Official Sensitive

Outline Business Case

The Future of Cannop Ponds

Part 1 – Project Management Information

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Contents

Part 2 – The Investment Project

Executive Summary

Upper and Lower Cannop ponds are, two high risk, large raised reservoirs, located approximately 2km North of the village of Parkend in the Forest of Dean. The reservoirs were constructed almost 200 years ago for industrial purposes and now provide significant amenity value, as well as being an important part of the landscape and industrial heritage.

Both reservoirs have significant issues with the condition of the earth embankments which hold back the reservoir water, as well as the spillway structures themselves. Significant voids were discovered below the spillway slab at Lower Cannop in 2021. These voids have been caused by continuing water seepage through the dams.

Both spillways are significantly undersized and do not meet current design standards in relation to the volume of flood water which they must be able to safely pass over the earth dams in an adverse flood event. Without this ability there is a serious risk of the earth embankments being over-topped in a storm and the dams breaching.

Consequently, both reservoirs are subject to Measures in the Interests of Safety under the 1975 Reservoirs Act. Forestry England therefore have a legal and moral obligation to take action.

This business case sets out four options to address the above issues by significantly upgrading the existing dams and spillways, their removal, or a combination of both. In addition to the primary project objective of preventing a future dam breach, there are several secondary objectives.

All four options have been evaluated against the project objectives, as well as several other qualitative and quantitative criteria. Option 4 (the complete restoration of the original watercourse) has not been taken forwards for full evaluation, as flood modelling indicates an increase in downstream flood risk in Parkend.

Following full evaluation of the remaining three options, Option 2 has been identified as the recommended option to be taken forwards for design development and consenting. This option maximises storm water storage, improving flood risk in Parkend and strikes a balance across the various other assessment criteria.

A financial appraisal has been completed for all three options. Initial cost estimates include significant risks and contingencies at this early stage of design and have been used for relative comparison of the options only. Significant further work will be required to develop further cost estimates, once the recommended option is confirmed and further design development is completed. The current medium construction cost estimate for Option 2 is £6.4m.

1 Introduction

1.1 Context

Upper and Lower Cannop Ponds are large water bodies in the Forest of Dean. Whilst locally known as 'Ponds' the water bodies are both man-made reservoirs. The reservoirs were originally constructed in 1825 and 1829 to provide a reliable supply of water to the ironworks at Parkend.

The use of the reservoirs to power industry was relatively short lived. They now provide an amenity space used for fishing and public enjoyment, with walking and cycling routes passing nearby.

The reservoirs have been a feature of the Forest of Dean and a focal point for the Cannop Valley for many years. They are highly valued by the Forest of Dean community and there is strong sense of ownership and connection with the reservoirs and their place in the landscape. They are also part of the area's rich industrial heritage.

The reservoirs lie in the upper part of the Cannop Brook / River Lyd catchment, which is designated by the Environment Agency as a 'Rapid Response Catchment'. The brook flows through two relatively small settlements, Parkend and Whitecroft, before passing through the town of Lydney and into the Severn estuary via Lydney harbour.

1.2 Background

Lower and Upper Cannop Ponds are both designated 'high-risk' large raised reservoirs in accordance with The Reservoirs Act 1975.

A reservoir is designated 'high-risk' where the Environment Agency (EA) assesses that an uncontrolled release of water could endanger human life. The threshold for registration under the Reservoir Act is currently 25,000m^3 of water above the natural level of any part of the surrounding land. Lower Cannop Pond holds more than 75,000m^3 of water above the natural level of the valley; and Upper Cannop Pond holds approximately 28,000m^3 of water.

Following recent inspections and investigation, both reservoirs are subject to Measures in the Interests of Safety (MIOS) under the Reservoirs Act. These are actions which must be taken to ensure the continued safety of the reservoir. Completion of MIOS are monitored by the Reservoirs Act enforcement authority which in England is the EA.

The MIOS for Upper and Lower Cannop include measures to address the overflow capacities for both reservoirs. The reservoirs were constructed circa 200 years ago and were not designed to the safety standards which apply today. Current design requirements

for the required flood events that reservoirs must be able to withstand are set out in Floods and Reservoirs Safety 4th Edition.

The dams and spillways have seen significant deterioration in their condition as they have aged. Seepage of water through the earth structure of the Lower Cannop dam has resulted in the creation (and repair) of significant voids at regular intervals in the dams history. Voiding is difficult to detect until the signs of ground movement are observed in the crest of the dam. Most recently, in 2021, substantial voids were identified beneath the spillway slab at Lower Cannop. These have subsequently been repaired, however the continuing risk of the presence of undetected voids and the potential for others to be created in the future remains.

The Dam Safety Assessment in Appendix A provides further information on the history and condition of the dams, the safety measures stipulated in various inspection reports and the overarching safety issues applicable to the dams.

Part 3 – The Five Case Model Investment Justification

2 Strategic Case

As England's largest land manager, Forestry England is responsible for managing approximately 165 waterbodies in the nation's forests which impound water above the surrounding ground level. These comprise an array of assets, ranging from small ponds of limited volume, to reservoirs exceeding the 25,000m^3 threshold and requiring registration as a large raised reservoir.

In early 2022 an improvement plan was presented to the Forestry England Executive Team. The plan outlined the challenges facing Forestry England's reservoir assets, including potential future legislative changes, climate change impacts, as well as the need to increase investment in their maintenance and upkeep to keep pace with the rate of deterioration of an ageing asset base.

The plan recognises the benefits and risks that Forestry England's reservoirs bring to the nation's forests. It also makes provision to consider discontinuance of reservoirs, where the benefits provided by the assets are outweighed by the resources required to maintain them.

2.1 The Reservoirs Act 1975

The 1975 Act replaced the 1930 Act that was brought about following failures of reservoirs at Skelmorlie and Eigiau resulting in loss of life. The Act places legally binding obligations on the undertakers of large raised reservoirs to inspect and maintain their assets.

The reservoir inspection regime, set out in the Act, requires two levels of inspection to be carried out by independent engineers. An annual inspection, or 'S12' is carried out by a Supervising Engineer, ahead of providing the undertaker an annual statement of the reservoir's condition. An Inspecting Engineer, a member of the all-reservoirs panel, and independent from the undertaker, carries out an inspection every 10-years, this is the 'S10' inspection. Whilst a Supervising Engineer may advise the undertaker to carry out certain maintenance works, only the Inspecting Engineer has the authority to instruct legally enforceable MIOS.

Forestry England is the undertaker at Upper and Lower Cannop Ponds, and as such is legally obliged to act to address the current MIOS. If these actions are not addressed then enforcement action may be taken by the EA.

2.2 Recent reservoir incidents

There have been no dam failures resulting in fatalities in the UK since the Reservoir Act was first passed in the 1930's. However, there have been and continue to be dam failures across Europe and further afield, with a series of concerning incidents in England over the last 20-years which could have led to a catastrophic failure if prompt remedial action had not been taken. The most high profile of which was the Toddbrook Incident of 2019.

The Toddbrook incident resulted in the evacuation of 1500 people. An emergency drawdown of the reservoir was instigated, and the damaged spillway was shored up to remove the very real risk of a catastrophic dam failure.

Due to the Toddbrook Reservoir incident, two independent reports were undertaken by Professor David Balmforth. These focussed on determining any lessons which could be learnt from the incident and a wider review of the implementation and suitability of the reservoir safety arrangements across the sector at that time.

Toddbrook Reservoir stores approximately 12 times the combined volume of Upper and Lower Cannop, and has a substantially higher risk profile due to the height of the dam, its proximity to downstream communities, and the characteristics of the catchment which drains into it. But, that is not to say that there aren't similarities with Upper and Lower Cannop and lessons that Forestry England need to learn.

Toddbrook was originally constructed in the 1840s, Cannop was constructed in the same era. Both are earth core dams. The auxillary spillway which failed at Toddbrook was built far more recently, in the 1970s, following an incident which showed the original spillways to be undersized and unable to take flood flows safely. The auxillary spillway was constructed of concrete slabs which are thinner than would be expected today, unreinforced and poorly jointed, lying on compacted clay soil. Lower Cannop's spillway was replaced in 1976, and is of similar construction, albeit far smaller.

Professor Balmforth identified systemic issues with reservoir inspections, and in particular, a tendency for inspection reports to be written in an understated style where the importance and urgency of remedial work was not sufficiently highlighted, so reservoir undertakers did not necessarily take the right actions quickly enough. The Inquiry highlighted that Toddbrook, a reservoir managed in compliance with the Reservoirs Act, sustained potentially critical damage in an unexceptional rainfall event – and that must be a wake-up call for the reservoir industry.

It is human nature to believe that the unthinkable won't happen, however the risk of a dam failure, whilst unlikely, is real and present.

- In August 2002 a dam failure occurred in Glashutte, Germany releasing 50,000m^3 of water during a storm event. 45 minutes after the dam overtopped due to an

undersized spillway, the earth dam had been washed out. No fatalities but very significant property and infrastructure damage occurred in the town 2 miles downstream of the dam as a result of the flood surge.

