

## Havant Thicket Reservoir

# Section 73 - Engineering & Design Report Addendum

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## Document Control

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# 1. Project Overview

## 1.1. Introduction

1.1.1. The goal of the Havant Thicket Reservoir (HTR) project is to provide a new resource to supply drinking water in the water-stressed South East of England, while maximising the community and environmental benefits of a new raw water reservoir.

1.1.2. The key elements of the scheme are as follows:

- Havant Thicket Reservoir for raw water storage. complete with control house, visitor centre and recreational facilities for public amenity (Section 2 of this report).
- A new pipeline from Bedhampton and Havant Springs to the reservoir site to allow the reservoir to be filled and for stored water to be provided for public water supply (Section 3 of this report).

1.1.3. This report is an addendum to the Engineering and Design Report and provides updated details of the preliminary engineering design of the main embankment elements of the scheme and supports the section 73 planning application for changes to the main reservoir embankment, outlet culvert & valve tower.

1.1.4. Chapter 2 of this Development Specification addendum describes the principal components of the Scheme for which are updated as part of the section 73 application.

1.1.5. Chapter 3 sets out key design principles, actions and commitments which planning applications for reserved matters will be required to comply with.

1.1.6.

## 1.2. Project Drivers

1.2.1. Portsmouth Water's Project Drivers provide the high-level framework guiding the project. These drivers have informed the Design Principles which were developed to inform the reservoir design. Other drivers influencing the scheme design include the planning policy framework, which sets out the criteria against which the planning applications will be determined, and the planning application strategy, which identifies the level of detail required to inform the planning applications.

### Portsmouth Water's Project Drivers

**Quality:** Quality in procurement. design and delivery to deliver an exemplar project to serve Customers in the short, medium and long term.

**Timeliness:** In service and operating by 2029 to support a major bulk transfer to Southern Water. Deliver efficiency in procurement.

**Innovation:** Develop best practice in the largest new reservoir project in the South East for decades. Capture learning from companies working in partnership deliver better value for customers.

**Flexibility:** Create a project that offers multiple uses and enables the Company to be a strategic water supplier for the South over the medium and long term.

**Responsibility:** Realise and build upon our health, safety and well-being goals.



**Connectivity:** Positive connection for all stakeholders - Customers, the local community, regulators, staff, contractors, shareholders, commercial partners, environment groups and individuals with a passion for the environment.

**Environment;** A positive contribution to local and internationally Important habitats. Direct support for Government's objective to reduce the damaging abstraction of water from rivers.

### Design Principles

1.2.2. As part of the design development, Design Principles were agreed to inform development of Scheme components ensuring that they reflected the project drivers, relevant legislation and policy, Portsmouth Water and stakeholder aspirations, constraints and opportunities:

- Create a safe environment to work and play. Use creative and intelligent design to minimise any short and long-term health and safety issues.
- Maintain and Integrate with the rural landscape character and woodland setting, through the design layout and material selection process, and where possible developing soft engineering solutions - limiting structures and ancillary clutter.
- Design to be sympathetic to and blend in with the historic park and gardens landscape. Specifically considering impact on setting and views to and from the designated sites including the Grade II listed park and gardens, conservation area and South Downs National Park.
- Design to minimise whole life costs such as maintenance and need for replacement ensuring durability in a challenging public setting and flexibility in the design to manage future requirements.
- Maintain and enhance public access to the site, optimise opportunities to link to existing walking, cycling and bridleway routes.
- Design of the site and all facilities for all ages and abilities.
- Incorporate recreational facilities that are in keeping with the quiet enjoyment of the countryside setting, optimising health and wellbeing opportunities.
- Optimise educational opportunities in all design elements.
- Maximise opportunities for biodiversity in the design of the landscape and buildings and minimise and mitigate any conflict with wildlife through forward planning.
- Where possible avoid ancient woodland, an irreplaceable habitat, and maintain a minimum 15m gap as buffer along the boundary.
- Incorporate public art into the design in an innovative and robust way.
- Optimise opportunities for a sustainable design where practical to Include:
- Improving energy efficiency in base design, consider decentralised low carbon energy sources to achieve an overall improvement in operational energy efficiency.
- Improving climate resilience of the reservoir, ensuring management of reservoir flows, considering whole life sustainability impacts.
- Minimising material quantities as much as possible and select alternative low carbon materials in design wherever possible.
- Support the UK's Net Zero Carbon target by minimising where practical greenhouse gas emissions at all stages of the infrastructure lifecycle, and maximising opportunities for greenhouse gas removals through sequestration by vegetation and renewable energy generation.
- Design infrastructure which is resilient to expected climate change and extreme weather

events.

