.3.4 EDP Summary

The review of the EDP against each option has demonstrated that there are a variety of benefits that can be weaved into the design during development whichever option is selected. The options assessed have a score range very close together and hence it would be difficult to justify selecting an option based on the success of achieving EDP alone.

5.4 Planning Policy and Legislative Appraisal

The options have been appraised for their compliance with relevant national planning policy and Local Plans for Spelthorne and Elmbridge. Any significant conflict with applicable legislation has also been identified. The full appraisal is provided in Appendix G, with a summary of the findings provided below. Options 4 and 5 have been omitted here because of their poor performance in the Technical and Feasibility Appraisal, although they are included in Appendix G.

Landscape (trees)

All options considered would require the removal of trees that are the subject of a Tree Preservation Order (TPO) and which Local Plan policies seek to protect. In accordance with planning policy, high-quality replacement planting would need to be undertaken in all cases as part of a detailed landscape design strategy. However, the scale of removal of protected trees would differ considerably. Option 3 would require a significantly larger amount of protected trees to be removed than the other options to enable the construction of a channel to the west of the lake, directly conflicting with applicable planning policies. Although Option 2 is likely to require removal of a relatively low number of individual trees (including in private gardens), these would be very difficult to mitigate. In contrast, the potential impacts on protected trees associated with Options 1, 6a and 6b are likely to be capable of mitigation through the sensitive routing of the proposed access track.

Cultural heritage

Any impact on the setting of Listed Buildings is likely to be mitigated through screening and any impact on archaeology managed via an archaeological Written Scheme of Investigation (WSI). For all options, it is considered that the benefits of the Scheme would outweigh the harm to heritage assets, which would not be substantial and, as such, all options would be in compliance with national and local planning policy.

Flood risk

All options would have equal benefits in terms of flood risk reduction. The sequential test[4] is not relevant to this options appraisal because Scheme elements in this location are considered water-compatible development and are within the functional flood plain. A full sequential test for the Scheme will be included in the application for development consent.

Climate resilience and adaption

Climate resilience and adaptation is a national and local planning policy objective and one of the main goals of the Scheme. As such, there is no difference between the options in terms of their compliance with planning policy. Sustainable construction practices would be employed across the Scheme as a whole, although this is unlikely to include the use of recycled construction materials for this element of the Scheme. The primary difference between options would be the amount of embodied carbon in the construction materials used. Option 1 performs best against the policy objectives in this respect.

Green infrastructure connectivity

All options would retain and enhance the connectivity of the green infrastructure network with the introduction of a new active travel route.

Landscape character and visual impact

Potential adverse landscape and visual effects arising from the construction and operation of all options, except Options 2 and 3, could be mitigated. This would include, throughout detailed design, the consideration of materials used and planting, and would therefore be in accordance with relevant national and local planning policies.

Biodiversity

It should be noted that compliance with the Water Framework Directive is not considered as part of this policy and legislative review. Impacts on the water environment are considered in the Environmental Appraisal, and the preferred option will be included in the Scheme-wide WFD assessment. Additionally, biodiversity net gain (BNG) is the subject of ongoing work at a Scheme-wide level, and as such an appraisal of compliance with BNG policies are not considered specifically for Ferris Meadow Lake options.

None of the options are fully policy compliant with planning policy objectives for biodiversity for the reasons given below:

[4] The sequential test is used to guide development to areas at lowest risk of flooding, by requiring developers to demonstrate that there are no alternative lower-risk sites available where the development could take place.

- Options 1, 6a, 7 and 8 have the greatest adverse effects on water quality in Ferris Meadow Lake.
- Options 2, 6a and 6b are also considered not to be fully policy compliant due to long-term adverse impact on water quality in the Chap, Ferris Meadow Lake and Ferry Lane Lakes 1 and 2. In addition, Options 6a and 6b would also have impacts on Ferry Lane Lake 3.
- Although Option 3 only has short-term impacts on Ferris Meadow Lake associated with construction, it would have the greatest loss of Ferris Meadows SNCI habitat, including grassland and woodland with engineering work presenting risk to protected species.
- All options would incur some loss of habitats and effects on the Chap (part of the River Thames SNCI) and/or Ferris Meadows SNCI.