- In June 2007 the stepped spillway on the Ulley dam, Yorkshire, partially failed leading to a partial failure of the earth dam, evacuation of 700 residents and closure of the M1 motorway for two-days during which time the reservoir was drawn down. The Ulley reservoir had ceased to have an economic purpose and had been incorporated into a country park. The investigation report identified that whilst the engineering inspections had taken place in compliance with the Reservoirs Act, the Council's ranger staff at the country park had not been trained or briefed about what to look for, or when, or how to report apparent deficiencies at the dam. This was relevant as the local site staff were aware of the cracking and leakage of the spillway, but hadn't acted upon it. In contrast, also in June 2002, a potential catastrophic collapse of Upper Rivington Reservoir in Lancashire was avoided after a site maintenance operative reported that the flow of water through one of the drawdown pipes had increased overnight, and was now flowing 'brown' indicative of high sediment levels resulting from internal erosion of the earth core. An immediate emergency drawdown was instructed and a collapse avoided.
- More recently in August 2023, the Braskereidfoss dam on the River Gloma in Norway partially collapsed following a period of extreme rainfall. The cause was the failure of an automated sluice gate that did not open, which then lead to the dam overtopping with the high river flow.
- The tragic events in Derna, Libya in September of this year where not less than (and quite likely far more than) 5,000 residents died also highlight the importance of dam safety and maintenance. The exact cause of the Derna collapse is unknown, however, the failure did coincide with an extreme rainfall event and followed decades of alleged neglect. Similarly to Cannop Ponds the events in Derna involved two reservoirs in cascade.

The United Nations University, Institute for Water, Environment and Health report 'Ageing Water Storage Infrastructure: An Emerging Global Risk' was published in 2021. The report identifies and discusses the growing risks posed by water storage infrastructure, principally large, raised reservoirs having a dam height of 15m or more, and built in the last 100-years with a design life of 50 to 100-years.

The report presents an international perspective, but also provides statistics for the UK. The report states that the UK has 580 large dams with an average age of 106-years. The risks to the public are identified in the report, with note that *'development downstream*

of dams is persistent and this elevates the magnitude of the consequences of dam failure'.

Common failure modes are noted as being *'excessive seepage, overtopping or structural failure'*. The report identifies that dam safety incidents are most likely to occur in newly built dams (under 5-years of age) or dams over 50-years of age. As a dam ages it is more likely to suffer from internal degradation due to ground movements and internal erosion from seepage / leakage flows. The report also identifies climate change as a key risk with extreme rain events leading to increasing risks of over-topping. The report identifies increasing risks to dams world-wide after they cease to have an economic function due to a loss of focus on, and funding for, routine maintenance.

Overtopping of a reservoir is a known, and relatively common, reason for dam failures. The climate change models[1] for the Forest of Dean predict that the Cannop catchment will receive more rainfall, and that rainfall will be more seasonal with wetter autumn and winter periods, and drier spring and summer periods. The models also predict that more extreme rainfall events could occur at any time of the year, with risks of flash flooding as rain falls on either already saturated ground (winter) or baked dry soils (summer).

2.3 Barrier removal

The United Nations University report presents reasons to decommission or remove dams, with the following excerpts particularly relevant:

> *'Dam removal may impact the cultural history and heritage of a particular region. Dams that no longer serve their original purpose may still hold value to residents because of their longstanding history and ties to long-past industries'.*

> *'When considering dam removal, scientists and policymakers prioritise safety and economics while residents prioritise recreation and aesthetics. The local community is a key stakeholder in dam removal projects, and the potential loss of aesthetics also needs consideration even though aesthetics can be subjective and a polarizing topic. There is also a misconception that removing a dam will negatively alter the scenery by leaving a muddy and unsightly reservoir footprint. This is true immediately after the dam removal and reservoir drawdown. However, this newly exposed zone can quickly evolve to increase wildlife and water quality.'*

The United Nations University report also discusses the emerging trend of dam decommissioning projects, citing the United States as leading, numerically, at least in dam removals in recent years.

[1] Climate modelling extracted from Met Office Hadley Centre for Climate Science and Services

In Europe, the same dam safety risks apply, but arguably the drive for dam removals has been led by the drive to restore natural river function. This is typified by the ambition of 'Dam Removal Europe' as their website states:

> *'The overall ambition of Dam Removal Europe is to restore rivers in Europe that have high natural or cultural importance. Currently, there are many of these rivers in Europe that are fragmented by obsolete dams and weirs. By removing these barriers, we can once again have healthy free-flowing rivers full of fishes for all to benefit.'*

Dam Removal Europe describes itself as a coalition of partners led by the World Fish Migration Foundation and including the World Wildlife Fund (WWF) as one of the seven core partners. The UK's Environment Agency is listed as a supporting partner.

Dam Removal Europe track dam and weir removals, with 239 removed from European rivers in 2021. In recent years Spain and France have removed most dams, with Sweden not far behind. In the UK, the pace of dam and weir removal is increasing. Although the rationale for each project is different, the restoration of river channels for fish migration is a key driver, with natural flood management and public safety also cited.

This dichotomy between hard engineering and nature-based solutions to reducing harm from environmental hazards, namely flooding, is recognised in the Government's Environmental Improvement Plan, with the commentary:

> *'**Use Nature-based Solutions for flood management**: Whilst hard infrastructure will still be needed to manage flood risk in future there are also ways of managing flood risk naturally which supports progress towards our other environmental goals and targets.'*

Those other environmental goals are many, but improved biodiversity delivery is certainly a key plank in the improvement plan.

2.4 Growing the Future

https://www.forestryengland.uk/growing-the-future

Growing the Future sets out Forestry England's priorities for the 5-years to 2026.

The plan recognises and responds to the climate emergency, the biodiversity crisis and the need to support people's health and wellbeing.

Our plan for people states '*We want the nation's forests to be a living treasure for all, deeply connected to people's lives and improving the health and wellbeing of the nation'*. We recognise that the nation's forests are among the most popular natural spaces in the country, visited hundreds of millions of times every year. But we aim to go further, breakdown down barriers, reaching across all of society so everyone feels welcomed.

In the Forest of Dean there is already a well established network of walking trails and cycle trails for people of all-abilities. The Our Shared Forest plan for the Dean (https://www.forestryengland.uk/oursharedforest) sets a commitment for all way-marked walking trails provided by Forestry England to be tramper friendly. At Cannop Ponds currently, safe access to the water's edge is limited and the path infrastructure to and around the reservoirs is unsuitable for trampers or others of limited mobility. There is also only limited interpretation to help visitors appreciate the depth of history, and the diversity of wildlife using the Ponds. The well used cycle trail passes alongside Cannop Ponds, albeit woodland vegetation obscures the view for much of the time, and through the main car park.

Our plan for wildlife recognises the biodiversity crisis and our role in protecting and enhancing the rich, diverse and connected habitats in the nation's forests. Our plan sets out our ambition to go further, enhancing the habitats we have, improving linkages between habitats and reintroducing lost species with a focus on allowing and promoting natural processes. The Forest of Dean is one of England's largest areas of continuous woodland, and as such is a nationally important place for wildlife to thrive. The Our Shared Forest plan for the Dean sets out our commitments to wildlife and wild places, as well as our commitments to enhancing our management of surface water for the benefit of wildlife. This is work that is being delivered now, through our Forest Waters project and in partnership with organisations such as Gloucestershire Wildlife Trust, and Gloucestershire County Council.

Our plan for climate recognises the immediate and longer term challenges of the climate emergency. Our plan sets out the work we are doing to make the nation's forests more resilient to our changing climate. Resilient to the damaging impacts of pests and disease, of drought, and of wildfire. In the Forest of Dean the impacts of our tree disease are clear to see with ash dieback, oak decline and the large-scale clearances of larch due to Phytophthora disease.

The Our Shared Forest plan for the Dean sets out how we are changing the forest structure and species composition to make it more resilient to disease, fire and drought. With the climate change projections showing a steady increase in annual rainfall, and that rainfall more seasonal with wetter winters and drier summers the risk of winter flooding and summer droughts will become more acute in future years. Those climate predictions also warn that intense rainfall events will have the potential to become more extreme, and occur at any time of the year with attendant risks of flash flooding. Forestry England's Forest Waters project is responding to this with interventions across the Forest aimed at holding up surface water for longer to mitigate downstream flood risk and droughts whilst also delivering benefits for wildlife. The requirement to undertake works at Cannop Ponds were not foreseen when the Our Shared Forest plan and Forest Waters project were developed. There is now an opportunity to incorporate the principles from this work in the development of future options for Cannop Ponds.

2.5 The case for change

Forestry England have a legal obligation under the Reservoirs Act at Cannop Ponds and as such we know that doing nothing is not an option.

Given the age and condition of the reservoirs and the obligations to discharge the MIOS, substantial investment would be required to maintain the status quo of the existing reservoirs, as well as ensuring that these are suitable for the next 100 years.

A project was therefore commenced in spring 2022 to consider all options for the future of the reservoirs, which would also address the immediate legal requirements under the Reservoirs Act.

The project seeks to identify whether there are options for the future of Cannop Ponds which have benefits beyond maintaining the status quo, such as biodiversity gains and reducing downstream flood risk. The project also seeks to consider the benefits of the various options against the value for money requirements associated with the expenditure of public funds and their potential to deliver against objectives from Forestry England's Five-Year Plan.