### Planning Policy Framework

1.2.3. National and local planning policy identifies what should be included within any planning application and what the application will be assessed against. The table below summarises the key planning policy requirements and considerations which have been considered throughout the scheme development. These policies, and how the Scheme meets them, are considered in more detail in the Planning Statement which accompanies the planning applications.

**Table 1 Key Planning Policy Requirements**

| Policy Themes          | Summary of key policy requirements/ considerations                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Leisure and recreation | <ul style="list-style-type: none"> <li>• An attraction for local communities</li> <li>• Network of connected paths for walking, cycling and horse riding</li> <li>• Green infrastructure links</li> <li>• Maximise opportunities for deprived areas</li> <li>• Opportunities for an improved quality of life</li> <li>• Provision of new facilities to promote tourism</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Environment            | <ul style="list-style-type: none"> <li>• Avoid potential adverse impacts on wildlife sites, protected species and priority species</li> <li>• Create additional habitats</li> <li>• Compensate for loss of habitats and woodland</li> <li>• Avoid habitat fragmentation and severance of species migration and commuter routes</li> <li>• Consider opportunities for biodiversity enhancements at reservoir and along hermitage stream</li> <li>• Improve network of multi-functional green and river corridors</li> <li>• Minimise impacts on Langstone and Chichester harbours and hermitage stream</li> <li>• Minimise the risk of flooding</li> <li>• Avoid great copse</li> <li>• Consider the predicted future impacts of climate change</li> <li>• Consider renewable energy</li> <li>• Improve local air quality</li> <li>• Minimise noise pollution</li> </ul> |
| Transport              | <ul style="list-style-type: none"> <li>• Minimise construction traffic</li> <li>• Restrict the use of public vehicular traffic within the site</li> <li>• Ensure appropriate means of access</li> <li>• Promote sustainable transport</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |

Heritage and  
Landscape

- Protect and enhance the conservation area
- Integrate the reservoir and new landscape within the historic landscape and existing woodland
- Minimise impact on Staunton country park and setting of south downs national park
- Protect rights of way

## 2. Havant Thicket Reservoir

### 2.1. Overview and Design Parameters

2.1.1. Section 2 of this report sets out the design of the key elements of the proposed Havant Thicket Reservoir and associated engineering works relevant to the section 73 application, including:

- The embankment structure including the alignment route and reservoir capacity: geotechnical design for stability
- The outlet culvert structure
- The valve tower structure
- The control house and associated ancillaries Including the functional requirements for the building and the emergency drawdown discharge chamber at the reservoir;
- Public realm.

#### Design Parameters

2.1.2. The Basis of Design parameters of the current reservoir and embankment design proposed for the section 73 planning application are given in Table 2.

**Table 2 Basis of Design Parameters**

| Element            | Parameter                                                                                                                                                                                     | Level of Detail | Performance Criteria                                                                                                             |
|--------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|----------------------------------------------------------------------------------------------------------------------------------|
| Reservoir capacity | Minimum required total capacity: 8,700 million litres.<br>Maximum capacity: at least 9,000 million litres, up to a Top Water Level (TWL) of 39.5m AOD.                                        | Fixed           | Minimum required total capacity: 8,700 million litres.                                                                           |
| Supply Rate        | Output Capacity: at least 21 Ml/d in extreme (currently defined as 1:200 year) drought conditions.                                                                                            | Fixed           | 21 Ml/day over the reservoir operational envelope. Flow rate measured at reservoir control house and Bedhampton Pumping Station. |
| Embankment         | Max 20 m high.<br>Crest level 40.5 m AOD.<br>Length 2,800 m.<br>Inside slope: to range from 1:7 to 1:8.<br>Outside slope: majority 1:7 to 1:9.<br>Outer toe (edge): +/- 2 m horizontal range. | Outline         | Embankment slope stability factor of safety to be minimum 1.1-1.5 for the "end of construction" case.                            |