From a legislative perspective, Options 7 and 8 are identified as potentially causing a reduction to the functioning of Ferris Meadow Lake as a supporting water body to the South West London Waterbodies SPA and Ramsar site, potentially adversely affecting the integrity of the SPA. Given this, and that the Scheme has considered alternative options at this location that could be brought forward (which is one of the tests to be considered if adverse effects on integrity to a European Site are identified), Options 7 and 8 risk Scheme non-compliance with the Conservation of Habitat and Species Regulations 2017 ('Habitats Regulations') which would be a significant risk for the Scheme.

Recreational Use and Socio-economic impact

Local planning policy seeks to protect recreational use of the River Thames, including visitor facilities.

- The separation of the open water swimming area from the flood channel under Option 7 should mean there is no long-term impact on the use of that recreational facility, and therefore no conflict with policies seeking to protect recreational use.
- Under Options 1 and 6a, there may be a risk to the long-term attractiveness of Shepperton Open Water Swim facility if users perceive a risk to their health associated with the anticipated reduction in bathing water quality equivalent from 'Excellent' to 'Good'.
- Option 8 would reduce bathing water quality equivalent to Poor – due to its direct and open connectivity with River Thames – which is likely to significantly reduce the attractiveness of the open water swim facility.
- Option 6b should not be in conflict with local planning policies to safeguard recreational facilities on the River Thames, it would have no direct effect on the open water swim facility or the sailing club and bathing water quality would be unlikely to deteriorate.

- Option 2 would have short-term impacts on recreational activity due the need to relocate the sailing clubhouse to enable construction, but this is capable of mitigation to avoid conflict with local plan policies, which seek to safeguard facilities which support recreational use of the River Thames.
- For Option 3, disruption during construction would need to be carefully managed to reduce short-to-medium-term impacts on the open water swimming facility. However, this option should not have any operational (long term) impact on the attractiveness of the open water swimming facility to its users, and so should not conflict with local plan policies supporting recreational use of the River Thames.

Materials and Waste

Planning policy requires applicants to demonstrate that waste generated during construction and excavation is limited to the minimum necessary, so the appraisal against this objective has been undertaken on the basis of volume of waste material generated through excavation.

Options 1, 6a, 6b and 7 perform best against this policy objective as they require the least amount of waste material excavation, including from historic landfill.

Summary

In policy and legislative terms, the most significant differences between the options relate to biodiversity, socio-economic, materials and waste and carbon objectives. Although all of these objectives would need to be considered in the context of the Scheme as a whole, the likely conflict of Options 7 and 8 with the Habitats Regulations would be a significant risk for the Scheme if either of those options was taken forward. Impact on the open water swimming facility differs considerably between the options. Only option 6b and 7 are considered to be fully policy compliant with the local plan objective to protect recreational facilities along the River Thames. Options 2 and 3 would have short-term impacts, which may be capable of mitigation. Options 1, 6a and 8 would only conflict with this policy objective if they reduced the attractiveness of the facility and its long-term operation.

All options present challenges in relation to compliance with national and local planning policy in relation to landscape, cultural heritage, and biodiversity. The extent to which they are acceptable would depend upon the identification of appropriate mitigation, or where this may not be possible, the need to demonstrate that the overall benefits of the Scheme would outweigh the negative effects.

5.5 Construction Costs

Estimated construction costs are provided below in Table 7. As explained in Section 4.5, the estimate has been made from the cost of the construction itself and the cost of disposal or processing of excavated material.

Typically, the options that would need to have the level retention weir (FCS19) to the west of Ferry Lane require the largest quantity of excavation in the area of landfill. Option 3 would have the largest quantity and hence the largest cost for disposal and processing of material from landfill. This is closely followed by Options 2 and 8.