2.6 Work completed to date

In March 2022, the engineering consultancy Arup were appointed via the Environment Agency's Collaborative Delivery Framework to support Forestry England by exploring options for the future of the reservoirs.

Since Arup's initial appointment the following key activities have been completed:

1. Initial review of options for discharging Lower Cannop Section 10 actions
2. Dam condition assessment
3. Review of environmental and permitting requirements
4. Stakeholder mapping work and support with communications and engagement strategies
5. Heritage impact assessment, Preliminary ecological appraisal
6. Ecology surveys including MoRPH, Habitats Suitability Index, Aquatic Habitat Mapping, eDNA sampling, Aquatic invertebrate & macrophyte, invasive species, otters, water vole, bats, wintering birds, reptiles, dormouse and GCN.
7. Hydrological catchment modelling and associated river channel surveys
8. Biodiversity net gain baseline calculations and assessment of opportunities
9. Geotechnical and geo-environmental desk study and ground investigation specification

10. Development of concept options and landscaping vision
11. Delivery of two public engagement days and virtual engagement platform
12. Completion of intrusive ground investigation works
13. Continuing liaison with the Environment Agency Reservoir Safety Team over progress with the project

This early project work and the data gathered through various surveys and modelling has been used to inform the development of possible options for the future of Cannop Ponds as well as forming the basis for this Outline Business Case.

3 Economic Case

The Economic Case brings together the key considerations that are required to appraise the options for Cannop Ponds and recognises the need for an innovative and sustainable solution that addresses the MIOS requirements.

Eleven key areas have been appraised. Based on this appraisal, a recommended option has been identified to be taken forwards for design development and planning approval.

3.1 Project objectives

The primary objective of the Future of Cannop Ponds Project is to safeguard downstream communities from the potential risks associated with a dam breach.

This can be achieved in two ways:

1. By upgrading the existing reservoir infrastructure to address the current MIOS and comply with current reservoir design standards
2. By reducing the volume of the reservoirs so that any remaining water bodies hold less than 10,000m3 of water above the surrounding ground level.

Upgrading the existing reservoir infrastructure reduces the risk of an uncontrolled release of reservoir water (i.e. dam failure) to be As Low As Reasonably Practicable (ALARP).

Reducing the volume of stored water eliminates the risk and would remove the existing reservoirs from the scope of the Reservoirs Act. By ensuring that any new water bodies store less than 10,000m3 of water, these will be unlikely to be impacted by proposed future legislative changes to reduce the volume of water which determines whether an impounded water body falls under the Reservoirs Act.

In addition to the primary project objective, there are several secondary objectives, which are to:

1. Maintain, or improve storm water attenuation at the site (so as to maintain, or improve downstream flood risk arising from storm events);
2. Maintain, or deliver a net gain in biodiversity;
3. Maintain the sites sense of place and tranquillity;
4. Respect the heritage of the valley, and promote the cultural understanding of Cannop Ponds for future generations; and
5. Deliver a solution which represents value for money.

These secondary objectives aren't necessarily complementary, and a solution is sought which provides the optimum balance between these competing priorities.

3.2 Proposed options

From an initial review of possible options for the future of the reservoirs, four were shortlisted for further consideration and inclusion in this Outline Business Case. All options meet the primary objective of safeguarding downstream communities from the potential risks associated with a dam breach.

Further details of these options, including concept plans and illustrations, are included in Appendix B. An overview of these options is described in the following sections.

Option 1 – Spillway and dam upgrades

This option upgrades both dams and spillways and will allow both reservoirs to remain as they are now. The existing spillways will be replaced with new larger concrete structures that are designed to safely carry more water in extreme storm events. The top and sides of the dams will be raised and strengthened. Works will also be undertaken to improve the watertightness of the dams to reduce leakage. The embankment of Upper Cannop will be strengthened and reprofiled.

Option 2 – Storm water storage

This option provides additional water storage in storm events. The water level in Lower Cannop Pond would be dropped by 1 to 2 metres retaining it as a smaller reservoir. As with Option 1, a new larger spillway would be required for Lower Cannop. The Upper Cannop Pond spillway would be removed. This will reconnect the watercourse and allow creation of a series of smaller ponds and wetland which will slow storm water flows. This option aims to reduce the risk of downstream flooding from storms.

Option 3 – Cascade of ponds

This option removes both reservoirs and creates a series of smaller ponds through the valley. The cascade of ponds would be achieved through the construction of embankments, or 'leaky' woody structures across the valley to store and attenuate water during periods of heavy rain. The risk of a future dam failure would be removed and the creation of ponds through the valley would re-connect the floodplain and pose less of a barrier to the movement of fish and other aquatic fauna.

Option 4 – Re-naturalising Cannop Brook

This option removes both reservoirs and reinstates Cannop Brook. The risk of future dam failure would be removed. Natural processes would shape the valley creating a mix of grassland and woodland habitats. The brook would be reconnected with no artificial barrier to fish movement.

3.3 Appraisal methodology

The appraisal methodology and subsequent evaluation has been guided and developed using the independent, multi-disciplinary consultants, Arup.

Eleven key areas were selected for consideration in the appraisal. The selection was governed by the project objectives, relevance of the areas to the likely scheme solution, and to those where meaningful datasets are available to enable a comparison of the options. The areas are listed in Table 1.

Given that the design development of the options at this stage is to a concept level, there are varying degrees of accuracy that can be applied to each assessment. Where possible, quantitative assessments have been undertaken using the available data and tools. However, in some cases, there are limited data or tools to make quantitative assessments and so a qualitative approach was adopted.

Table 1 – List of areas considered in the appraisal

Area	Qualitative or Quantitative?
Flood Risk	Quantitative
Social Value	Qualitative
Biodiversity Net Gain (BNG)	Quantitative
B£ST Assessment (assesses benefits of infrastructure development incorporating Biodiversity and Ecology, Carbon, Flooding, and Health)	Quantitative
Cost Estimates	Quantitative
Carbon	Quantitative
Heritage	Qualitative
Water Environment Report (WFD)	Qualitative
Environmental Impact Assessment (EIA)	Qualitative
Planning	Qualitative
Habitats Regulation Assessment (HRA)	Qualitative

3.4 Evaluation approach

To be able to aggregate the assessment data, a standardised scoring system was developed so that each option in each area could be compared. The approach used for the options appraisal evaluation is shown in Table 2.

Table 2 – Scoring System

Description	Score
Major Risk / Negative Impact	1
Minor Risk / Negative Impact	2
Neutral / Negligible Impact	3
Minor Opportunity / Positive Impact	4
Major Opportunity / Positive Impact	5

The evaluation ranges from 1, where the option creates a major risk or a major negative impact, to 5 where there is a major opportunity or major positive impact that might be delivered.

Further detail, including how the scoring is applied to each area is detailed in Sections 3.6 to 3.16.

3.5 Evaluation summary

A summary of the outcome of the evaluation of each area and option is shown in

Table 3.

During the initial assessment of Option 4 for flood risk, it was found that the removal of the reservoirs and re-naturalisation of Cannop Brook would have a significant negative impact on downstream flood risk.

It was therefore concluded that the project objective to maintain or improve flood risk could not be met without significant design changes. Option 4 was therefore discounted partway through the appraisal process, as indicated by the grey boxes in the following table.

Table 3 - Summary of Results

	Option 1	Option 2	Option 3	Option 4[2]
Key Project Objectives				
Flood Risk	3 – Neutral / Negligible Impact	4 - Minor Opportunity / Positive Impact	3 - Neutral / Negligible Impact	1- Major Risk / Negative Impact
Social Value (inc public consultation)	3 – Neutral / Negligible Impact	2 – Minor Risk / Negative Impact	2 – Minor Risk / Negative Impact	1 - Major Risk / Negative Impact
Biodiversity Net Gain	2 – Minor Risk / Negative Impact	4 - Minor Opportunity / Positive Impact	4 – Minor Opportunity / Positive Impact	4 - Minor Opportunity / Positive Impact
B£ST	3 – Neutral / Negligible Impact	4 - Minor Opportunity / Positive Impact	4 - Minor Opportunity / Positive Impact	4 - Minor Opportunity / Positive Impact
Cost Estimates	3 – Neutral / Negligible Impact	4 - Minor Opportunity / Positive Impact	5 - Major Opportunity / Positive Impact	
Supporting Objectives				
Carbon	3 – Neutral / Negligible Impact	5 - Major Opportunity / Positive Impact	5 - Major Opportunity / Positive Impact	
Heritage	2 – Minor Risk/ Negative Impact	2 – Minor Risk/ Negative Impact	1- Major Risk / Negative Impact	
WFD	2 – Minor Risk/ Negative Impact	4 - Minor Opportunity / Positive Impact	4 - Minor Opportunity / Positive Impact	
Consenting				
EIA	2 - Moderate likelihood of EIA	1 - High likelihood of requiring EIA	1 - High likelihood of requiring EIA	
Planning	2 - Likely Major Planning Application	1 - Likely Major Planning App with EIA	1 - Likely Major Planning App with EIA	
HRA	3 – Neutral / Negligible Impact	4 - Minor Opportunity / Positive Impact	4 - Minor Opportunity / Positive Impact	

Further detail on how the evaluation was undertaken for each area in the above table is included in the following sections.