| Element                                      | Parameter                                                                                                                                                                                                                                                                                                                                                                  | Level of Detail | Performance Criteria                                                                                                                                      |
|----------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                              | Crest line position: +/- 20m horizontal range from that shown on drawing HTR-COF-EM-RE-DR-GE-4002 to accommodate any potential alignment change.                                                                                                                                                                                                                           |                 |                                                                                                                                                           |
| Embankment adjacent to Staunton Country Park | Toe (edge) of the embankment is fixed at a minimum of 25 m from the edge of woodland along the southern boundary of the Site (known as Hammond's Lands Copse). Embankment with slope varying from 1:8 to 1:9.<br><br>Staircase detail along alignment of The Avenue joining pedestrian access from Staunton Country Park with viewing area at the crest.                   | Fixed           | Embankment slope stability factor of safety to be minimum 1.1-1.5 for the "end of construction" case.                                                     |
| Top Water Level (TWL)                        | 39.5 m AOD.<br><br>1.0 m freeboard (height from TWL to embankment crest) to prevent/limit overtopping.                                                                                                                                                                                                                                                                     | Fixed           | 1.0 m freeboard (height from TWL to embankment crest) to prevent/limit overtopping.                                                                       |
| Spillway/overflow                            | 3 m long weir/700 mm diameter pipe.                                                                                                                                                                                                                                                                                                                                        | Fixed           | Spillway to pass Design Flood (DF) and Safety Check Flood (SCF) with minimum flood freeboard to prevent overtopping due to waves.                         |
| Slope protection material                    | Range of up to 450 mm thick layer of protection. Rip-rap (rock armour). Rock mattresses would be brushed with topsoil allowing planting with aquatic/marginal species such as reeds and sedge grasses.                                                                                                                                                                     | Fixed           | Wave action contained below crest level during design flood, for the highest likely upstream slope.                                                       |
| Lowest Operating Level                       | 27.5m AOD.<br><br>Lowest 20% to be considered dead storage, minimum level before reservoir operationally fails.                                                                                                                                                                                                                                                            | Fixed           | Lowest 20% to be considered dead storage, minimum level before reservoir operationally fails.                                                             |
| Emergency drawdown facility                  | Discharge capacity of 10.9 m <sup>3</sup> /s<br><br>Reservoir can be lowered by 1/3 of water depth in 6 days.<br><br>1.4 m diameter scour pipe and submerged discharge valve discharging into Riders Lane Stream at the proposed control house.<br><br>1.2 m diameter inlet /outlet pipe discharging into the Hermitage Stream 3km downstream                              | Fixed           | Installed drawdown rate following Environment Agency guidance to be 0.85m in first 24 hours (5% of reservoir depth) Time to lower 1/3 of the water depth. |
| Control house                                | Maximum width of building frontage: 33 m.<br>Maximum height of building wall above external ground level: 6m (excluding security fence).<br>Schedule of accommodation: total area approximately 567 m <sup>2</sup> (excluding courtyard).<br>Reinforced concrete outer structure with cladding, composite roof slab with green roof, steel frame/blockwork internal walls. | Outline         | Functional requirements and accessibility, security classification from Security and Emergency Measures Direction (SEMD) assessment.                      |
| Viewing Area                                 | Location along the western boundary and outline design.                                                                                                                                                                                                                                                                                                                    | Outline         |                                                                                                                                                           |



## 2.2. Reservoir Embankment Structure

### Sustainability and Environment

2.2.1. The embankment design has been progressed with the key design philosophy which can be summarised as:

- Materials to be used in the embankment will be sourced from site as much as possible
- Off-site disposal of materials found on site will be avoided as much as possible
- Materials will be selected that will be sustainable and suitable for the rural context of the reservoir in a country park. Importing of materials not found on site will be minimised as much as possible; where required the aim will be to utilise local sources where appropriate
- The embankment has been designed to integrate with the natural landscape, taking account of the design principles in section 1.2 and slope gradients that reflect the local landform. Changes associated with the Section 73 application reduce slope angles to more natural 1:7-1:9 profile.
- Realignment of the embankment to respond to environmental constraints such as minimising the loss of ancient woodland at The Avenue and Round Wood, and avoiding ancient woodland on the site boundary through and avoidance of root protection zones.