The option with the lowest estimate construction cost is Option 1, which has an estimated cost of £20.3million. It has the smallest amount of construction work and least work required in the area of landfill.

Option 6a has the second-lowest estimated cost of £24.3 million. It is more than Option 1 due to the addition of a small channel to be excavated for augmented flow and requires additional excavation in the area of landfill.

Options 2, 3, and 8 have estimated costs ranging from £29.2 million to £34.6 million which includes a sizable cost for disposal and processing of landfill material. Out of these three options, it is Option 3 that has the highest construction costs. This is due to the creation of the large flood channel to the west and south of Ferris Meadow Lake and the need for sheet piles and bed protection.

Option 7, like Option 1, has the lowest costs for disposal and processing of landfill material but has a high construction cost. The high construction cost is due to the installation of the sheet piled bund across the lake, giving a total estimated cost of £36.8 million, which is the second-highest construction cost.

Option 6b has the highest overall estimated cost of £39.6 million. Like Option 6a, it is more expensive than Option 1 due to the addition of a small channel for the augmented flow. However, the major cost for this option is that of the full gated structure required.

Table 7 - Estimated construction costs (£ million)

All costs in millions of £	Option 1	Option 2	Option 3	Option 6a	Option 6b	Option 7	Option 8
Estimated cost (excl. excavated materials)	17.5	22.8	25.8	21.0	36.0	34.0	22.0
Estimated costs of disposal and processing excavated material from landfill	2.8	7.2	8.8	3.3	3.3	2.8	7.2
Total estimated construction cost	**20.3**	**30.0**	**34.6**	**24.3**	**39.3**	**36.8**	**29.2**

5.6 Land Costs

Options 1, 3, 6a and 6b affect fewer landowners than the others, which reduces the associated land compensation costs.

Each individual landowner has an entitlement to claim fees for surveyor representation through the process, and for solicitor representation in finalising an option agreement. The more landowners that are affected, the more these costs rise. Not all landowners will choose to appoint a surveyor or a solicitor, but it has been assumed all will to ensure estimated land costs are based on a worst-case scenario.

The worst-case figures for Options 1, 6a and 6b assume the open water swimming business would be permanently closed. They therefore have significantly higher costs due to the disturbance to the landowner (although these disturbance costs are at low certainty levels).

Option 3 achieves the lowest cost, principally because it is assumed the open water swimming business would not have to close due to this option and therefore the landowner's disturbance cost is reduced.

Option 2 affects a particularly large number of landowners and therefore significantly increases both the land cost and the overall burden on landowners. In addition, Option 2 incorporates garden land, which is generally a more valuable land type than that affected by other options. The permanent acquisition of garden land could affect the value of the house that it is part of (known as 'marriage value') which adds to the land costs. Table 8 below summarises the cost estimates.

Table 8 - Estimated land costs (£ million) for each option

All costs in millions of £	Option 1	Option 2	Option 3	Option 6a	Option 6b	Option 7	Option 8
Estimated land costs	0.90	6.85	0.75	1.10	1.10	0.70	1.00
Total estimated worst-case land costs	**1.75**	**8.35**	**0.90**	**2.05**	**2.05**	**1.55**	**1.85**

The estimated land costs are based on the following assumptions and caveats:

- They are intended for use only in comparative assessment of the different options against each other.

- They represent an estimation of the relevant heads of claim in the Compensation Code. Any final settlement would be subject to a fully submitted and evidenced claim.
- Some costs will change with further design development, landowner engagement, changes in the property market, inflation, and land use changes.
- No allowance is made for land costs associated with land required temporarily for construction use.

6. Statutory Consultation Feedback

As noted in Section 1. of this report, two new suggestions for the design at Ferris Meadow Lake that were suitable for appraisal were received during statutory consultation. These have been included in this appraisal as Options 7 and 8.