[2] Option 4 consists of the removal of both Upper Cannop Pond and Lower Cannop Pond spillways and re-naturalising Cannop Brook. In the initial assessments of flood risk, it was found that Option 4 would have a significant negative impact and therefore would not achieve the Project Objectives. As such, the option was discounted so further assessments such as costings and carbon were not prepared.

3.6 Flood risk

Fluvial flooding vs Dam breach

The types of flooding which can affect properties downstream of a reservoir are fluvial flooding, dam breach flooding, or a combination of both. The difference between these types are their causes and characteristics.

Fluvial flooding is usually caused by extreme and / or prolonged rainfall and is characterised by gradual rising water levels along riverbanks. Dam breach flooding results from the failure of a man-made dam and is characterised by the sudden and often more severe release of the impounded reservoir waters. Dam breach flooding can lead to a more immediate and devastating impact on downstream properties, infrastructure and habitats.

Risk of dam breach flooding can be reduced to an acceptable level (As Low As Reasonably Practicable (ALARP)) through ensuring the safety of the dam structure, or removed through discontinuance of the applicable dam and reservoir. Due to all the options either addressing safety concerns with the Cannop Pond dams, or discontinuing them, dam breach flooding has not been assessed further in this appraisal.

Risk of fluvial flooding can be reduced through slowing down flows and temporarily holding water volume upstream, although the risk itself cannot be removed. It is important to understand how the different options influence fluvial flows and flood risk to downstream properties, making fluvial flooding the focus of this topic area.

Methodology

The assessment of flood risk impacts focussed on changes to downstream fluvial flood risk from each option in the normal range of return periods for which Flood Risk Assessments are carried out. This is for storms with a typical likelihood of occurrence in any year from 1 in 2 to 1 in 1,000. As discussed above, risk to properties and population from an uncontrolled release of reservoir water (i.e. dam breach) is not included.

Simulations were carried out using a 1D-2D hydraulic model. The existing arrangement was modelled as the ‘Baseline’ against which changes due to each option could be assessed. In initial model runs, it was found that Option 4 would cause an unacceptable increase in downstream risk. It was therefore decided that Option 4 would be discounted as it would not meet the scheme objectives. As such, not all return periods were modelled for Option 4.

Flood risk was assessed based on two parameters:

1. The number of flooded properties. Properties were considered as flooded when the maximum flood depth across the footprint of a building was above 0.15m, which is the typical threshold level corresponding to a doorstep.

2. The average maximum flood depth across all flooded properties.

Full details of the flood risk modelling are provided in the Technical Note in Appendix C.

Evaluation approach

Table 4: Flood Risk scoring approach

Description	Criteria	Score
Major Risk / Negative Impact	Major detriment to downstream flood risk +Low confidence of being able to mitigate during design development	1
Minor Risk / Negative Impact	Minor detriment to downstream flood risk + Low confidence of being able to mitigate during design development	2
Neutral / Negligible Impact	No change + Low confidence in being able to achieve further betterment Or Minor detriment to downstream flood risk + High confidence of being able to mitigate during design development	3
Minor Opportunity / Positive Impact	Minor improvement to downstream flood risk + Low confidence in being able to achieve further betterment	4
Major Opportunity / Positive Impact	Major improvement to downstream flood risk + High confidence in being able to achieve further betterment	5

Evaluation

The number of flooded properties and the average maximum flood depth across flooded properties for three key scenarios, namely 1 in 30, 100 and 200 events, are shown in the tables below.

Table 5 - Number of flooded properties

Occurrence of 1 in….	Baseline	Option 1	Option 2	Option 3	Option 4
30	15	15	15	17	
100	18	19	18	19	22
200	21	21	19	21	

Table 6 - Average maximum flood depth (metres)

Occurrence of 1 in....	Baseline	Option 1	Option 2	Option 3	Option 4
30	0.623	0.622	0.555	0.637	
100	0.662	0.674	0.619	0.655	0.713
200	0.718	0.723	0.649	0.727	

Table 7 - Flood Risk Evaluation

	Option 1	Option 2	Option 3	Option 4
Flood Risk	3 – Neutral / Negligible Impact	4 - Minor Opportunity / Positive Impact	3 - Neutral / Negligible Impact	1 - Major Risk / Negative Impact
Reasoning / Key Driver	Negligible increase to the number of flooded properties and the maximum flood depths with high confidence in being able to be mitigate during design development	Reduces the number of flooded properties and the maximum flood depths due to attenuation in Lower Cannop Pond	Minor increase to the number of flooded properties and the maximum flood depths with high confidence in being able to be mitigate during design development	Significantly increases the number of flooded properties and the maximum flood depths due to the removal of any attenuation currently provided by the reservoirs

The options have been modelled against the baseline at high level design stage only, representative of the level of detail currently developed. However, through analysis of the results and the behaviour of the interventions within the model, there is high confidence that the minor detriment shown in the results for Options 1 and 3 could be mitigated through straightforward geometry changes within the design without deviating from the original design intent of the options.

Option 4 has the intrinsic issue of having removed a significant storage volume of water from the valley. Without re-introducing some form of flood storage reservoir to the option (effectively becoming Option 2 or 3) there is little potential to mitigate the detriment to flood risk within the site boundary.

3.7 Social Value

Methodology

Social value is about the wellbeing of both current and future generations. It encompasses the recreational use, mental health impacts, feeling of ownership and connection to nature, and more generally, how a site like Cannop Ponds serves the needs and desires of the people who visit and interact with them.

Quantifying the social value of Cannop Ponds and potential changes from interventions is highly subjective, particularly without the ability to first benchmark then undertake monitoring post completion of the scheme.

Feedback on the concept options has been sought from key stakeholder groups including community groups, local public, visitors, and local businesses. While feedback can be heavily influenced by the strength and organisation of contributing stakeholder or community groups, for this appraisal the feedback has been considered in its entirety and key themes drawn out around how each option may influence social value.

Key Stakeholder Feedback

On the 2nd February 2023 two Stakeholder workshops were held with the aim of listening to key local community groups and people who currently use Cannop Ponds, to help establish design principles to carry into the options development and future design stages of the project.

Key outcomes included:

- Cannop Ponds is considered a destination site, used for a range of activities by a wide range of users, but accessibility to many of the site's walking trails is challenging.
- There is a strong sense of place, considered as a quiet and tranquil location, while also providing a strong cultural connection to the industrial heritage of the Forest.
- Regarded and valued (for physical and mental well-being) as a 'wilder' site than many within the Forest owing to the open water and visible wildlife.
- Some concerns were raised over impacts to wildlife from the increased visitor numbers owing to the publicity created by this scheme.

Public Engagement Feedback

In March 2023 two days of public engagement events were held, open to 800 visitors. In parallel a virtual engagement platform was open to the public to access from the start of the events to two weeks after. Four options were presented at the events and virtually,

which are the same options set out in this business case. A total of 736 feedback responses were received and analysed. A summary report of the feedback received is provided in Appendix D.

Key responses considered as part of the scoring include:

- Rank of options in order of preference.
- Whether the responder would continue to enjoy visiting Cannop Ponds if each option was implemented.
- The main themes, concerns, and positive reactions received for each option, in particular those concerning likely future social value.

Evaluation approach

The below scoring approach has been applied for scoring the Options. Where a disparity is apparent between the ranked preference for the option and feedback relating to the potential change to social value, the written feedback has been preferentially weighted.

Table 8: Social Value scoring approach

Description	Criteria	Score
Major Risk / Negative Impact	Predominantly unsupported by Public / Stakeholders and likely decrease in long term social value	1
Minor Risk / Negative Impact	Predominantly unsupported by Public / Stakeholders, but with potential for increase in long term social value	2
Neutral / Negligible Impact	Some public / stakeholder support, with potential for increase in long term social value	3
Minor Opportunity / Positive Impact	Some public / stakeholder support, with positive feedback on social value related elements	4
Major Opportunity / Positive Impact	Supported by Public / Stakeholders and social value likely to be enhanced	5

Evaluation

Option 1 - Spillway and Dam Upgrade

The public and numerous professional stakeholders (particularly groups or parties who are politically driven) have shown strong support for dam rehabilitation (maintaining the status quo). However, many of the feedback comments have been contradictory, with significant concern around the visual impact that the larger spillways and alterations to the dams would have on the aesthetic and social value of the site.

Table 9: Option 1 Social Value score considerations

	Feedback & reactions	Likely Impacts on Social Value
Positive	• Climate change and resilience • Maintaining the landscape • Opportunity to invest in visitor facilities	• Reassurance of dam safety to downstream property owners • Current recreational use could be unchanged
Negative / Concerns	• Visual appearance of the design • Changing the appearance of the landscape • Limited biodiversity enhancement opportunities	• Public acclimatisation to new dam structures will take time • Dams remain with ongoing upkeep / safety issues the burden of future generations

Option 2 - Storm Water Storage

Most public feedback suggests this is perceived as the 'next best' option, but Option 1 is preferrable. This is potentially reflective of the significant interest in the scheme from the local angling club and the potential for a large water body remaining upon completion. Key Stakeholders have also recognised this has the greatest potential for improving flood risk downstream in Parkend.

The impact of the changes to Upper Cannop had limited specific feedback, leaving further engagement being required to determine whether the presented option could be developed to further retain / improve social value.

