Atkins

Hampstead Heath Ponds Project
Preferred Solution Report 5117039/62/DG/182 Rev 1

Contents

Executive Summary

The purpose of this report is to put forward the case for the preferred solution for each chain of ponds, and to give updates on refinements to the engineering design following environmental reviews, and the non statutory process of information giving and public consultation.

The report will describe the design development process that has been carried out since the Preferred Options Report of October 2013, including the development of environmental mitigation design. It will explain how new information, surveys and ideas have contributed to the development of the design.

The current version of the design is a complete cascade solution for each chain, drawing on feedback from both phases of the consultation (with the Ponds Project Stakeholder Group (PPSG) and with the wider public).

A brief outline of the preferred solution for each of the Highgate and Hampstead chains of ponds is provided below:

Note:
'Left hand' and 'right hand' describes the location of a feature of a dam when looking downstream, usually south, so 'right hand' usually means 'west end'.

Highgate Chain of Ponds: Option 6

- Stock Pond: Restoration of the dam crest and a new open grass spillway at the right hand end of the dam;
- Kenwood Ladies' Bathing Pond: Restoration of the dam crest and a new open grass spillway over the right hand part of the dam. Potential options for refurbishing or replacing the existing changing room building are being considered separately, pending a structural assessment of the adequacy of the existing building slab, beams and piles;
- Bird Sanctuary Pond: Minor restoration of the dam crest and relocation of the overflow pipe to the right hand end of the dam;
- Model Boating Pond: Raising of the existing dam by 2.5m with an earth embankment on the upstream side and a new open grass spillway over the raised and existing dams at the right hand end;
- Men's Bathing Pond: Raising of the existing dam with a maximum 1.0m high wall and a new open grass spillway at the right hand end;
- Highgate Pond No.1: Raising of existing dam with a maximum 1.25m high wall, and a new open grass spillway at the right hand end.

The preferred solution for the Highgate chain of ponds has been chosen because locating the major works at Model Boating Pond minimises the dam raising works required at Men's Bathing Pond and Highgate No.1 Pond which are more ecologically sensitive ponds.

Option 6 is preferred over Option 4, because the wall to raise the dam at Men's Bathing Pond is closer to the height of the existing fence than the 1.5m wall in Option 4, so the impact on views and the character of the pond is minimised.

Hampstead Chain of Ponds: Option M

- Vale of Health Pond: Restoration of the dam crest and a new open grass spillway at the right hand end of the dam:
- Viaduct Pond: Restoration of the dam crest and a new open grass spillway at the left hand end of the dam;
- Catchpit area: new flood storage dam up to 5.6m high, with an open grass spillway along the whole crest of the dam
- Mixed Bathing Pond: Existing dam raised by 1.0m, with a spillway over the majority of the crest of the dam;

- Hampstead No. 2 Pond: Restoration of the dam crest with 0.2m high edging, a new box culvert overflow at the right hand end with a dropshaft inlet
- Hampstead No. 1 Pond: A new box culvert overflow through the top of the embankment near the left hand end of the existing dam, and buried in the downstream slope.

The main amendment to Option M since the Preferred Option Report (October 2013) is the addition of the 0.2m high edging along part of the dam at Hampstead No.2, combined with a dropshaft inlet with the new box culvert overflow. These elements allow the reduction in total width of the new box culvert overflow by 50%. This is the most appropriate solution to minimise the impact on a number of plane trees whose roots would otherwise be potentially affected by the works at Hampstead No.2 Pond.

Option M has been selected as the preferred solution for the Hampstead chain because there is less dam raising involved. The 1m raising of the dam at Mixed Bathing Pond in Option M has less impact on views and the character of the pond than the 2m raising proposed in Option P, which would have required either retaining walls or encroachment into the pond. Similarly, a 0.5m high wall on the dam at Hampstead No.2 pond is avoided in Option M.

The key elements of Options 6 and M, such as the heights of raising the dams, are substantially the same as the Options presented in the Preferred Options Reports and at the non-statutory information giving and public consultation between 26th November 2013 and 17th February 2014.

However, some sub-options (such as alternative spillway locations) have since been investigated and the preferred sub-option selected, and these decisions will be explained in this report.

The reader is referred to the Constrained Options, Shortlist Options, Preferred Options Reports on the City of London's Hampstead Heath Ponds Project website for detail on the option development and design process leading up to this report.

Hampstead Heath Ponds Project home page:
http://www.cityoflondon.gov.uk/things-to-do/green-spaces/hampstead-heath/ponds-project/Pages/default.aspx

The following webpage is dedicated to the Preferred Options Report, issued in October 2013, and includes links to the comments and a log of questions and answers from the stakeholders, and wider public:
http://www.cityoflondon.gov.uk/things-to-do/green-spaces/hampstead-heath/ponds-project/Pages/Preferred-Options-Report.aspx

A glossary of terms is included on the Hampstead Heath Ponds Project home page: http://www.cityoflondon.gov.uk/things-to-do/green-spaces/hampstead-heath/ponds-project/Pages/default.aspx

The results of the non-statutory public consultation are summarised in a report at:
http://www.cityoflondon.gov.uk/things-to-do/green-spaces/hampstead-heath/ponds-project/Pages/Information-Giving-and-Consultation.aspx

1. Overview of Options Development Process

As in previous options reports, an overview of the process of engagement with stakeholders, Heath Staff, and the wider public, and how this has informed the options development, is shown in the flow chart in Appendix A **(Overview of Preferred Solution Development Process).** The process started with the problem definition stage, and has then progressed through three iterations of option development with stakeholders, the Heath Staff, and the wider public, culminating in a 12 week non statutory process of information giving and consultation by the City of London Corporation between 26th November 2013 and 17th February 2014.

While there was no clear preference between the various options consulted upon, there were a number of themes about design that emerged from the comments received, and these have been fed into the design process to date and will be taken forward as part of detailed design.