Alongside these additional suggestions, a significant number of the 2,569 respondents to the consultation provided comments on the Scheme's design at Ferris Meadow Lake. This included two separate campaign[5] emails that were submitted from a combined total of over 1,000 respondents. Both campaigns expressed support for Option 2 and, for the most part, also expressed opposition to Option 1 and the other options that involved passing augmented flow through Ferris Meadow Lake.

Of those who responded expressing support for Option 1, the reasons provided included it being the most cost-effective option, it maximising the use of existing natural features in its design, its ability to effectively reduce flooding, and it having the least amount of construction.

The reasons provided in opposition to Option 1 included concerns that the design would impact open water swimming at Ferris Meadow Lake, as well as impacts on biodiversity and socio-economics, and that the proposed Public Rights of Way would threaten local habitats and wildlife.

With regard to Option 2, of those who responded expressing support for it, the reasons offered included those saying that the design would preserve Ferris Meadow Lake as a swimming area and Site of Nature Conservation Interest, that it meets flood mitigation needs, and makes use of an existing waterway.

The reasons provided in opposition to Option 2 included its requirement for extensive engineering work which could lead to higher costs, impacts on the character and biodiversity of the Chap, compulsory purchase of land from residents, and the view that the design potentially moves flood risk towards residential areas.

This report and its appendices demonstrate that all of these factors have been considered as part of the technical, cost and environmental appraisals of options 1 and 2, and that these factors are also reflected in the appraisal of the other options for Ferris Meadow Lake.

Any feedback received during supplementary consultation will also be considered in any further design development at Ferris Meadow Lake.

A summary of the issues raised during statutory consultation in respect of the whole Scheme has been published on our website (www.riverthamesscheme.org.uk).

[5] A 'campaign' response is one that sees an identical or very similar piece of text being submitted as a consultation response by a number of respondents, typically after consultees are prompted to respond in a particular way by a stakeholder such as a local interest group.

A comprehensive explanation of the issues raised during statutory consultation and supplementary consultation, along with the project's detailed responses to those issues, will be presented in the Scheme's *Consultation Report*. This report will be submitted as part of the Scheme's application for development consent, expected in 2025.

7. Appraisal Conclusions

This section summarises the findings of the Ferris Meadow Lake Options Appraisal and explains why the preferred option has been chosen.

Option 1 is the preferred option because it performed better overall in the appraisal than the other eight options, while also continuing to allow for safe swimming in the lake, which was a concern identified in the feedback received during statutory consultation.

Option 1 performed best against the Technical and Feasibility Appraisal and Construction Costs criteria, while performing very well with regards to the EDP Appraisal, Environmental Appraisal, Planning Policy and Legislative Appraisal, and the Land Costs criteria. This is why Option 1 is our preferred option, with the next-best performing option (Option 7) being more expensive overall and having a significant legislative non-compliance risk. Each option's performance against the criteria is summarised below.

Table 9 below summarises the reasons why Option 1 is our preferred option with reference to each of the appraisal areas.

Table 9 - Summary of the Appraisal Outcomes

Appraisal Criteria	Summary of Appraisal Outcomes
Technical and Feasibility Appraisal	Option 1 performed best of all the options in the Technical and Feasibility Appraisal. This included being the easiest to build, having no impact on existing structures, having the smallest carbon footprint, and the lowest operational and maintenance requirements.

Appraisal Criteria	Summary of Appraisal Outcomes
Environmental Appraisal	The appraisal has demonstrated that Options 1 and 7 are the best-performing options overall environmentally. The key difference between them is that the appraisal of Option 1 identifies potential human health and socio-economic impacts from perceived risks to swimming, while the appraisal of Option 7 identifies a high risk to biodiversity, which could lead to non-compliance with the Habitats Regulations (in respect of the South West London Waterbodies SPA and Ramsar site). This analysis needs to be seen in the context that the Environmental Appraisal showed that in non-flood conditions, water quality in the lake for Option 1 is predicted to be 'Good' (equivalent bathing water standard) once the Scheme is operational. This would be a reduction in quality from the current level, which is 'Excellent', but Option 1 would allow for continued safe swimming in the lake.
EDP Appraisal	All of the options performed well in the appraisal against the project's EDP.
Planning Policy and Legislative Appraisal	The potential non-compliance of Option 7 with the Habitats Regulations would be a significant risk for the Scheme if that option were taken forward. Option 1 presents minor challenges in relation to compliance with national and local planning policy, but nothing that would present a significant risk to its implementation.
Construction Costs	Option 1 has the lowest estimated construction costs.
Land Costs[6]	Option 7 has the lowest estimated Land Costs, with Option 1 only slightly higher.