Table 10: Option 2 Social Value score considerations

	Feedback & reactions	Likely Impacts on Social Value
Positive	• Disturbances to wildlife and loss of habitat • Changing the appearance of the landscape • Visual appearance of the design	• Reassurance of dam safety to downstream property owners and reduced risk of fluvial flooding • Maintains angling potential and broadens other recreation uses
Negative / Concerns	• Disturbances to wildlife and loss of habitat	• Reduced feeling of local ownership of the site • Lower dam remains with ongoing upkeep / safety issues

	• Changing the appearance of the landscape • Visual appearance of the design	the burden of future generations

Option 3 - Cascade of Ponds

While little support has been shown by the public, very little targeted negative feedback has been received either. This option appears to have been given little attention between Option 1 being preferred, Option 2 weakly accepted, and Option 4 being seen as either abhorrent or important for nature.

However, the design of this option provides opportunities for improving access, walking trails, access to nature, and retains the large open water aesthetic of the more regularly visited Upper Cannop. It does however remove some of the open water aesthetic from Lower Cannop which is considered to provide mental health benefits. This was reflected in various responses against other options which suggested the same interventions proposed in this option should be incorporated into others.

Table 11: Option 3 Social Value score considerations

	Feedback & reactions	Likely Impacts on Social Value
Positive	• Biodiversity enhancement opportunities • Positive impact on habitat of wetland birds and beavers • Accessibility and inclusion opportunities	• Risk of dam breach flooding removed • Risk of fluvial flooding to local property owners reduced • Maintains some angling potential and broadens other recreation uses
Negative / Concerns	• Disturbances to wildlife and loss of habitat • Level of commitment to long-term maintenance	• Some connection to nature lost from smaller open water and wildlife spotting potential. • Uniqueness of site within the Forest reduced if the valley is left to return to a more wooded, natural state.

Option 4 - Re-naturalising Cannop Brook

The public has provided significant negative feedback and comments towards this option. A small number of responses have however noted the importance of the approach of removing human interventions from nature to ensure biodiversity and climate resilience for future generations.

While this principal is a key factor in maintaining long-term social value, the option was developed prior to the quantification of the biodiversity value and flood risk modelling. The marginal % increase in biodiversity and detriment to flood risk is not therefore likely to convert into a long-term social value gain.

Table 12: Option 4 Social Value score considerations

	Feedback & reactions	Likely Impacts on Social Value
Positive	• Biodiversity enhancement opportunities	• Removes the burden of dam safety concerns for future generations
Negative / Concerns	• Disturbances to wildlife and loss of habitat • Loss of cultural/industrial heritage • Visual appearance of the design of the concrete spillways	• Loss of a uniqueness within the Forest likely to lead to fewer visitors • Ability to connect with nature altered due to change in space

Overall Social Value Assessment Score

Table 13- Social Value Assessment Scores

	Option 1	**Option 2**	**Option 3**	**Option 4**
Social Value	3 – Neutral / Negligible Impact	2 – Minor Risk / Negative Impact	2 – Minor Risk / Negative Impact	1 - Major Risk / Negative Impact
Reasoning / Key Driver	Option strongly supported by public. Maintains status quo only and increased size of spillways will detract from natural aesthetic of the site.	'Next best' option in public feedback, but with marginal support. However, provides opportunity to reduce anxiety from flooding and enhance accessibility to nature while maintaining current recreational use.	Minority support from public feedback, but proposed enhancements related to recreational and heritage would mitigate to some extent and were suggested to be incorporated into the recommended solution.	Poorly supported by public due to loss of open waterbodies and uniqueness of site within the Forest. Enhancements unlikely to be able to fully restore social value.

3.8 Biodiversity Net Gain (BNG)

Methodology

Biodiversity Net Gain (BNG) is an approach to development, and/or land management, that aims to leave the natural environment in a measurably better state than it was beforehand. While BNG focuses on the habitats provided and likely influence on biodiversity, the impacts on designated sites and protected species are considered as part of the Habitats Regulations Assessment (HRA) (Section 3.16) and wider ecology / arboriculture under the Environmental Impact Assessment (EIA) (Section 0).

The value of habitats within the existing site were quantified through the use of the Natural England Biodiversity Net Gain Metric 3.1.[3] This allows for baseline habitat value to be objectively compared against changes in habitats after a development, which informs the level of habitat enhancement and/or creation required in order to achieve BNG targets.

The Environment Act (2021) is a key mechanism for delivering the improvements. The Environment Act (2021) includes the mandatory requirement for new developments to provide a BNG. This will require planning applicants to demonstrate that proposals will achieve at least a 10% increase in the level of biodiversity after the development, when compared to the level of biodiversity pre-development. This mandate will come into effect in England only by amending the Town & Country Planning Act (TCPA) (1990) [4]. The amendments are expected in January 2024 and therefore will apply to the delivery of this project.

To achieve BNG, the baseline value of habitats present within the site must first be established. This was achieved through a combination of field studies and desk-based assessment to produce a quantitative value of biodiversity for the given area. All vegetated and freshwater habitats have an ecological value. The biodiversity value of the area was calculated using the Natural England Biodiversity Metric and measured in Habitat Units, Hedgerow Units and River Units. These are based upon a range of factors, including habitat type, area, condition, and distinctiveness.

The Biodiversity Metric enables a valuation of all semi-natural habitats within the site, and allows a biodiversity baseline to be established, against which the repercussions of design

[3] Natural England (2021). Biodiversity Metric 3.1 – Auditing and accounting for biodiversity calculation tool. Available at: https://publications.naturalengland.org.uk/publication/6049804846366720. Accessed September 2023

[4]Town and Country Planning Act 1990. Available at: https://www.legislation.gov.uk/ukpga/1990/8/data.pdf. Accessed September 2023.

decisions can be assessed i.e. the value of habitats lost, retained or created, and area required to offset any residual loss through enhancement in order to achieve a net gain in biodiversity. Terrestrial habitat surveys within the site were conducted by suitably experienced ecologists as part of the Preliminary Ecological Appraisal (PEA) in July 2022. BNG compliant River Condition (MoRPh) surveys within the site were conducted by freshwater ecologists trained and certified to undertake MoRPh surveys in July 2022[5].

To support the options appraisal, a BNG calculation was carried out for the four proposed concept design options for Cannop Ponds. This enabled the number of habitat units associated with the potential habitat losses and creation to be quantified. All options are likely to require further enhancement of habitats on site that are not directly affected by a respective option to achieve the mandated 10% net gain. To allow a true comparison of options, enhancements (and the biodiversity units they will produce) have not been considered as part of the options appraisal.

Evaluation approach

Table 14: BNG scoring approach

Description	Criteria	Score
Major Risk / Negative Impact	Major loss in habitat and / or river units relative to baseline	1
Minor Risk / Negative Impact	Minor loss in habitat and / or river units relative to baseline	2
Neutral / Negligible Impact	Negligible change in BNG units relative to baseline	3
Minor Opportunity / Positive Impact	Minor gain in habitat and / or river units relative to baseline	4
Major Opportunity / Positive Impact	Major gain in habitat and / or river units relative to baseline	5

Evaluation

Details of the BNG assessment are included in the Technical Note in Appendix E. Summary scores are provided below.

Table 15- BNG Scores

[5] Gurnell, A., England, J., Scott., S., Shuker, L (2020) *A Guide to Assessing River Condition Part of the Rivers and Streams Component of the Biodiversity Net Gain Metric.*

	Option 1	Option 2	Option 3	Option 4
Score	2 – Minor Risk / Negative Impact	4 - Minor Opportunity / Positive Impact	4 – Minor Opportunity / Positive Impact	4 - Minor Opportunity / Positive Impact
Reasoning / Key Driver	Delivers a minor reduction (-3.81 units) in habitat units, driven largely by a reduction woodland area associated with the proposed Upper Cannop Pond embankment works	Delivers a minor increase (+9.24 units) in habitat units and a minor increase in river units (+0.59 units), driven largely by the proposed creation of reedbed habitat in both the Upper and Lower Cannop Pond.	Delivers a minor increase (+4.34 units) in habitat units and minor increase in river units (+1.19 units), driven largely by loss of open-water habitat in the vicinity of the Upper and Lower Ponds, which would be replaced by reedbed at the Upper and wet grassland at the Lower.	Delivers a minor increase (+9.06 units) in habitat units and major increase in river units (+4.52 units), driven largely by creation of wet grassland and aquatic marginal vegetation.
Enhancements of woodland, grassland and scrub (not directly affected by the option) required to achieve 10% BNG	Enhancements equal to 32.85 habitat units.	Enhancements equal to 19.80 habitat units.	Enhancements equal to 24.70 habitat units.	Enhancements equal to 19.98 habitat units.

3.9 CIRIA B£ST assessment

Methodology

In order to compare the relative benefits of the options in regard to Biodiversity and Ecology, Carbon, Flooding and Health, various tools were considered. After reviewing applicability of each tool to this scheme, the CIRIA B£ST Tool was selected as the preferred approach. CIRIA B£ST has been developed for assessing the benefits of blue-green infrastructure which has several similarities to works that would be undertaken at Cannop Ponds.