Problem Definition

The problem definition can be summarised as follows:

- Industry standard best practice guidelines state that the City of London should ensure the dams can pass the flows associated with the PMF safely. Moreover, the modelling showed that most of the dams will also be overtopped in very much smaller return period floods, from as low as a 1:5 year return period events. **Any size flood event, whether 1 in 20, 1 in 1,000 or the Probable Maximum Flood, could theoretically happen tomorrow**;
- This the capacities of the existing overflow pipes at each pond are too small, and the storage capacities of each pond, between the overflow level and the dam crest level, are not sufficient to deal with the floods without floodwater flowing over the dam crests onto the downstream faces;
- In most cases, overtopping of the dams is not acceptable because of the speed of flow and duration of overtopping, and also because of the tree cover on the downstream slopes of the dams which could concentrate water flow paths and could lead to erosion of the dam. There is therefore an unacceptably high risk of a breach of the dams leading to an uncontrolled escape of the stored water in the ponds;
- To make the ponds safe, spillways are required which would pass the excess floodwater safely round the dams. The design standard for these spillways is the Probable Maximum Flood, according to established industry best practice (Floods and Reservoir Safety, Institution of Civil Engineers, 1996).

Atkins have developed a preferred solution that virtually eliminates the risk of any dam breach caused by a flood within the Highgate and Hampstead chains of ponds, and the attendant risk to life and property downstream, in order to meet the City's existing obligations under the Reservoirs Act 1975, and expected additional obligations under amendments introduced by the Flood and Water Management Act 2010, whilst preserving the natural aspect and state of the Heath as far as possible, in accordance with the Hampstead Heath Act 1871.

Key Objectives

The preferred solutions meet the key objectives of the project identified in the options reports:

- They improve dam safety on all the dams in the chains;
- They maintain (or increase) the standard of protection downstream. In other words, the frequency of overtopping of the proposed spillways on the last dams will not be more than the frequency of floods that would cause overtopping of the existing dams;
- They do not increase the rate of flow discharged from the last dam in any flood event, compared to the flows expected in the existing scenario;
- They preserve the Heath as a natural open space.

Design Principles and Design Philosophy - An Overview

The project design principles and design philosophy have informed the development of the preferred solutions. The design principles and design philosophy summarised in the previous options reports have been retained and developed with feedback from engagement with stakeholders, Heath Staff, and the wider public, including the non-statutory public consultation, and having regard to the environmental considerations of each pond and the need to preserve the natural aspect and state of the Heath as far as possible, whilst ensuring that dam safety requirements are met.

These considerations include:

- Maintaining existing water levels and the distinctive character of the Heath and key views, and minimising the scale of intervention, and impact on visual amenity and the use of the Heath for all users – including swimmers, anglers, walkers and nature enthusiasts;
- Environmental management is an integral part of the project. In addition to improving water quality the project must ensure that, following construction work, reinstatement of the Heath's natural aspect takes place as soon as possible. The collaboration between technical specialists has already ensured that none of the options being considered preclude pond and terrestrial habitat reinstatement and restoration. The use of appropriate and natural materials and minimal intervention will be used to preserve the natural aspect and state of the Heath as far as possible.

Design Principles

Design principles that apply to the preferred solutions to enable integration of the dams with the Heath character include:

- Each chain of ponds is considered as a whole system, so that any significant increases in storage capacity are focused in the least sensitive locations, minimising the increases of dam height at more sensitive ponds, and reducing the impact of residual works required elsewhere;
- Each dam must be able to pass the design flood inflow safely, in accordance with Table 1 of 'Floods and Reservoir Safety' (ICE, 1996). For all dams, this is the Probable Maximum Flood (PMF) as they are all Category A dams where "a breach could endanger lives in a community downstream". A community is defined in 'Floods and Reservoir Safety' as 10 people or more;
- Tree loss is to be minimised to retain the character and natural aspect, of the Heath;
- Each preferred solution has been designed as a passive system to improve the resilience of the dams without reliance on any mechanical system (such as valves or pumps) or human intervention. The passive system of each preferred solution has been designed to pass excess flood water at each dam following these principles:

    1 A spillway is required at most ponds that will pass as much as possible of the PMF, depending on whether overtopping is tolerable (see Table 1 of 'Floods and Reservoir Safety', ICE, 1996.)
    2 Where overtopping of the dam crest is tolerable (which only applies to the dams at Mixed Bathing and Bird Sanctuary Ponds), and excess floodwater up to the PMF still needs to be passed over the dam crest, reinforcement works to the downstream face will be required to allow flow over part or all of the width of the dam crest.
    3 Where the overtopping of the dam crest is not tolerable, which applies to the majority of the dams (due to the number of trees on the crests and downstream slopes), some works to raise or restore the dam crests and create natural open grass spillway channels are proposed, to pass the PMF in order to minimise risk of dam failure. There is therefore a trade off at each pond between the amount of dam crest raising, and the width and depth of the spillway required to pass the PMF safely.

The design is constrained by these principles, which have a basis in legal requirements and standard dam safety guidelines.

Design Philosophy

The design philosophy of the preferred solutions is strongly influenced by the requirement to comply with the Hampstead Heath Act 1871, the City's Vision for the Heath, and the Hampstead Heath Management Plan. The solutions have also been influenced by feedback from engagement with stakeholders, Heath Staff and the wider public from engagement with stakeholders and the wider public, including the non-statutory public consultation.

The design philosophy includes:

- More storage capacity, which has been added in the middle of each chain of ponds for the preferred solutions to reduce the rate of flow of floodwater to the downstream ponds. The amount of works required to increase the resilience of the dams to overtopping has therefore been reduced in scale;
- Reinforcing the whole dam crests (and removing all trees on the dams) would not be required in most cases. Similarly works would only be required to install spillways, therefore preserving the majority of the trees on the dams;
- The water level has been retained in each pond to protect the visual amenity and character of the Heath. Any new spillway has been set above the typical water level of the pond in question, so that it would be normally dry and allow the spillway surface to be covered in grass. The nature of the grass mix (either plain 'amenity' grass, or 'native wildflower' grass mix) will depend on the expected speeds of water flows down the spillway in each case;
- 'Naturalised' spillways have been proposed in the optimum locations around the ends of dams, to minimise tree loss and visual impact. In addition to grass seeding on spillways, other environmental mitigation measures identified to integrate the works, and to retain the distinctive character of the Heath and key views, include planting on the upstream face of the dams and marginal planting eg reedbeds on the pond perimeter;
- The preferred solution design development has been constrained and informed by the existing environmental considerations and an overriding aim identified for each pond to reflect the unique landscape character of the pond. These distinct characteristics have informed the landscape design strategy to include earthmodelling and planting to integrate and soften the appearance of the dams and will be used to develop a planting list and materials palette that considers the type and finish of materials e.g. the potential type, colour, design etc. of potential cladding as the design progresses.