The following section summarises the appraisal outcomes for each of the nine options:

Option 1 (the preferred option)

This option requires the Spelthorne Channel to pass through Ferris Meadow Lake. It has been ranked the highest out of all options in the Technical and Feasibility

[6] The variable nature of these costs is set out in the assumptions in Section 5.6 of this report.

Appraisal. This option has the lowest construction costs. Land costs are slightly higher compared with those for Options 3, 6a, 6b, 7 and 8 and over seven times lower than those for Option 2.

During statutory consultation, there were a high number of responses opposing Option 1, with water quality and other environmental impacts to Ferris Meadow Lake featuring substantially within those responses. These responses should be seen in the context that the Environmental Appraisal – carried out since statutory consultation – showed that in non-flood conditions, water quality in the lake for Option 1 is predicted to be 'Good' (equivalent bathing water standard) once the Scheme is operational. This would be a reduction in quality from the current level, which is 'Excellent', but Option 1 would allow for continued safe swimming in the lake, with no risk to human health.

Option 1 performed very well with regards to the Environmental Appraisal. Of the 13 separate topics considered, all topics were rated as either green or amber, with no red RAG ratings assigned to Option 1.

The Water Quality Assessment has concluded that during augmented flow conditions microbes from the River Thames are unlikely to reach Ferris Meadow Lake in a viable state or large enough numbers to cause a risk to human health and would be expected to support a Bathing Water classification of at least 'Good' at the Ferris Meadow Lake.

The RAG ratings for water environment, health and socio-economics have been assessed as amber. This is on the basis that although the Water Quality Assessment demonstrates swimming could continue in Option 1 without risk to human health, it is understood that there may still be a perception of those risks which means that some swimmers may stop coming to the lake to swim, leading to an adverse health and socio-economic effect.

Option 1 is not expected to permanently impact the lake's ability to provide supporting habitat for the South West London Waterbodies SPA and Ramsar site and any temporary effects would be able to be mitigated by suitably timing the construction.

Option 1 performed best against the Technical and Feasibility Appraisal and Construction Costs criteria, while performing very well with regards to the EDP, Environmental Appraisal, Planning Policy and Legislative Appraisal, and the Land Costs criteria. This is why Option 1 is our preferred option, with the next-best performing option (Option 7) being more expensive overall and having a significant legislative non-compliance risk.

Option 2

Option 2 allows the Scheme's channel to bypass Ferris Meadow Lake, which attracted significant support during statutory consultation because this option would maintain the water quality in the lake, whereas it was perceived that other options

would not. However, concerns about other options posing a risk to human health due to changes in the water quality at Ferris Meadow Lake were not realised.

Furthermore, Option 2 does not perform well against the appraisal criteria. Its construction would be complicated due to the close proximity to properties along the Chap, the need to realign Ferry Lane, and major construction in the area of landfill. There are also health and safety concerns with introducing high speed water flows into the Chap.

Environmentally, there is high risk within the Landscape and Visual topic due to the widening of the Chap and the altering of its setting from the existing contained, quiet, wooded and vegetated character with the moored sailing craft to a broader, larger scale, more open channel and a relocated sailing club. The loss of a backwater habitat results in a high risk for biodiversity. There is also a high risk for impact to soils and land due to the construction of a larger water control structure and wider flood channel within an area of historic landfill.