The 2019 Excel-based tool was selected over the more recent 2023 web-based tool due to its ease of use and future accessibility for amendments as the scheme design progresses. The methodology of the two tools remains the same, with the main difference being the user interface (spreadsheet based vs web based). Therefore, to ensure the assessment uses the most up-to-date data and science behind CIRIA B£ST, the 2019 spreadsheet was manually updated with the latest parameters from the 2023 tool.

Of the 20 assessments available within the tool, a shortlist of 4 have been selected for scoring. Others have been screened out either due to non-applicability to the scheme, or for avoiding double counting of benefits (as per guidance).

Biodiversity & Ecology

Changes to the calculated habitat areas and units resulting from the BNG study have been taken and converted into monetary values. This has used published values for offsetting loss of credits, or amounts which represent the cost of creating a particular replacement habitat.

- BE1.1 conversion uses guidance Statutory Biodiversity Credit Prices published by UK Gov.
- For BE1.2, all LPAs will have the choice of setting their own values following BNG becoming a mandatory part of planning applications. The Forest of Dean LPA currently has not set values and references Government guidance figures. For this assessment, values selected by different Local Planning Authorities (LPA) were reviewed and an example was selected which used £20k as a flat rate for all habitat biodiversity credit prices.
- BE2 uses CIRIA B£ST's suggested Values for Biodiversity Improvements, supplemented by UK Broad & Priority Habitat figures for missing habitat types.

The monetary benefit value of each conversion method is shown below.

Table 16- BNG conversions to monetary benefit values

	Option 1	Option 2	Option 3	Option 4
BE1.1 - Value based on Statutory Biodiversity Credit Prices	- £500k	+ £8k	- £450k	- £210k
BE1.2 - Value based on example LPA figures	- £68k	+ £200k	+ £110k	+ £270k
BE2- Biodiversity and Ecology change to existing baseline (present value after confidence applied)	- £2k	+ £68k	+ £99k	+ £390k
Average Benefit Estimate	**- £188k**	**+ £91 k**	**- £79k**	**+ £152k**

As demonstrated by the variability above, the results are heavily influenced by the high values given to river and lake habitats which are rarely considered for creation in most schemes. The basis for many of the habitat monetary values are not well documented.

Although there is significant variability in these results, it is the magnitude and relativity of the benefit / disbenefit which will be considered as part of the overall B£ST score.

Carbon Reduction & Sequestration

The B£ST tool only considers benefits associated with carbon sequestration and not costs. The CS3 method within the tool determines the carbon sequestration potential from restoring flood plains.

A separate lifecycle carbon assessment has been carried out for the options and is discussed in Section 0. The BNG study outputs have been used to inform the area of restored floodplain and are shown below.

Table 17 - Restored flood plain sequestration to monetary benefit values (absolute & relative)

	Option 1	Option 2	Option 3	Option 4
Carbon Sequestration (present value after confidence applied)	£0	+ £6k	+ £3k	+ £2k

As discussed in Section 0, the potential carbon sequestration, flux, and GHG release of large waterbodies is not well defined and is therefore not included in these scores.

Flooding

Using results from the flood model, to estimate the potential benefit provided by each option, the change in Standard of Protection (SoP) for each individual property within the fluvial flood zone has been compared to the existing baseline.

Monetary values for the benefit of change are provided within the B£ST tool guidance. These have been applied across 50 years, confidence adjustment applied, and present value calculated.

Table 18- Benefit derived from change to flood risk.

	Option 1	Option 2	Option 3	Option 4
Flooding (present value after confidence applied)	- £1.5k	+ £193k	- £5k	- £1.5k (1:100yr AEP only)

Only the 1:100yr annual probability of occurrence event was modelled for Option 4. The disbenefit would therefore be anticipated to be significantly greater if all AEPs were modelled and compared.

Health & Wellbeing

The B£ST tool recommends the use of the 'WHO Health Economic Assessment Tool' where specific information and external assessment of health and wellbeing are not available. This tool allows for the valuing interventions which influence numbers of active users (in this case taken as walkers and runners) and changes to their habits (taken as additional minutes spent being active per visit). This in turn allows for the estimation of avoided costs to society due to improved health of the user.

The base data used has been derived from Forestry England's Active Users Dashboard which captures visitor numbers and types / frequencies of activities being undertaken within their assets, including the Forest of Dean. Assumptions have had to be taken on the percentage of visitors to the site who are active and, owing to no data being available for current or predicted duration of activity, nominal values representing change have been used. i.e. an change in visitor count has been represented by +/-1% increase in active users, while duration has been represented by +/-1 min per visit.

While these values estimates should not therefore be taken as absolute, the high estimate values are reflective of the high visitor numbers to Cannop Ponds and the influence they have on habitual behaviours of the local community.

Table 19- Benefit derived from change to Health (from Active Users) results (relative to option 1 taken as status quo)

	Option 1	Option 2	Option 3	Option 4
Likely change to visitor numbers	No Change	Increase	No Change	Decrease
Change to duration of active visit	No Change	No Change	Increase	Increase

Health (present value after confidence applied)	£0	£760,000	£2,520,000	£1,730,000

Overall Benefit Estimates relative to Option 1

Table 20- Overall benefit estimates made relative to a £0 value for Option 1 (status quo)

	Option 1	Option 2	Option 3	Option 4
Biodiversity & Ecology	£0	+ £278 k	+ £110k	+ £340k
Carbon Sequestration	£0	+ £6k	+ £3k	+ £2k
Flooding	£0k	+ £195k	- £3.5k	£0k (1:100yr AEP only)
Health	£0	+ £760k	+ £2.5m	+ £1.7m
Overall Benefit Relative to Option 1	£0	+ £1.2m	+ £2.6m	+ £2.1m

Evaluation approach

As discussed in the Costing section of this report, the range in cost of options varies by approximately £5m when looking at averages between Low and High estimates. As the benefit estimates are not suitable for being taken as absolute values due to variability on some of the estimates, a cost benefit assessment has not been made. However, the £5m mark has been used as threshold for determining major or minor risk / opportunity.

Table 21: CIRIA B£ST scoring approach

Description	Criteria	Score
Major Risk / Negative Impact	More than £5m loss in benefit estimation	1
Minor Risk / Negative Impact	Less than £5m loss in benefit estimation	2
Neutral / Negligible Impact	Negligible change relative to Option 1	3
Minor Opportunity / Positive Impact	Less than £5m gain in benefit estimation	4
Major Opportunity / Positive Impact	More than £5m gain in benefit estimation	5

Evaluation

Summaries of the individual criteria assessments are provided in Appendix F.

Table 22- CIRIA B£ST Assessment Scores

	Option 1	Option 2	Option 3	Option 4
B£ST Assessment	3 – Neutral / Negligible Impact	4 - Minor Opportunity / Positive Impact	4 - Minor Opportunity / Positive Impact	4 - Minor Opportunity / Positive Impact
Reasoning / Key Driver	Taken as the status quo. However, the biodiversity and ecology assessment shows a disbenefit and there is no carbon sequestration or health benefit opportunity. No flood risk benefit is provided through this option.	Option 2 demonstrates a positive benefit associated with all assessed benefits.	Option 3 shows a benefit to the carbon sequestration and health. No flood risk benefit is provided. There is significant variation between the valuation of biodiversity and ecology through the BE1 and BE2 assessment methods, but overall a benefit is anticipated.	This option shows some benefit through carbon sequestration and health benefits. No flood risk benefit is provided through this option. There is significant variation between the valuation of biodiversity and ecology through the BE1 and BE2 assessment methods, but overall a benefit is anticipated.

3.10 Financial appraisal

Methodology

Base Construction Cost Estimates

An outline cost estimate has been prepared for each of the options. The Base Construction Cost Estimates are based upon the high-level concept plans and the associated principle items required for each.

Cost data has been derived from a mixture of sources, including:

- prevailing market rates determined from current projects
- historic rates from past projects
- benchmark cost data from published cost information
- market enquiries from suppliers and contractors

Source cost information has been adjusted to reflect variances in price levels from the timing and location of the source cost data to the Base Date of this estimate (2nd Quarter 2023).

No provision has been included for Inflation from the Base Date of this estimate to the midpoint of construction since these dates have not yet been identified. This adjustment would need to be made once the timing of the proposed project is identified.Each Option has been presented with a low and high value to reflect potential ranges of specification for component parts which have yet to be defined.

Additions have been made to the Base Construction Cost Estimate for:

- estimating tolerance (-5% - +5%)
- contractor's preliminaries (20% - 35%)
- contractor's overheads and profit (5% - 7.5%)
- risk contingency and optimism bias (40% – 60%)

The cost estimates prepared are for the capital works and are for comparative use only. They do not necessarily reflect the absolute cost of implementing all aspects of any given option. Examples of items which may increase costs but are not within the construction cost estimates are:

- Design/permitting/planning/owner costs
- Wider habitat improvement (e.g. to achieve 10% BNG) outside of the immediate capital works areas

The sums in Table 23 reflect the Base Construction Cost Estimate inclusive of Risk, Contingency and Optimism Bias for the different options. Build-ups for the costs are provided in Appendix G.