The ponds and pond margins provide diversity in aquatic and terrestrial habitat. These habitats need protection and monitoring to minimise the risk of habitat loss/damage and the risk of harm/disturbance to animals including the spread of invasive species. Where any potential detriment to these habitats is identified this requires mitigation and reestablishment to achieve a balanced ecology around the ponds.

Environmental mitigation* and compensation** measures have been considered collectively across the chains and are proposed as an integrated part of the options, including consideration of the engineering works (ie the permanent works) and the temporary construction impacts on the ponds. All pond restoration will be integrated with the existing form and function of each individual pond, and the approach to improve water quality.

Four approaches have been proposed to restore the ponds, whilst retaining each of their individual traits (so not all these treatments have been proposed for all ponds):

- Softening the edges and banks in their current locations;
- Softening the edges and banks by creating new margin in the pond;
- Softening the edges and bank by excavating new margin set back from the pond;
- Restoring by adding new islands or internal margins.

Note
**Environmental mitigation measures provide the environmental restoration local to construction, for example, replacement of lost waterside margin.*
***Environmental compensation involves measures in other ponds remote from the main work areas and may include sediment removal and creation of marginal habitats in other ponds.*

In addition to the pond restoration measures, further feasible water quality improvements have been identified for each pond to help comply with the Water Framework and Bathing Water Directives. These directives can be found under:

http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32000L0060

Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy

http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32006L0007

Directive 2006/7/EC of the European Parliament and of the Council of 15 February 2006 concerning the management of bathing water quality and repealing Directive 76/160/EEC

These include:

- The removal and consolidation of sediment, which can be relocated within islands, pond margins, and borrow pits excavated for dam material;
- The provision of reedbeds at the upstream end of each pond to trap sediment and stop it moving down the pond chain;
- Selective pruning back of overhanging trees to reduce seasonal leaf litter;
- Aeration of the ponds to improve dissolved oxygen content;
- Precipitation of phosphorous from the water column (a standard water treatment process) or locking of phosphorous in the sediment.

Incorporation of Suggestions from Consultation with Stakeholders, the Heath Staff, and the Wider Public

A number of suggestions have been considered as feasible and have influenced the design of the preferred solution for each chain of ponds. These include:

- Providing extra storage capacity by building a flood storage dam at the Catchpit Area in order to minimise works at the most sensitive ponds;
- Keeping the Kenwood Ladies' Bathing Pond changing rooms in the centre of the dam;
- Desilting ponds at the same time as the dam safety works. Complete desilting is currently planned for Stock, Viaduct, Mixed Bathing, Ladies Bathing and Men's Bathing Ponds. Partial desilting is planned for Model Boating Pond;
- Retaining the group of trees on the west bank of the Model Boating Pond and turning the area into a peninsula;
- Traffic management ideas, such as prohibiting the use of Millfield Lane or traffic across the Heath from one pond chain to the other;
- Modelling of options to reduce the loss of plane trees at Hampstead No 2 Pond;
- Adding an overflow pipe to Model Boating Pond, in order to reduce the spillway width;
- Widening the proposed reinforced spillway at Mixed Bathing Pond to reduce the dam raising;
- Relocating the overflow pipe between Bird Sanctuary Pond and Model Bating Pond.

Feedback from the Non-Statutory Public Consultation

There was a 12 week non-statutory process of information giving and consultation carried out between 26th November 2013 and 17th February 2014. The consultation sought views on the two preferred options for each chain of ponds.

Based on the responses received from those who completed a questionnaire (mainly people who live close to the Heath and who are regular users of the Heath) there is a strong body of concern about the whole project. These concerns are to do with increases in dam height and perceived negative impacts on the Heath's amenity (especially for swimmers), it's landscape or wildlife.

However, respondents from the downstream area in potentially impacted communities said that they supported the improved safety the work would bring. There are also a number of people who feel that the proposed works could create an opportunity for improvements to the Heath, especially for wildlife.

The comments received do help to develop a set of design criteria that are informing the preferred solution for the Highgate and Hampstead chains of ponds:

- Preference for natural style landscaping of earth banks and natural features over walls wherever possible;
- Paths to have proper surfacing;
- Access and safety of children, families and the disabled needs to be shown, especially, but not exclusively for the Model Boating Pond;
- The need to maintain the present visual rural / countryside landscape and current (or improved) amenity across the Heath;
- Opportunities to create and enhance wildlife habitat should be taken where possible;
- As far as possible views should be maintained.

These messages will be factored into the design wherever possible, and will continue to exert influence as we progress to detailed design.

Appointment of the Contractor

The contractor (BAM Nuttall) has recently been appointed. Their early involvement has already assisted the design process by providing positive contributions in relation to the buildability of designs, the assessment of construction impacts and the planning and execution of the ground investigation. Their proposals have evolved since the tender stage and have included developing the methods for removing silt from the ponds for use in landscaping and minimising tree loss at Hampstead No 2 Pond during construction. More details have been provided in Section 2.

The contractor has also started to assist Atkins through the provision of construction information for the preparation of the Environmental Impact Assessment (EIA) that will support the planning application. This construction information includes traffic management, working areas, delivery routes, vehicles and equipment, and methods of working.

The ground investigation commenced on the 24th March 2014 and is programmed to last approximately 10 weeks on site. While analysis of the results of these investigations will not be complete before the submission of the planning application, the initial findings from boreholes, window samples and trial pits will provide answers to key questions that affect the EIA and the planning statement, namely:

1. The suitability of the soil on the Heath for use in construction of the raising of Model Boating Pond dam and the Catchpit dam;
2. The size and location of potential borrow pits which will provide the material for the raised dams; and
3. The stable slopes, and therefore the plan areas (footprints), of the raised dams.

However, it is reasonable to expect that the land west of the Highgate chain ponds will be underlain by London Clay, volumes required have been calculated, and the current assumption is that all the fill material for the works can be obtained from sources on the Heath.

The final location of borrow pits cannot yet be decided, as the decision would be based on many factors including: proximity to construction areas to reduce transportation impacts, environmental considerations and the amenity of users and nearby residents.

Samples obtained during the GI are also being looked at by Museum of London Archaeology Services.