Land costs are estimated to be very high due to the large number of landowners affected. The design would require garden land, which is generally more valuable. The permanent acquisition of garden land also potentially reduces the value of the associated property (known as ‘marriage value’), which adds to the overall land costs.

For these reasons, Option 2 is not the preferred option.

Option 3

This option also allows the Scheme’s channel to completely bypass Ferris Meadow Lake. It performs just slightly better than Option 2 against the Technical and Feasibility Appraisal. This option performs poorly against the materials management criteria due to it requiring the largest excavation both to the east of Ferry Lane (channel excavation connecting to the River Thames) and the west of Ferry Lane (channel and weir construction). The carbon footprint is significant as it requires sheet piles to both side of the channel and bed protection due to high flow speeds, which all contribute to this option having the third highest costs.

Environmentally, there are high risks as this option would cause the greatest loss of SNCI habitat of all of the options due to the large amount of land needed to excavate the new channel and concerns over visual impact of the sheet piled channel in this setting. As with Option 2, there is a high risk for impact to soils and land due to the construction of a larger water level control structure and wider flood channel within an area of historic landfill.

The route of the proposed channel to the south-west of Ferris Meadow Lake would make it more difficult to have the proposed active travel route passing through this section and linking to the proposed bridge over the River Thames. There would likely have to be some infilling of the lake edge in order to achieve this alignment.

For these reasons, Option 3 is not the preferred option.

Options 4 and 5

As a result of their poor performance in the Technical and Feasibility Appraisal, it was concluded that Options 4 and 5 should both be rejected.

This is because Option 5 presents major concerns on buildability with the challenges of construction of such a large diameter tunnel in this location. There is uncertainty on the technical feasibility of this tunnelling option, due to underlying aquifers and ground conditions. Construction costs are likely to be extremely high for a tunnel of this scale and would be much more expensive than all other options.

Option 4 requires construction in two separate sections and hence has a significant carbon impact, materials management concerns, construction complexities and has most of the issues of both Options 2 and 3 but combined in one option.

For these reasons, neither Option 4 nor 5 are the preferred option.

Option 6a

This option continues to allow the Scheme to flow through the lake in flood events, but the augmented flow would pass through the Chap into the River Thames. However, it is important to note that unlike option 6b there is no gated structure to fully prevent flow to the lake. It did fare reasonably well in the technical and feasibility assessment.

Option 6a has a significant issue regarding utility diversions. As well as the diversions required in Options 1, 3, 7 and 8, the gas main and foul water main inside the existing Ferry Lane culvert may need diverting to avoid damage and debris snagging and potentially a second pumping station installed for the foul water main to the north.

It is also the case that a definitive flow separation between the Scheme's augmented flow and Ferris Meadow Lake could not be guaranteed, so may not reduce concerns over water quality. The environment assessment has rated the topics of health, socio-economics and water environment as a medium risk, which is the same as Option 1.

This option provides little change compared with Option 1 in terms of preventing the Scheme's flows from entering Ferris Meadow Lake. It therefore is not considered worthwhile taking forward, particularly as it is more expensive.

For these reasons, Option 6a is not the preferred option.

Option 6b

This option would allow the Scheme to flow through the lake in flood events, but the augmented flow would pass through the Chap into the River Thames the rest of the time. This option has a fully gated flow structure across the full width of the Spelthorne Channel to enable closure of flow to the lake, meaning that the augmented flow from the River Thames would not impact the lake's water quality during normal conditions. In the technical and feasibility assessment one area where

this option performed poorly was operation and maintenance due to the addition of this large gated structure requiring operation along with the other Scheme intake structures. The operation of the intake would need to be carefully managed to ensure it is opened when the Scheme is in operation during flood conditions. Failure to manage it correctly would prevent the flood flow entering Ferris Meadow Lake and cause flooding upstream. Ongoing maintenance of the gated structure would be essential.

Another major issue with this option is the utility diversions that are required. As well as the diversions required in Options 1, 3, 7 and 8, the gas main and foul water main inside the existing Ferry Lane culvert may need diverting to avoid damage and debris snagging and potentially a second pumping station installed for the foul water main to the north.