### Health and Safety

2.2.2. Health and Safety by Design principles have been applied in the design and planning of the embankment construction. Key risks have been identified as:

#### Construction

- Flooding of borrow pits during construction from flow from northern streams – to be mitigated by the temporary diversion of the stream routes running through site to allow flow of upstream catchment area to mostly bypass the footprint of the reservoir. In addition, temporary surface water management of the site will ensure that a minimum catchment of water upstream of the borrow pits are able to enter them. This will be via a series of small to medium sized ditches to redirect the water from the site into the surface water management system, and onwards to the outfall location, again mitigating the risk of borrow pit flooding.
- It was originally envisaged that the wetland retaining structure would be utilised for attenuation purposes, however during design development this has been adapted to maintain stream inflows through site in key locations to aid surface water management and minimise the temporary impact of flows through the site
- Large flood events in the catchment during construction will be diverted out of site through the culvert.

#### Operation and Maintenance Risks

- Erosion of upstream face of the embankment – mitigated with slope protection material



- Overturning of grass cutting equipment on embankment – mitigated by considering new equipment such as remotely controlled lawnmowers to manage slopes up to 1:8

#### Public Amenity Use

- Risk of small children falling into reservoir – mitigated by safety fence with mesh on the embankment crest.
- Risk of drowning – further consideration to be given as develops through a PRSA (Public Safety Risk Assessment). This will incorporate consideration of guidance from the Environment Agency and best practice from similar assets including education in local schools on risks of swimming in deep ocean water, need for appropriate signage and public safety measures e.g. life rings

2.2.3. Dam safety has been ensured by compliance with the Reservoirs Act (1975) whereby an All Reservoirs Panel Engineer has been involved in supervising the design and a Construction Engineer will be appointed under the Act to supervise construction

2.2.4. The design is also reviewed by an independent Panel of Specialists including an All Reservoirs Panel Engineer

#### Buildability

2.2.5. A construction sequence has been developed which informs the embankment design and vice versa. Environmental constraints in the programme have been a key consideration in this process. Managing protected species on the reservoir site, specifically within woodland areas, has influenced the timing and distribution of the earthworks construction on site.

2.2.6. Considerations of buildability and associated safety issues have influenced proposed design changes, including:

- Relocation of the reservoir culvert to avoid groundwater issues and instability of the ground along the route proposed in the reference design
- Movement of the valve tower out of the core of the embankment, to provide an uninterrupted core of homogenous material along the full length of the main embankment

#### Innovation

2.2.7. The design of the embankment and associated structures has been carried out using an interface of several 3D modelling platforms:

- Civils 3D for modelling of the existing ground strata, allowing design of the borrow pit and cut/fill balance;
- Civils 3D allowing rapid measurement of reservoir volumes stored by embankment realignment options, and reduction in embankment volumes through realignment, notably south-west and eastern sections;
- Navisworks for a combined federated model;

## Embankment Alignment

2.2.8. The initial reference design alignment was based on surveys including ground investigations which were carried out over several years. In the last years following this, Future Water have completed extensive additional ground investigations, produced a detailed topographical survey and constructed a trial embankment, built using clay which was excavated from the reservoir site. This work has given us a more detailed view of the ground conditions and topography, and a greater understanding of how clay from this site behaves during and after construction. This information has been used to inform the detailed design of the reservoir and subsequently concluded that changes are necessary to the initial reference design. The changes to the reservoir embankment as a result of this are as follows and shown in Figure 1:

- Moving of the embankment crest and upstream toe further into the reservoir footprint, to maintain working room and limit loss of ancient woodland to the south of the site.
- Adjustment of the downstream embankment toe in the southwest corner between the culvert and spillway to account for discrepancies in the recorded topography and incorporate reduced slope angles.
- Extent of the main embankment increased on the north east corner, to accommodate updated topographical survey information and reduced slope angles