Further Survey Data

Since the Preferred Option Report (October 2013), new information informing the design of both dam safety works and environmental mitigation has included the following:

- A new topographical survey, covering larger areas than the previous survey, and providing more details on the locations of trees. When combined with the information from the tree survey undertaken to BS5837, this allowed the creation of root protection plans and informed decisions, including the exact position of spillways;
- Bathymetric surveys of the ponds, picking up hard and soft (silt) bed levels. This allowed the estimation of silt volumes;
- Silt testing in all ponds, indicating that all contaminants were inert or at non-hazardous levels, which informed the assumption that silt from the ponds can be disposed of within the Heath, subject to the granting of licenses from the Environment Agency;
- Species surveys, including roosting bats, bird nesting, great crested newts, and fungi, the results of all of which are informing the Environmental Impact Assessment (EIA);
- Cultural Heritage – assessment of the archaeological / built environment;
- CCTV survey of existing overflow and scour (outlet) pipes, which will allow detailed decisions on the future of pipes and the need for new pipes.

2. Details of Preferred Solution

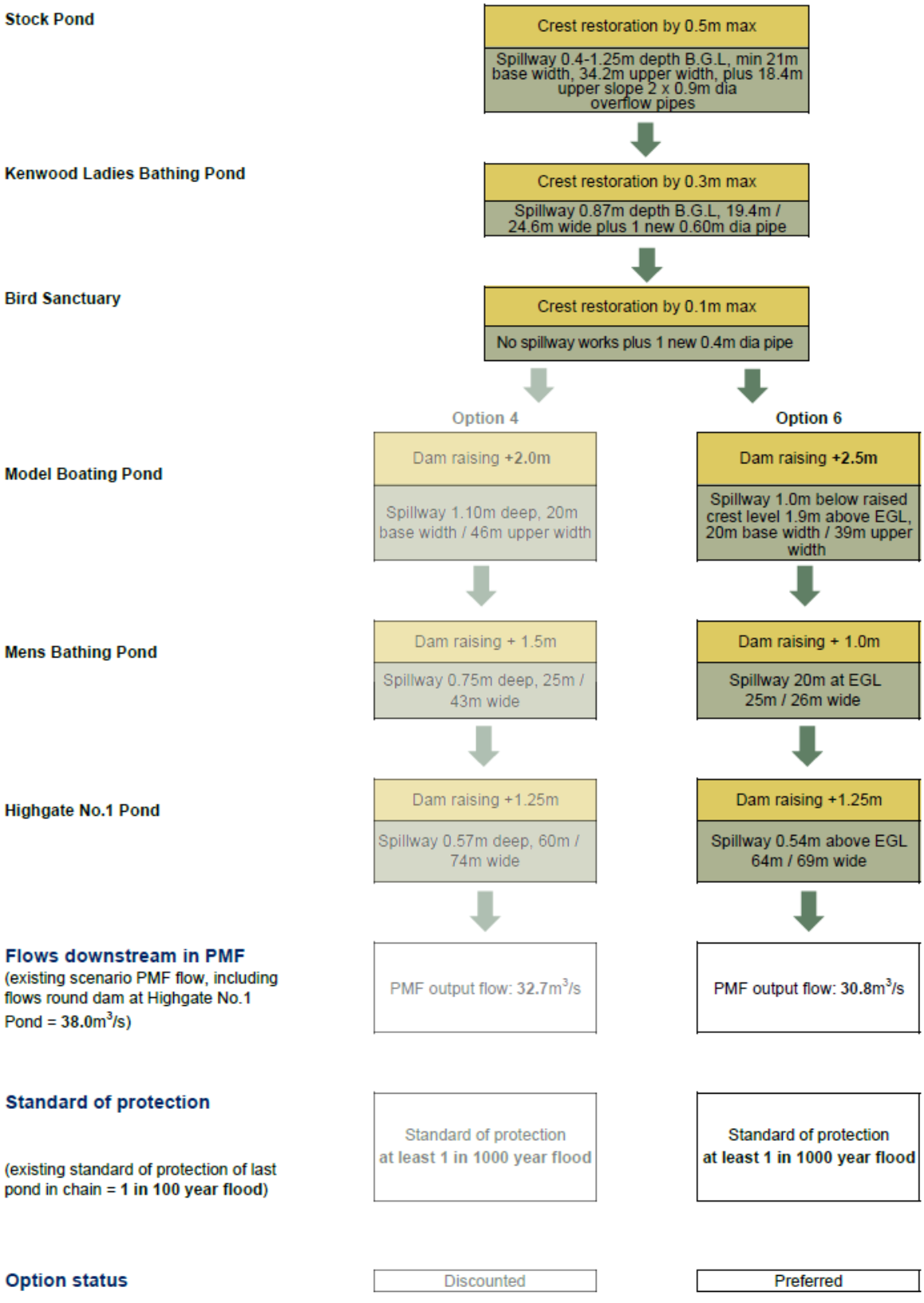
In this section, the preferred solution for the Highgate and Hampstead chains of ponds is described in a way which is consistent with the format of the previous options reports, but with some updates to details. These updates are informed by the development of the outline design and the results of the non-statutory information giving and public consultation.

Preferred Solution: Highgate Chain: Option 6 (2.5m raising at Model Boating Pond)

An options flowchart for the Highgate chain is shown below. This shows the same two options (4 and 6) that were selected for further development at the preferred options stage, but with some updates to spillway dimensions. These have been adjusted following amendments to the design which have been incorporated into the hydraulic model created in the earlier options appraisal stage in 2013.

Highgate Chain - Modelled Options flowchart

Preferred solution as at 14/05/2014



Stock Pond

Proposed works would include:

- Crest restoration of the dam. To limit the loss and pressure on trees on the upstream face, the crest height would be restored by up to 0.5m using fill (earth with stone surfacing). This would match the cover level over the outlet pipe, and continue that same level along the length of the dam until the transition point with Millfield Lane. At the left hand end of the dam a shallow bund would help tie the path in with the existing access and keep the works away from the root protection areas of the veteran trees on the western edge of Millfield Lane. To ease pressure on the trees on the upstream edge, the path along the crest would be shifted slightly to the south and retained along the downstream edge;
- An open channel, grass lined spillway, 21m wide at the base, would be located around the right hand end of the dam. The side slopes would be gentle at a maximum of 1:12 to maintain access along the footpath on the crest of the dam;
- Two new 0.9m overflow pipes, to run parallel to the existing overflow pipe;
- Removal of the silt.