Construction costs are high, even though land costs are not expected to be significant.

No high environmental risks have been identified with this option.

For these reasons, Option 6b is not the preferred option.

Option 7

This option requires the Scheme's channel to pass through Ferris Meadow Lake as with Option 1 but includes a division of the lake in the form of a bund constructed with sheet piles and fill material.

This option was ranked second-highest in the Technical and Feasibility Appraisal and achieved only green or amber RAG ratings.

Environmentally, the option is similar to Option 1 but with some key differences. The RAG ratings for water environment, health and socio-economics are green whereas they are considered to be amber for Option 1. This is on the basis that although the Water Quality Assessment demonstrates that swimming could continue in Option 1 with no risk to health, it is understood that there may still be a perception of those risks which means that swimmers may stop coming to the lake to swim, leading to an adverse health and socio-economic effect. In Option 7, channel flows do not enter the north-east part of the lake, thus neither real nor perceived health risks would not apply to that area, and so is considered to perform better than Option 1 in these topics.

Option 7 has one topic RAG rated at red, which highlights the high risk of impact to biodiversity. This is because splitting the lake in two is likely to reduce the lake's function as a supporting waterbody to the South West Thames Waterbodies SPA and Ramsar site and potentially cause adverse effects to the integrity of that site. Evidence to show that there are no satisfactory alternatives to Option 7 is likely to be required if this option is selected. This would be unlikely to be achievable given the range of options being considered which have a reduced impact on the SPA and Ramsar and so there is a risk of non-compliance with the Habitats Regulations with Option 7. This would be a significant risk for the Scheme.

Construction costs for this option are very high due to the sheet piled bund structure across the lake. Constructing in water would make it more complex and expensive. The bund would also increase the carbon footprint compared with Option 1. The bund needs to be a substantial structure because the lake is deep. There could be some reduction of costs if the bund could be reduced in length during design development and consultation with the lake owner, but these are not thought to be able to make a significant difference.

Overall, the appraisal process has shown Option 7 fared well in the Technical and Feasibility Appraisal and well in the Environmental Appraisal. Furthermore, the estimated construction costs are more than £16.5 million greater than Option 1 and Option 7 has a slightly higher carbon cost, which does not align with the Scheme Goals. However, the most significant issue with Option 7 is that it could lead to compliance issues from a Habitats Regulations perspective, which would be a significant risk to the Scheme's consent.

For these reasons, Option 7 is not the preferred option.

Option 8

Option 8 has the Scheme's channel passing directly through Ferris Meadow Lake, with an open link to the River Thames. It performed fairly well in the technical appraisal (slightly less so than Option 7) and construction and land costs are not significantly higher than Option 1. However, environmentally, it has been assessed to have several high risks associated with it.

The open connection to the River Thames from Ferris Meadow Lake is expected to cause large permanent changes to Ferris Meadow Lake water quality and hydromorphology. It could cause a reduction in the lake's ability to be a supporting habitat of the South West Thames Waterbodies SPA and Ramsar site, which may result in an adverse effect on the site integrity of the SPA. As with Option 7, evidence to show that there are no satisfactory alternatives to Option 8 is likely to be required if this option is pursued. This would be unlikely to be achievable given the range of options being considered that have a reduced impact and, as such, there is a risk of non-compliance with the Habitats Regulations with this option. This would be a significant risk for the overall Scheme.

With regards to health and socio-economics, the unrestricted flow of River Thames water into Ferris Meadow Lake (as compared to journeying down the Spelthorne channel) would have the potential for permanent impact to water quality in the lake and the Shepperton Open Water Swim business.

As with Options 2 and 3, there is a high risk for impact to soils and land due to the construction of a large water control structure and wider flood channel within an area of historic landfill.

For these reasons, Option 8 is not the preferred option.

Contact

If you would like to contact us outside of your response to this consultation, you can use one of the options below:

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