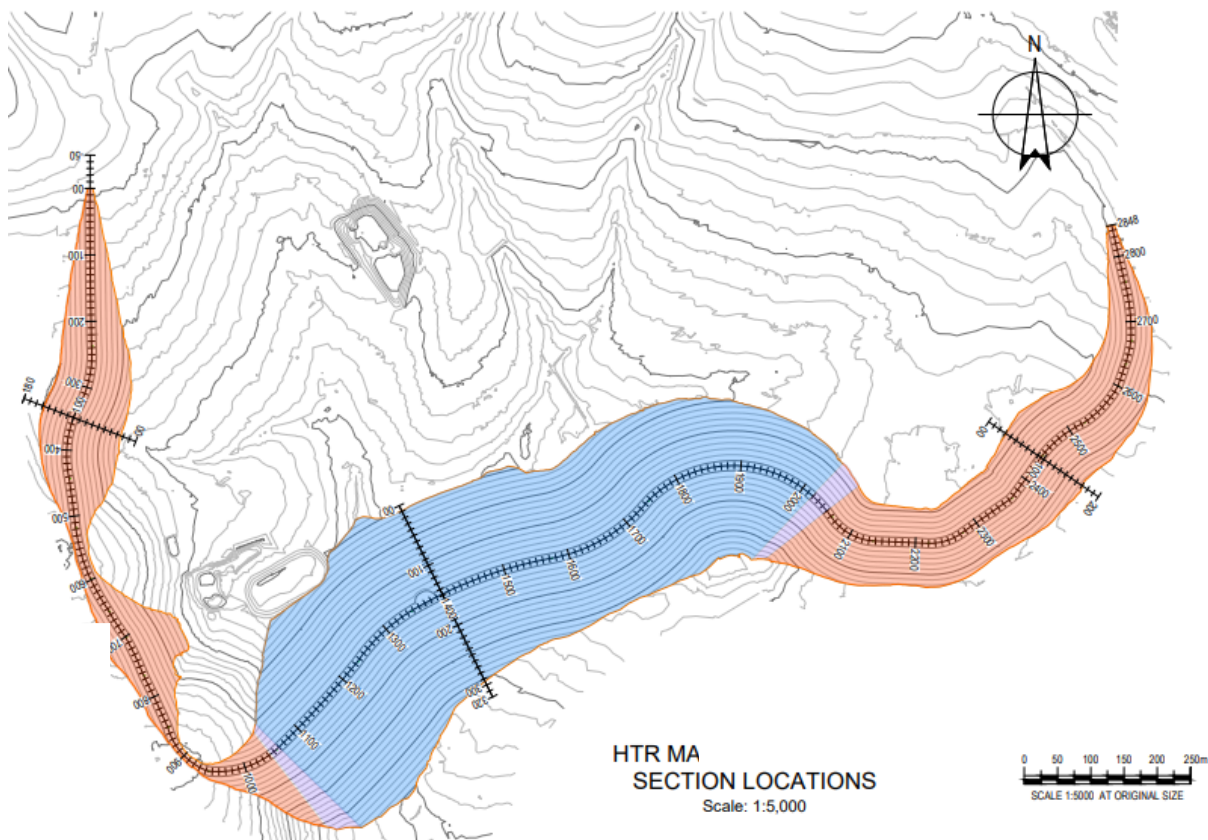


**Figure 1 - Embankment Alignment Design Evolution - 1:8 slope area (red) 1:8/9 transition slope area (purple), 1:9 slope area (Blue)**

2.2.9. The embankment slope change and alignment was designed in conjunction with the borrow pits to ensure a cut and fill balance and ensure minimal net change in reservoir volume.



## Flood Study

- 2.2.10. The initial assessment of freeboard was carried out using the results of the previous flood study at the time of the reference design (2007) and since then there have been significant changes to the guidance to assess the freeboard of reservoirs.
- 2.2.11. The 4th Edition of Floods and Reservoirs Safety (ICE, 2015) defines two assessment conditions: Design Flood (OF) and Safety Check Flood (SCF) which for a Category A reservoir are the 10,000 year return period flood and the Probable Maximum Flood, respectively. The OF must be discharged under normal conditions with a safety margin provided by an accepted freeboard limit. The SCF is defined as the flood beyond which the safety of the dam cannot be assured. which in practice means that small wave overtopping is tolerated for this event.
- 2.2.12. The 1m freeboard was re-assessed through a new flood study for the proposed arrangement of the reservoir, with a 1v:5h upstream slope lined with rip rap.
- 2.2.13. Reservoir Inflow hydrographs were derived and routed through the reservoir to evaluate the flood surcharge for the OF and SCF. An evaluation of the minimum flood freeboard and overlapping flows due to wave action were also carried out for these two flood conditions and also for a dry weather/extreme wind scenario.
- 2.2.14. The critical scenario for the assessment of the reservoir freeboard is the Design Flood. The 1m total freeboard is sufficient to contain the design flood surcharge (0.38m) and the significant wave height (0.53m). This currently allows 90mm for long-term settlement of the embankment height (and therefore freeboard) increased as required. The maximum flood rise for the SCF takes the peak water level to 39.96mAOD which is contained below the top of the embankment clay core at 40.00mAOD.
- 2.2.15. The overflow capacity of the reservoir relies mostly on the attenuation effect provided by the large surface area of the reservoir at TWL. The spillway weir was defined with a relatively small length of 3m to limit the discharges downstream. The maximum discharge for the SCF is 1.59m<sup>3</sup>/s. The proposed pipe to convey the flows from the spillway crest to Riders Lane Stream will be designed for this flow.
- 2.2.16. For the design of the temporary diversion works during construction, the 30 year flood was assessed, which represents a risk of exceedance of about 10% during the 3 years estimated for the construction. The conveyance capacity of temporary pipes in the culvert under the embankment would need to be provided by the contractor for the peak flow of the 30 year flood (4.6m<sup>3</sup>/s).