The presence of Japanese Knotweed in the vicinity of the existing dam will require reducing / controlling as a consequence of the alignment of the spillway and raised section. By locating the spillway at the right hand end of the dam, the slope of the spillway would be reduced, and, therefore, the velocity of any overflowing water would also be reduced. This means that the lining material under the spillway can be thinner, and therefore would require shallower, less intrusive works.

Kenwood Ladies' Bathing Pond

Proposed works involve:

- Crest restoration by up to 0.3m using fill (earth with stone surfacing);
- Removal of the section of concrete slab on the dam crest, to provide a clear view of the dam crest;
- An open channel, grass lined spillway is proposed on the right hand part of the dam, adjacent to the building platform. The spillway would have sides sloping at 1:3, with an overall upper width of 24.6m;
- Potential options for refurbishing, or replacing, the changing room building are being considered separately, pending a structural assessment of the adequacy of the existing building slab, beams and piles. The design of this building is still being developed following consultation with the Kenwood Ladies Pond Association, and will be described in full in a separate feasibility report;
- Removal of the silt.

In either sub-option, the spillway would be excavated about 0.7m deep into the dam crest and the existing footpath to the western access gate potentially retained at the same level, approximately half way down the slope of the dam. The spillway would be lined with concrete cellular mats, which would be covered with topsoil and grass seeded, except along the existing footpath where the stone surface would be reinstated. A number of trees would be potentially removed from the dam along the cut, but not from the perimeter of the pond as these screen the pond from the other parts of the Heath.
The bathing pond would have to be temporarily closed for the works. However, the contractor has made suggestions for minimising this closure, including the use of prefabricated elements for both the above and below ground structures.

Bird Sanctuary Pond

Works at this pond have been minimised by raising the dam at Model Boating Pond (see below), so that the dam at Bird Sanctuary Pond would be submerged in large flood events. A new spillway would therefore not be needed, and engineering works would be limited to:

- Removal of the concrete outlet slab to the overflow pipe, and the part of the pipe which extends above the surrounding ground;
- A new overflow pipe to pass around the right end of the dam, to discharge into the widened part of the Model Boating Pond;

- Regrading (smoothing) of the grass downstream slope (on the Model Boating Pond side of the dam), and lining of the slope with a shallow topsoiled and seeded, turf reinforcement mat.

Model Boating Pond

The preferred solution is to maximise storage at this pond, by raising the dam by 2.5m, in order to minimise works at Men's Bathing Pond. It is preferable to raise the dam at Model Boating Pond because it is ecologically less sensitive than the other Highgate chain ponds, with fewer trees, so it has an open character allowing more space for the raised dam. It is the only pond where the perimeter is completely lined with sheet piles.

The works would include:

- Raising the existing dam by 2.5m. This raised dam would be built upstream of the existing dam, into the pond, and the ends of the raised dam would tie into high ground either side of the pond. The downstream face of the embankment set back slightly from the existing footpath would be 1:3 whilst the upstream face would be varied and graded between 1:3 and 1:6;
- An upper open grass lined spillway which would be formed by creating a lower section of the raised dam (i.e., the base of the new spillway is higher than the existing ground);
- A lower spillway which would be formed by lining the topsoil with a shallow topsoiled and seeded, turf reinforcement mat and a low earth bund to run down the slope of the existing dam between the trees. This bund would train flows away from the existing dam and over natural ground into Men's Bathing Pond;
- An excavation of the west bank of the pond. The primary purpose of this excavation would be to provide the majority of the material needed to raise the dam. The excavation would go around the group of lime trees on the west bank, to form an island. The deepest and widest part of the excavation would be at the northern end of the pond, where the ground is flattest;
- The lower footpath at the water's edge would be re-routed to encircle the widened pond that could connect with a new footpath on the raised dam crest;
- The upper footpath on the west bank would be re-routed to pass above the new spillway and the island;
- Removal of part of the silt, to create a firm foundation for the raised dam.

The sheet piles would be removed from the west bank to enable the excavation to take place, and on the south bank they would be buried by the raised dam. The sheet piles would be reinstated along the western edge and an intermittent platform created for marginal planting.

The cross section of the raised dam at Model Boating Pond shows how new footpaths on the water's edge and along the crest of the raised dam would allow continued enjoyment of views north across Model Boating Pond and south across Men's Bathing Pond and further to London. Access to the water's edge, which many people value as a unique feature of Model Boating Pond, would be maintained with a new footpath along a platform on the upstream face of the raised dam. This footpath would be at the same level (relative to the typical water level) as the existing one, and the clear views across the pond would be maintained by only planting short sedge grasses in a platform just below the water's edge, to retain the feeling of closeness to the water.

There is a potential to use the silt removed from the southern part of Model Boating Pond and treat it in geotextile bags by compression, drainage and addition of flocculants to separate out the silt particles. These silt bags when firmed could be used to create the planting platform just below water level. The use of these silt bags will be further investigated and confirmed at the detailed design stage.

The works will require part draining down of the pond, in order to build the raised dam. This would be achieved with a cofferdam (a temporary dam, formed of either sheet piles or an A-frame covered with tarpaulin). This would extend across the downstream (southern) end of the pond.

Informal public access to the island formed around the lime trees will be provided via a wetland causeway as discussed with stakeholders in May 2014 so that the island can be managed as a wildlife sanctuary.

The City of London, in consultation with the Anglers, is reviewing the fishing offer on Hampstead Heath to determine the ponds suitable for fishing, access requirements and stocking arrangements.

Men's Bathing Pond

The works would involve:

- Raising the dam with a maximum 1.0m high wall on the dam crest, to follow the line of the existing fence. This wall would be constructed using sheet piles, potentially either steel or plastic, and will be designed to be deep enough to reduce the leak, which may be related to the high proportion of gravel and brick fill found in the dam. The wall would be clad to the preference of the Heath users. This could for example, be timber cladding, which might be sourced from the Heath;
- A low (max 0.75m high) reinforced earth bund, at the right hand end of the dam. This would be steep on the upstream (pondside) face, but could have a gentler slope on the downstream side to blend with the natural ground;
- An open channel, grass lined spillway, which would be essentially a gap between the raising wall and the earth bund, and would be located at the right hand end of the dam. The base of the spillway would be at the existing ground level with some lowering of the natural ground at one end to form a 25m wide flat area. The spillway would be lined with a shallow turf reinforcement mat;
- A return wall, to retain and train flows over the spillway. To minimise effects on a large crack willow on the dam, this wall could be formed with H-section posts with timber panels, so that the posts would miss the structural roots of the tree;

To maintain the existing boundary fence across the spillway a fence will be designed to fail when loaded with floodwater. This design will be investigated at detailed design stage.