Table 23 – Base Construction Cost Estimates

	Option 1		Option 2		Option 3	
	Low	High	Low	High	Low	High
Cost Estimate (Base Option)	£6.5m	£12.4m	£4.2m	£8.5m	£3.2m	£6.6m
Extra Over Costs						
Option A	+£160k	+£280k	+£80k	+£140k	N/A	N/A
Option B	+£580k	+£980k	+£290k	+£490k	N/A	N/A
Option C_{low}	-£710k	-£1.6m	-£270k	-£610k	N/A	N/A
Option C_{mid}	+£380k	+£140k	+£170k	+£90k	N/A	N/A
Option C_{high}	+£2.0m	+£2.8m	+£820k	+£1.1m	N/A	N/A

To give an appreciation of the potential range in costs for key risk items, estimates were also prepared which cover:

- Options for different surface finishes to the proposed concrete spillways, and
- Options for installing an alternative watertight cut-off to the dam embankments, in lieu of sheet piles.

These have not been used to score the options and are provided here for information to assist with OBC preparation for Options 1 and 2. The extra over costs determined are:

Upper & Lower Spillway treatment to walls:

Base option: Stone lined outside, smooth concrete inside
Option A: Stone lined outside, patterned formwork inside
Option B: Stone lined outside & inside

Dam Embankment Cut-Off:

Base option: Sheet Piles
Option C_{low}: Pressure Grout : Average Grout Take of $1m^3$ / m depth / hole
Option C_{mid}: Pressure Grout : Average Grout Take of $3m^3$ / m depth / hole
Option C_{high}: Pressure Grout : Average Grout Take of $6m^3$ / m depth / hole

Operation and maintenance costs

An outline assessment of the operation and maintenance costs has been developed for each option. This assessment includes routine requirements, such as:

- Statutory inspections (required under the reservoirs Act)
- Vegetation management costs

- Routine maintenance costs for the dam and spillway structures
- Major maintenance of the dam and spillway structures
- Maintenance of associated infrastructure, such as paths and trails

At this stage no allowance has been made for the management and maintenance costs of any habitat improvements works, which may be necessary to achieve the necessary 10% biodiversity net gain. This is anticipated to be broadly similar across the options and not material to the decision-making process.

In a similar way to the base construction costs estimates, the figures have been determined based on prevailing market rates and historic rates from past maintenance works.

The maintenance cost data will need to be reviewed at the next project stage, once a confirmed option has been selected and the design has been developed in further detail.

Evaluation approach

The base construction and maintenance costs for each option have been assessed using an 'Options and Financial Appraisal' tool. This information is also included in Appendix G. This tool has been used to visualise the cost estimates and provide the Net Present Value of each option.

For the purposes of the evaluation, a medium construction cost estimate has been assumed, which represents a middle ground between the high and low estimates included in Table 23. Also included are allowances for design works and project management; though these are consistent across all options and so do not impact the decision-making process.

A period of 50 years has been assumed in the financial appraisal. In practice, the design life of any option is intended to be 100 years, although this has limited impact on the decision-making process.

For simplicity, all non-maintenance costs are currently assumed to be incurred in year 0, the first year of implementation. This is not material to the investment decision and enables a relative comparison between the options. As the project moves forwards, the investment profile will be developed to align with the project programme. This will in turn depend on how the project progresses through the consenting process.

No provision has been included for Inflation and future cash flows have been discounted without any inflation factor added. Depending on when the project is initiated adjustments would need to be made that could materially affect the affordability and the short-term cash requirements.

The potential cost of 'extra overs' per Table 23 are excluded from these calculations given the uncertainty of their relative likelihood and possible combinations. These costs will be considered at Full Business Case stage.

It must be noted that, given the above assumptions on phasing and inflation, the figures do not precisely represent the short-term cash requirements of each option. Instead, they serve as a relative comparison between options. More precise cash requirements will need to be derived at the next stage of appraisal.

Each option has been assessed against the criteria in Table 24. In evaluating the cost estimates, Option 1 is considered neutral as that option represents 'business as usual' with the reservoirs retained in a similar capacity as they are currently. Options 2 and 3 are then evaluated relative to Option 1.

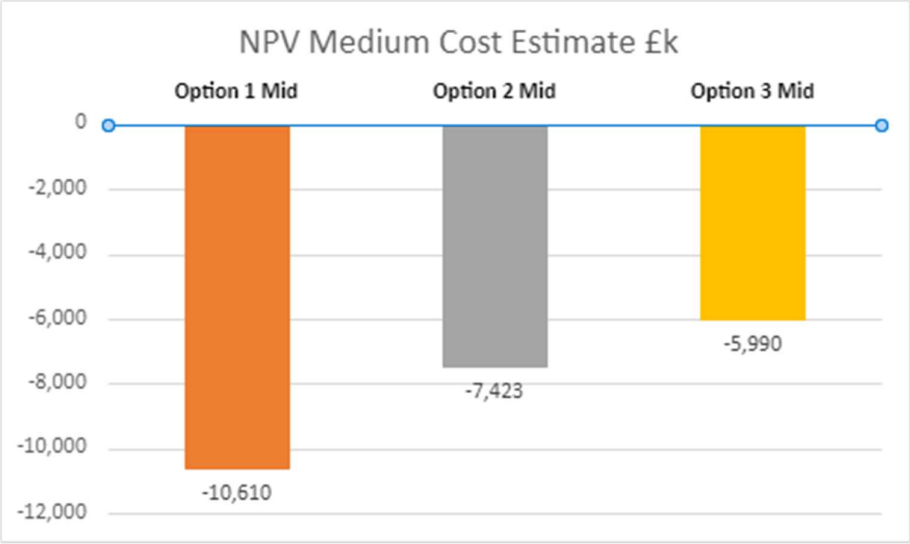
Table 24: Cost scoring approach

Description	Criteria	Score
Major Risk / Negative Impact	Significantly higher cost than Option 1	1
Minor Risk / Negative Impact	Moderately higher cost than Option 1	2
Neutral / Negligible Impact	Business as usual scored as neutral (Option 1) or Option with similar cost to Option 1	3
Minor Opportunity / Positive Impact	Moderately lower cost than Option 1	4
Major Opportunity / Positive Impact	Significantly lower cost than Option 1	5

Evaluation

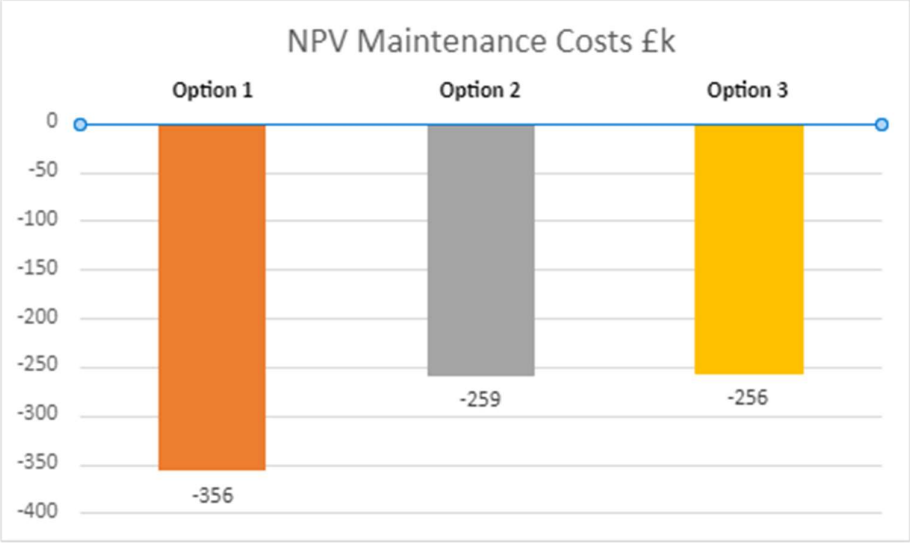
The Net Present Value of the three options over a 50 year period are set out in the following chart. These represent the sum total of discounted future cashflows. HM Treasury's Green Book discount rate has been applied to account for the time value of money.

Table 25: Net Present Value £000s – Options Comparison



The primary influence on the various NPVs is the short-term cost of implementation (i.e. the base construction cost estimate). Other factors are either consistent across the options (e.g. design costs) or are not materially different (e.g. future maintenance costs – see table 26 below)

Table 26: NPV of Maintenance Costs £000s



The above figures include allowances for uncertainty and risk which are appropriate for the nature of the investment and the stage of development. These figures will be subject to change, once the confirmed option is developed and taken forwards to design and consenting.

Based on the current cost estimates Option 3 is the most financially affordable. This must be considered in combination with the risks and opportunities associated with the other options set out in Sections 3.6 to 3.16 of this business case. Table 27 sets out the scoring of Options 2 and 3, relative to Option 1.

Table 27- Cost Estimate Scores

	Option 1	Option 2	Option 3
Score	3 – Neutral / Negligible Impact	4 - Minor Opportunity / Positive Impact	5 - Major Opportunity / Positive Impact
Reasoning / Key Driver	'Business-as-usual' with replacement of spillways and retention of ponds to address the MIOS for the reservoirs.	NPV Savings of £3.2m *(Range: £2.4m to £4.0m)* relative to Option 1	Savings of £4.6m *(Range: £3.3m to £5.9m)* relative to Option 1

3.11 Carbon

Methodology

The Environment Agency ERIC carbon calculator has been applied to the options to evaluate at a high level the whole life carbon of constructed assets. The excel based tool measures the greenhouse gas impacts of construction activities in terms of carbon dioxide equivalent (CO2e) by calculating the embodied CO2e of materials and the CO2e associated with their transport. Personnel travel, site energy use and waste management are also considered.