## Reduction in slope angle of the upstream and downstream slopes

- 2.2.17. As part of the embankment detailed design for the reservoir, slope stability analysis was carried out to assess the impacts of additional ground investigation information on the outline design. The analysis required that the slope angles be reduced to a range of 1:7 to 1:9, from 1:5 to 1:7.

## Slope Protection Material

- 2.2.18. An options exercise was undertaken to evaluate which materials would be feasible, sustainable and suitable for the rural context of the reservoir in a country park and conservation area. Materials considered were:
- Open Stone Asphalt (OSA)
  - Concrete Block Revetment (cable tied)
  - Rip-Rap (rock armour)
- 2.2.19. Following the results of the options exercise, rip-rap was chosen as the option to be implemented as protection to the upper embankment slopes
- 2.2.20. Low level erosion protection was also considered as part of the review process, to ensure that erosion would not impact the embankment during drought scenarios.
- 2.2.21. For low level drought erosion slope protection, Enkamat has been identified as the recommended proposal to be developed during design.

## Programme

- 2.2.22. The key programme phases for the work elements covered by the section 73 planning application at the reservoir are as follows:

**Table 3 Key Planning Policy Requirements**

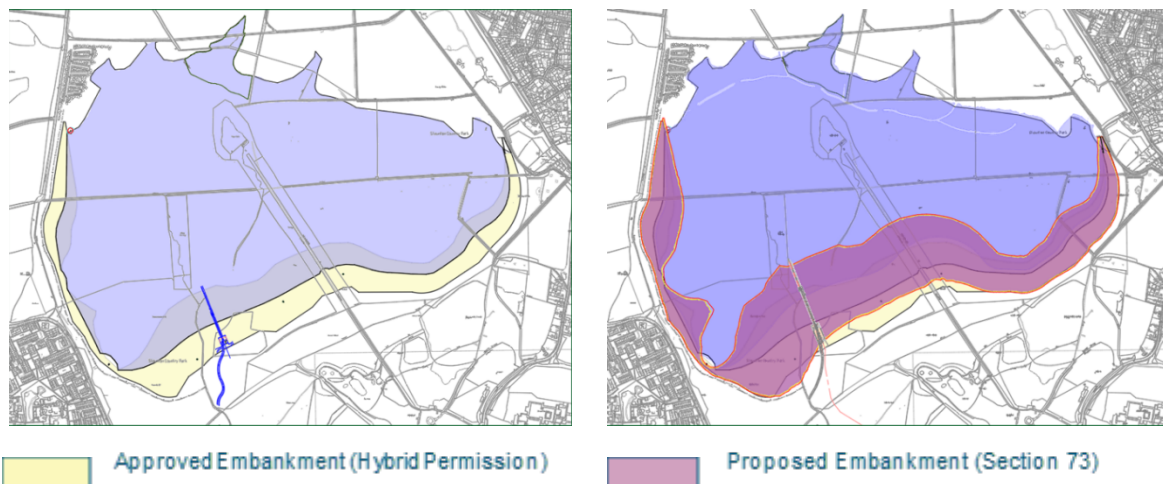
| Dates                      | Key Activity / Milestones                                                                                                                                                 |
|----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| October 2021               | Hybrid planning permission granted.                                                                                                                                       |
| Completed                  | Commence of works. Species relocation, tree felling, preparatory work on habitats avoiding breeding / nesting seasons, enabling works including access road construction. |
| August 2024 – August 2025  | Wetland retaining structure construction.                                                                                                                                 |
| August 2024                | Section 73 hybrid planning permission expected.                                                                                                                           |
| August 2024 – January 2026 | Culvert and valve tower construction.                                                                                                                                     |
| March 2025 – July 2028     | Construction of embankment and reservoir control house.                                                                                                                   |
| July 2025 – October 2025   | Southern access road construction                                                                                                                                         |
| May 2025 – August 2027     | Control house construction                                                                                                                                                |
| August 2028 – January 2030 | Emergency discharge structure                                                                                                                                             |
| Sept 2028 – July 2030      | Hard and soft landscaping                                                                                                                                                 |
| 2029 - 2031                | Filling of reservoir in stages with pumped water from Bedhampton Springs. Testing and Commissioning.                                                                      |
| TBC                        | Construction of visitor facilities.                                                                                                                                       |