Option 6 has less impacts on Men's Bathing Pond in two ways. Firstly, the raising wall would be smaller in this option, at a maximum 1.0m above the existing dam crest level, and would therefore have less impact on the landscape and character of the pond. Secondly, the spillway is less intrusive since the spillway base will be closer to the existing ground level.

Highgate No.1 Pond

The works would include:

- Raising the dam with a 1.25m high clad wall along the dam crest on the south-east and north-east banks of the pond;
- An open channel, grass lined spillway, which would be formed by filling in the low spot between the west end of the dam and the hill to the west. This spillway would have a shallow lining of turf reinforcement mat, which would be laid just below the topsoil. The footpath to the west of the pond would be raised by around 0.3m with a gently sloping ramp. The base of the spillway would be 64m wide, with part formed above the dam crest and part formed by lining the natural ground as it slopes up from the dam;
- A return wall would form one side of the spillway, following the existing fence down the slope. This wall would be formed with H- posts and timber to avoid tree loss on the other side of the fenceline.

Some trees would have to be removed where they are on the part of the spillway that it passes over the dam, but not on the natural ground where the roots are clear of the dam.

Not all the excess floodwater is stored in the PMF event by Option 6. However, by filling in the low spot, raising the dam, and creating flood storage capacity in this and two upstream ponds, floodwater will flow over the spillway at Highgate No.1 Pond less frequently, and with less volume and velocity, than is currently the case.

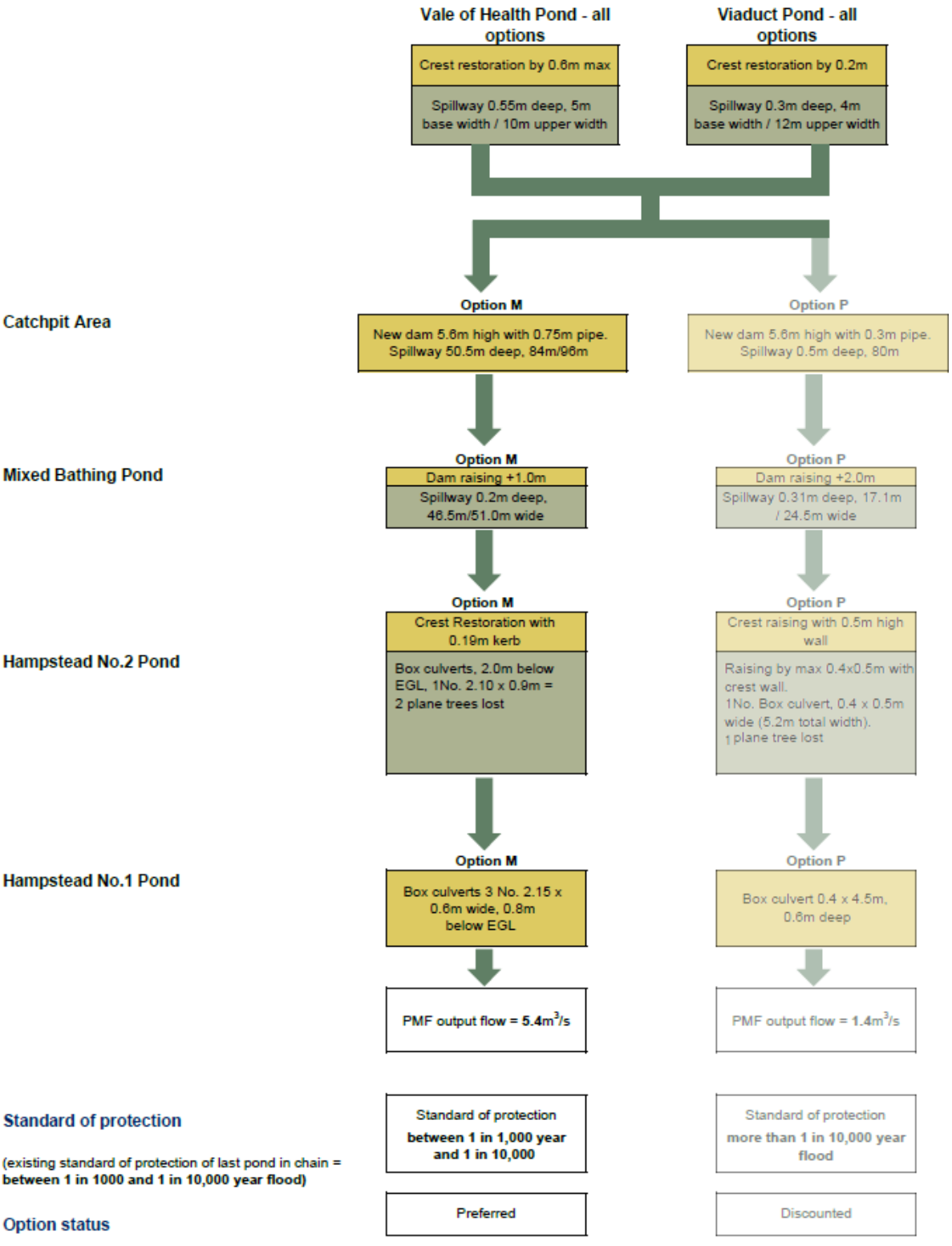
Preferred Solution: Hampstead Chain: Option M

An options flowchart for the Hampstead chain is shown on the next page. This shows the same two options (M and P) that were selected for further development at the preferred options stage, but with

some updates to spillway dimensions. These have been adjusted following amendments to the design which have been incorporated into the hydraulic model created in the earlier options appraisal stage in 2013.

Option M has been selected as the preferred solution for the Hampstead chain because there is less dam raising involved. The 1m raising of the dam at Mixed Bathing Pond in Option M has less impact on views and the character of the pond than the 2m raising proposed in Option P, which would have required either retaining walls or encroachment into the pond. Similarly, a 0.5m high wall on the dam at Hampstead No.2 pond is avoided in Option M.

Hampstead Chain - Modelled Options flowchart
Preferred solutions as at 14/05/2014



Vale of Health Pond

Works would include:

- Crest restoration by a maximum of 0.56m, along just over half of the dam. This would be achieved in two stages, comprising of 0.3m of fill added to the crest and the top 0.26m of a kerb;
- An open spillway, 5m wide at the base, located at the right hand end of the dam;
- An additional overflow pipe, 0.5m diameter, to run parallel to the existing overflow pipe.

The spillway would be located at the southern end of the dam (on the right hand side when looking downstream), in preference to the northern end, for the following reasons:

1. The dam is much lower at that end, so the spillway would only require a cut of around 0.1m below the existing ground level.
2. The views at the north end of the dam are more valuable.
3. A spillway at the left hand end would have required the removal of an English Oak (on the upstream edge of the footpath), and would have affected the roots of another larger tree on the downstream side. A spillway at the right hand end would require the removal of a Robinia, but this would allow the Coastal Redwood (also known as the giant sequoia) to be avoided.

The kerb could be buried under topsoil or clad. The stone and tarmac surface to the path would be reinstated.

Viaduct Pond

Works here include:

- Crest restoration by a maximum 0.18m of fill material along part of the dam;
- A new open spillway, 4m wide at the base, located at the left hand end of the dam;
- A new overflow pipe, 0.5m in diameter, to be buried under the spillway;
- Works to improve the inlet structure to the existing overflow pipe;
- Removal of the silt that is affecting water quality. There is potential for this silt to be treated and relocated within the borrow pit for the Catchpit dam.

The slope of the spillway as it crosses the dam crest footpath would be a maximum of 1:12 on the west side, to maintain access across the spillway base. However, the east slope of the spillway would merge into the existing ground, which is at a slope of around 1:3. Currently, access to the area near the east end of the dam from the viaduct footpath is down a set of steps which stop short of the dam crest. There is a possibility of continuing these steps down the valley sides and into the spillway, to improve the connectivity of access onto the dam from that side.

Catchpit area

This is the main area of major works planned for the Hampstead pond chain, and includes:

- A new flood storage dam, built of clay, 5.6m high at the lowest point of the valley. This would be located partly over the existing catchpit, which is a concrete lined pond that will be removed and filled in. The slopes of the dam have been assumed to be 1:3 upstream, 1:4 downstream (the Mixed Bathing Pond side). At these slopes the dam would be 40m wide at its widest point. These slopes are provisional, subject to the findings of the ground investigation, and have been assumed based on similar flood storage dams where the downstream slopes are gentler than the upstream slope in order to reduce flow velocities during overtopping. The crest of the dam will be approximately 100m long;
- A pipe, 0.75m diameter wide, to pass normal stream flows under the dam. The upstream end of the pipe will have a small concrete inlet structure with a debris screen, allowing the raking out of debris from standing above the headwall. The downstream end of this pipe would be allowed to discharge over land. The pipe under the dam would be encased in a steep sided

mass concrete block, allowing compaction of the clay fill material around the pipe to avoid seepage paths forming outside the pipe;
- The existing pipe (that runs from the manhole chamber to an outlet in the trees near the Mixed Bathing Pond) could either be repaired or replaced with a wetland area with a boardwalk to provide access across the valley bottom;
- Two new silt collection ponds, formed by two low stone check dams 1m deep, upstream of the main flood storage dam. Reedbeds will be planted on gravel beds on the upstream ends of the ponds. Small (0.2m diameter) pipes will pass low flows through the check dams to avoid stagnation in the ponds;
- A footpath down from the existing footpath along the right hand side of the valley. This would allow access to remove silt by hand from the new ponds and remove debris from the inlet screen;
- A new open silt collection area on the downstream side of new dam providing an opportunity for the creation of a new wetland habitat.

As described in the Preferred Options Report, the dam has been moved upstream by about 50m to avoid the large mature trees (such as oaks, hybrid black poplars and hornbeams) either side of the wide grass path that runs across the valley.

The flood storage reservoir would usually be empty, so tree removal will only be necessary within the footprint of the dam and a close working area around it. The trees in the new flood storage area would only be affected by floodwaters for short periods.

The dam crest would be designed to be overtopped, although this would only occur in extreme events, or if there is a blockage to the pipe inlet. The dam would therefore need to be covered in closely cut grass, with no other planting on the downstream side. Whilst this slope would appear uniform, it would be hidden from view (particularly from the Mixed Bathing Pond) by the trees to be retained downstream.

The grass crest of the dam would be lined to protect the crest from erosion due to walkers who are likely to use the dam to cross the valley. However, the crest would not be directly connected to the formal footpaths along the valley sides.

Mixed Bathing Pond

Proposed works would involve:

- Raising the causeway dam by 1m all the way along its length, with fill built up from the path along the crest. The new crest surface path would be 4m wide. The fill would have a 1:1 slope on the upstream face, and a 1:3 slope on the downstream face, which would merge with the existing downstream slope;
- Reinforcing the existing downstream slope of the dam with a turf reinforcement mat;
- Extending the overflow pipe further out into the pond;
- Removal of the silt, including excavation at the upstream end of the pond where the silt has solidified.

The works at the dam have been remodelled to avoid a separate spillway. Almost all of the crest of the dam would be overtopped, i.e. flood waters would flow over the clear width between the large trees at either end of the dam. By extending the length of dam to be overtopped, the velocities of overtopping water would be reduced, so that the reinforcement material in the downstream slope can be a shallow mat within the topsoil layer.

By having a steep slope on the upstream side, the works are contained within the width of the road, without affecting the trees growing in the dam on the west side, and without needing the draining of the ponds either side. Views across the Mixed Bathing Pond from the raised path would be unchanged while unauthorised access to the pond from the dam would be diminished. Stakeholders expressed a preference for raising the dam by 1m instead of 2m as in Option P, because there would be less impact on views from the dam looking upstream, from the pond looking towards the dam, or from the dam on Hampstead No.2 Pond. No large or mature trees would be

affected by the raising works, however, a group of smaller hawthorns at the eastern end (the left hand side looking downstream) would need to be partially cut back to allow the overflow inlet to be moved clear of the footprint of the raised footpath.