## 2.3. Wetlands Retaining Structure

- 2.3.1. The wetlands retaining structure is not affected by the changes presented in this Engineering and Design Report Addendum.

## 2.4. Culvert and Valve Tower Structures

- 2.4.1. The vertical alignment has been designed so that the culvert base will be set at the base of the embankment core trench, meaning that it is not founded on build up material. This is favourable from an engineering perspective as it reduces the impact of ground settlement on the structure
- 2.4.2. The valve tower has been moved out of the core layers of the embankment in order to maintain an uninterrupted homogenous core along the full length of the main embankment. This is preferable from an engineering perspective as it improves safety, further reduces risk, and enhances the design.
- 2.4.3. As a consequence of the main reservoir embankment being realigned, and the embankment footprint increasing, the overall length of the culvert is proposed to increase by approximately 80 m as shown on drawings HTR-COF-EM-RE-DR-GE-4002 Main Embankment Proposed Site Layout and HTR-GHD-ZZ-RE-DR-Z-0003 Valve Tower and Culvert Site Layout.





## Functionality

2.4.4. The following functionality is required of the culvert:

- Provide route through the embankment for reservoir supply water to Farlington Water Treatment works via Bedhampton Pumping Station
- Provide route through the embankment for reservoir supply water to monitoring equipment at the control room
- Provide route through embankment for water during emergency drawdown scenarios
- Provide route through embankment for compensation flows to local Riders Lane Stream
- Provide primary dry means of access for inspection and maintenance of the main outlet pipe, between the bulkhead and control room structures
- Provide primary dry means of access to the valve tower for operation, inspection and maintenance of the high level & low level draw off valves

2.4.5. The following functionality is required of the valve tower:

- Provide dry area for manual operation, inspection and maintenance of high and low level draw off valves
- Provide a dry shaft to enable valves and pipework to be removed from when required in accordance with scheduled maintenance activities

## Structural Form

2.4.6. An options study was undertaken to optimise the structural form of the culvert structure. The two forms considered were a rectangular culvert as per the reference design, and an arched-shape culvert

2.4.7. An arch shaped culvert was chosen to reduce the thicknesses of concrete walls/ceilings, leading to an overall reduced volume of concrete and steel being required for construction.

2.4.8. A further options study was undertaken to establish the final form of the valve tower section. This was done retaining the reference design internal dimensions of 6m x 6m. The options considered were:

- Option 1: Square valve tower with no haunches, as per the reference design
- Option 2: Square valve tower with haunches
- Option 3: Square tower with faceted haunches
- Option 4: Circular tower of 6m internal diameter
- Option 5: Circular tower of 8m internal diameter

2.4.9. Option 5 was carried forward as the chosen design following a review of operation and maintenance activities, and additionally results in the use of less concrete and steel when compared to the reference design option. The diameter of the tower was selected due to the size and positioning of the pipework and valves within the tower and to allow for stepped access to the high-level draw off, from culvert level.

2.4.10. The options for square towers were rejected due to challenges associated with compaction around sharp corners and load distribution on flat surfaces .

- 2.4.11. 8m internal diameter was selected to allow for adequate space around the high level draw off pipework and valves to facilitate maintenance.