Pedestrian access across the causeway would be maintained throughout construction. This could be achieved either by building up the fill in two halves, or by providing a temporary walkway on a platform supported off the downstream slope, with the works to install topsoiled and seeded, turf reinforcement matting left until the raised footpath is surfaced.

Hampstead No.2 Pond

Works at the dam would include:

- A new overflow formed with one precast concrete box culvert, 2.1m wide (internally) x 0.9m deep, set within the dam at the right hand end. This culvert curves round to the west, in order to avoid the plane trees on the dam which can be seen from the dam at Mixed Bathing Pond.
- A drop-shaft inlet structure to the culverts. This inlet would extend approximately 1.5m out from the existing sheet piles into the pond, and be 6m wide. The structure would be concrete, and would be clad. A security screen would be fitted across the top to stop entry.
- Rerouting the existing overflow pipe.
- Crest restoration with 0.2m high edging, on the edge of the dam crest above the sheet piles. This would extend for about 70m of the 102m length of the dam.

The culvert works would require the removal of two of the London Plane trees, but not the same two trees shown previously in visualisations. The development of the drop-shaft inlet structure, combined with the kerb above, allows a smaller and lower culvert. These changes maximise the head of water which would drive flows through the culvert, so that the culvert can be made narrower than the versions described in the outline proposals. (Previously the overflow was formed by 3 sets of 3m wide culverts, forming a total width including walls of around 9.6m). While the number of trees to be removed is the same, the above amendments would reduce the number of trees at risk, and affect different trees thereby reducing the impact on the view from Mixed Bathing Pond.

The box culvert would be approximately 26m long along in order to take flood flows past the existing dam. The culvert would then open out into a grass surfaced open channel which would drop into Hampstead No.1 Pond.

There may be an opportunity to cover the inlet to the drop shaft by extending a wooden viewing platform from the footpath out over the shaft, with the underside of the platform set above the peak water level expected in a PMF event.

Services in the dam crest (one gas main and two electricity cables) may require diverting, although it may be possible to route these services over the top of the culverts now that they have been lowered.

Hampstead No.1 Pond

Works would include:

- A new spillway, formed with a precast concrete box culvert, 0.5m deep x 7.2m wide, with the invert 0.84m below the existing dam crest level. The culvert overflow would pass through the dam crest at the east end of the dam (left hand side looking downstream).
- A culvert, same dimensions as the spillway inlet, to continue the flows down the downstream slope of the dam. This culvert would be buried under topsoil to reinstate the downstream slope profile as existing.
- A reinforced concrete stilling basin at the downstream toe of the dam, buried under a sacrificial layer of topsoil.

When floodwater flows into the culvert, it will push away the topsoil on the stilling basin, so this would require replacement after extreme events.

The culvert has been located at the east end of the dam, as far away as possible from the public footpath that runs along the west bank of the pond. The exact location has been amended in order to avoid the London Plane trees that run along the Cathedral Walk near the downstream toe of the dam. The current location requires removal of two lesser trees on the dam bank (a Common Ash and a Cherry), and a group of small trees (Hawthorn, Cherry and Sycamores) just downstream. These trees have been assessed as low value by an arboriculturist.

Topsoil would be reinstated above the box culvert, and planting either side of the box culvert inlet (e.g. with native shrubs) could substantially hide the inlet from the view of the public footpath on the west side of the pond.

3. Discounted options

Highgate Chain: Option 4

Option 4 involved raising the dam at Model Boating Pond by 2.0m. With the additional storage capacity reduced at Model Boating Pond, a 1.5m wall would be required to raise the height of the dam at Men's Bathing Pond in order to make up for the shortfall. The option was discounted for the following reasons:

- The raising wall would have been around 0.5m higher than the existing fence on the dam and would have been difficult for many people to see over when standing next to it.
- The spillway crest level at Men's Bathing Pond would have been 0.5m higher than the spillway in Option 6, most of which is at existing ground level. The extra 0.5m would have required more obtrusive landscaping of the natural ground between the pond and the pathway, and higher training walls or bunds to form the sides of the spillway coming away from the dam.
- Option 4 led to higher flows coming from the last spillway at Highgate No.1 Pond in the PMF event.
- If fishing is to be maintained at Men's Bathing Pond, access over the spillway and to the pondside would be easier in Option 6 where the spillway crest is lower.
- While 2.0m is less than 2.5m, it would have still blocked the view from standing on the crest footpath on Model Boating Pond. By providing a footpath along the crest of the new dam, the view over both ponds from a 2.5m dam would be reinstated. Therefore, the extra 0.5m at Model Boating Pond would make less of an impact than the extra 0.5m at Men's Bathing Pond.

Hampstead Chain: Option P

Option P involved raising the dam at Mixed Bathing Pond by 2.0m. This change in height was deemed unacceptable by many in the stakeholder group, particularly the Mixed Bathing Pond Association, due to the impacts on views and the character of the pond. While the option could have reduced the loss of plane trees at Hampstead No.2 Pond from two to one, the impact on views of a 2.0m raising would have been more significant. To achieve the extra 2m would have involved either retaining walls if works were confined to the existing crest path, or encroachment into one of the ponds.

The effect of the loss of the extra storage capacity associated with the 2.0m raising has been largely mitigated by the refinements in the design of the inlet structure, depth and route of the box culvert overflow, as detailed above.

4. Next stages

This report is intended to provide information to the City of London that will allow them to prepare their own report for the Hampstead Heath Consultative Committee, and the Hampstead Heath, Highgate Wood, Queen's Park, and Project Sub Committees.

Approval of the Preferred Solution will be required from the Hampstead Heath, Highgate Wood, Queen's Park, and Project Sub Committees, drawings will be prepared to accompany the Planning Application. This will be supported by the Environmental Impact Assessment (EIA), Flood Risk Assessment, Transport Statement and Planning, Design and Access Statement. The drafting of the EIA has already begun with the compilation of baseline information from species surveys, the historical environment assessment and other surveys. The contractors have started to provide information which will inform the EIA and will assist with the assessment of construction traffic impacts (dust, noise, community etc).

The plans will be presented to the wider public at a Development Management Forum and Member's Briefing scheduled for 5th June 2014, just prior to submission of the application.

The submission of the Planning Application to the London Borough of Camden is programmed for 4th July 2014.

A statutory consultation will commence after this date, normally over a 21 day period following validation of the application.