### Appearance

- 2.4.12. The culvert will not be visible normal operating conditions of the reservoir due to being within the embankment structure. A concrete inlet structure will be seen at the upstream toe of the embankment in the event that the reservoir is fully drawn down
- 2.4.13. The high level intake structure consists of a concrete headwall with rock lined channel extending to the face of the inner embankment slope. This structure will not be visible under normal operating conditions of the reservoir due to its positioning below the top water level. In drought scenarios where the water level drops below the intake structure; this will be visible.

### Accessibility

- 2.4.14. The culvert will be accessed via a stairwell in the control building. Internal stairwells in the valve tower will provide access to the high level draw off valves, continuing to the roof of the valve tower accessed through lockable covers.
- 2.4.15. The primary access to the valve tower will be via the control building and the culvert. Internal stairwells in the valve tower will provide access to the high level draw off valves, continuing to the roof of the valve tower accessed through lockable covers. The top of the valve tower can be accessed by boat, pontoon or other non-permanent method as secondary means of access in the case of an emergency, however, other options may be considered in the future, and if necessary, will be the subject of a future planning application.

### Health and Safety

- 2.4.16. Safety by design principles have been followed in the assessment of the location of the culvert and valve tower, with risks highlighted throughout a review process which engaged Portsmouth Water operations managers. Key risks have been identified as:

#### Construction risk

- Instability of ground close to river, covered in reasoning for relocation of culvert

#### Operation and maintenance risk

- Confined space created in culvert - mitigated by reducing frequency of access. Additional ventilation is being considered as part of detailed design
- Theft/ vandalism of assets resulting in injury to perpetrators, risk of fire - mitigated by locating key valves and equipment behind secure infrastructure interfaces (locked access covers, gates, access points etc)

### Buildability

- 2.4.17. The key design construction elements considered in the culvert and valve tower design included:
- Ground conditions along the culvert route, with the updated alignment being founded on undisturbed ground along the majority of its length to aid in reducing settlement
  - Timing of the construction of the culvert structure to begin in summer



- Minimising potential for differential settlement around the culvert and risk of initiation of piping / internal erosion mechanisms

## Innovation

2.4.18. The design of the Culvert and Valve Tower and associated structures has been carried out using an interface of several 3D modelling platforms:

- Civils 3D for modelling of the existing ground strata and proposed embankment, allowing for foundation levels to be determined
- Navisworks for a combined federated model to identify model clashes between multidisciplinary teams;
- Revit for the design of culvert and valve tower, allowing structural and mechanical design to be undertaken in 3D using standard industry components where possible.

## 2.5. Control house and associated structures

2.5.1. The control house is required to house operating equipment for the control of potential emergency discharge of the reservoir, and the routine operation equipment required for day-to-day running of the reservoir, including sampling instrumentation and mixing equipment.

2.5.2. The full details of the control house will be the subject of a separate Reserved Matters application, however, the outline details of its location have been amended to suit the realigned embankment, slope angle and culvert.

2.5.3. The total area of the control house has also been reviewed and based upon the information currently available it is proposed to increase the maximum floor space from 430m<sup>2</sup> to 567m<sup>2</sup> to accommodate the necessary equipment required for day-to-day running of the reservoir.

- Detailed design has determined that dual validation of all water monitoring instrumentation is required at the reservoir. Additional instrumentation was also determined to be necessary to monitor the water quality for operations. Therefore, the size of the water quality monitoring room has approximately doubled in size.
- Outline design provision did not provide geotechnical and structural monitoring equipment. Due to the limited ability to remotely measure some of this equipment, a sizeable monitoring room is required for these critical instruments. This requirement has been a at detailed design.
- No provision was allowed in the outline design for ventilation of the culvert and valve tower for personnel access. As these areas are a confined space, mechanical ventilation equipment is required to be improve airflow.
- Additional space is required for various service infrastructure such as a metering room and transformer. For aesthetics and noise reduction, this equipment is proposed to be housed inside the control building, increasing the required accommodation area.
- Additional space is required for back-up electrical systems to power critical gear such as actuators on the emergency discharge system.

2.5.4. The full details of the control house and its accommodation will be submitted as part of the separate Reserved Matters application.

## Control house functionality

- 2.5.5. The control house functionality remains unchanged by the changes presented in this Engineering and Design Report Addendum.

## Building design: Control house vision

- 2.5.6. The vision for the control house building design remains unchanged by the changes presented in this Engineering and Design Report Addendum.