Waterbodies like reservoirs can both sequester and release carbon, and the balance between these processes is influenced by various natural and human-related factors. The net effect of a waterbody on carbon sequestration or release depends on several factors, including the type and amount of organic matter, water temperature, oxygen levels, nutrient availability, and the history of the waterbody (whether it was recently created or has existed for a long time). Reservoirs, in particular, can be complex systems, with variable impacts on the carbon cycle.

Created habitats also sequester carbon during their lifespan. However the volume is also variable depending on the species, environment, upkeep, human activity and age.

Given the limited research, potentially large variability, and available estimates on the carbon and GHG flux of large waterbodies, the sequestration of the options has been omitted from the calculations and only the whole life carbon of the civil works and maintenance of the asset have been considered.

The key components for each option are based on the concept plans and are further detailed within the Carbon Technical Note included in Appendix H.

Evaluation approach

Table 28: Carbon scoring approach

Description	Criteria	Score
Major Risk / Negative Impact	Significantly higher TCO2e than Option 1 (>2x)	1
Minor Risk / Negative Impact	Marginally higher TCO2e than Option 1 (<2x)	2
Neutral / Negligible Impact	Business as usual scored as neutral (Option 1) or Negligible difference to Option 1	3
Minor Opportunity / Positive Impact	Marginally lower TCO2e relative to Option 1 (<2x)	4
Major Opportunity / Positive Impact	Significantly lower TCO2e relative to Option 1 (>2x)	5

Evaluation

The results from the EA ERIC calculation are shown in Table 29.

Table 29- Net Whole Life Carbon Results

Option	Net Whole Life Carbon (TCO2e)
Option 1	2690
Option 2	780
Option 3	250

Table 30- Carbon Assessment Scoring Results

	Option 1	Option 2	Option 3
Score	3 – Neutral / Negligible Impact	5 - Major Opportunity / Positive Impact	5 - Major Opportunity / Positive Impact

Reasoning / Key Driver	The total whole life carbon is significant due to the construction of two new spillways and embankment cut-off required to address the dam safety concerns.	Overall significantly less carbon generated relative to Option 1. The construction of a new spillway and embankment cut-off required for Lower Cannop Ponds will generate a substantial amount of carbon, but owing to this being the smaller of the two spillways and the majority of earthworks for Upper being able to re-use material on site, the carbon footprint is much lower.	Overall significantly less carbon generated relative to Option 1. The total whole life carbon is primarily driven through the earthworks and removal of existing structures which is relatively small compared to other options.

3.12 Heritage

Methodology

A qualitative assessment of the options has been undertaken to consider the potential impacts to heritage assets and the historic landscape. To inform this, a Heritage Impact Assessment was carried out to establish the heritage baseline, the significance of potentially impacted heritage assets and the historic landscape and identify the potential implications of different types of options.

A review of available data identified 74 heritage assets within a 500m study area, 20 of which are located within the site boundary. This includes archaeological evidence of prehistoric, Roman, medieval, post-medieval and 20th century date.

The area has been profoundly shaped by its industrial history – the natural resources of iron ore, coal, timber, stone and fast flowing water, made it a centre for iron production from an early date. The Cannop Ponds are a part of this industrial story; created in the 19th century to supply water to the Parkend Ironworks, and later used to supply water to the neighbouring stone processing works and railway. While water management is a core part of the Forest of Dean's industrial story, there are few places where this is so

apparent as at the Cannop Ponds, due to their survival and legibility in the historic landscape. The two ponds are a feature of the historic landscape of the Forest of Dean and are non-designated heritage assets.

Evaluation approach

The qualitative assessment of the options employed below uses the definitions below, developed from the DMRB approach[6]:

Table 31: Heritage scoring approach

Description	Criteria	Score
Major Risk / Negative Impact	Loss of heritage asset/historic landscape and/or quality and integrity of the asset; severe damage to key characteristics, features or elements	1
Minor Risk / Negative Impact	Some measurable loss to heritage asset/historic landscape, but not adversely affecting the integrity; partial loss of/damage to key characteristics, features or elements	2
Neutral / Negligible Impact	No change to the heritage significance of the ponds or the surrounding historic landscape	3
Minor Opportunity / Positive Impact	Benefit to, or addition of, key characteristics, features or elements; improvement of attribute quality	4
Major Opportunity / Positive Impact	Large scale or major improvement to heritage asset/historic landscape; extensive restoration; major improvement of attribute quality	5

The assessment is based on the current level of design. There may be further impacts to heritage assets beyond the immediate scheme footprint which are not considered here, such as those resulting from access creation, compounds and construction method.

There may also be opportunities for mitigation not considered here, such as partial retention of spillways. As these are not included in the current detail level of the design, a worst-case scenario has been assessed.

Further details are set out in the Heritage Impact Assessment in Appendix I.

[6] DMRB LA104 Environmental assessment and monitoring

Evaluation

Option 1

This option would retain both ponds as waterbodies, meaning that their significance as part of the historic industrial landscape would be maintained. The option would require the complete removal of the historic spillway structures at both ponds, modification to the Upper Pond embankment and likely also the removal of the historic dam structure of the Lower Pond. This would mean that the significance of the historic structures affected would be lost. This would include the loss of any surviving parts of the Lower Pond dam which relate to the Bixslade Tramway, which predates its construction. There could also be impacts beyond the footprint of the existing Lower Pond spillway due to the likely need to increase the spillway size – this could remove parts of the surrounding historic environment, such as the leat earthworks which once connected the pond to Parkend Ironworks.

Mitigation and enhancement measures, including creating new interpretation to promote understanding of the historic industries alongside recording of the existing structures in advance of construction (preservation by record) are recommended, but would not change the overall scoring of the assessment.

Option 2

This option would involve the removal of the dam spillway at Upper Pond with the re-naturalisation of the brook and the creation of small wildlife ponds. Although the embankment would be retained, there would be a loss of historic structures in the removal of the spillway. There would also be a change to the appearance of the valley and a reduction in the legibility of it as part of the historic landscape. This would not be a complete loss that the removal of the pond would create, as the smaller wildlife ponds and reedbed wetland which would be created would retain a sense of the waterbody, which could be supplemented with heritage interpretation.

The Lower Pond would be retained as a waterbody, meaning that its significance as part of the historic industrial landscape would be maintained. However, this option would require the complete removal of the historic spillway structure of Lower Cannop and likely also the modification of the historic dam structures at both Upper and Lower Cannop, meaning that the significance of the historic structures would be lost. This would include the loss of any surviving parts of the dam which relate to the Bixslade Tramway, which predates the construction of the dam. There could also be impacts beyond the footprint of the existing spillway due to the likely need to increase the spillway size – this could remove parts of the surrounding historic environment, such as the leat earthworks which once connected the pond to Park End Ironworks.

Mitigation and enhancement measures, including creating new interpretation to promote understanding of the historic industries alongside recording of the existing structures in advance of construction (preservation by record) are recommended, but would not change the overall scoring of the assessment. Option 2 would result in a partial loss of significance to both the built and landscape components of the Upper Pond and the complete loss of the built components of the Lower Pond, although it would remain as a part of the historic landscape.

Option 3

This option would involve the removal of the dam spillway at Upper Pond and the dam spillway and structures at the Lower Pond. In the area of the Upper Pond there would be some retention of the historic landscape character as, although they would be changed in appearance, there would still be ponds present. There would be a complete loss of the historic landscape feature of the Lower Pond. Option 3 would result in a partial loss of significance to both the built and landscape components of the Upper Pond and a loss of significance to both the built and landscape components of the Lower Pond. If assessed separately, the Upper Pond would score as 2 (minor risk/negative impact), while the Lower Pond would score as 1 (major risk/negative impact).

Table 32 - Heritage Scoring Results

	Option 1	Option 2	Option 3
Score	2 - Minor Risk / Negative Impact	2 - Minor Risk / Negative Impact	1 - Major Risk / Negative Impact
Reasoning / Key Driver	This option would result in the loss of the built components of both ponds, but they would remain as a part of the historic landscape.	This option would result in the loss of the built components of the Lower Pond, but it would remain as a part of the historic landscape. At the Upper Pond there would be a partial loss of significance to both the built and landscape components.	This option would result in the loss of significance to both the historic built structures and the historic landscape components of the Lower Pond and the partial loss of significance to both the built and landscape components of the Upper Pond.

3.13 Water Environment Report (WFD)

Methodology

The Water Environment (Water Framework Directive) (England and Wales) Regulations (WER) (amended 2017) transposes the European Commission Water Framework Directive (WFD) into English and Welsh law. Although the UK legislation is now referred to as the 'WER' the common usage term /abbreviation remains as 'WFD'; this is the preferred term of reference for legislation and associated data in this report.

The following section sets out a study-specific approach to the assessment of WFD risks and opportunities associated with the three options. This section considers several elements:

- A review of the water legislative context as an integrated approach to the sustainable management of water by considering the interactions between surface water, groundwater, and water-dependent ecosystems
- Review of relevant water bodies, water courses, geology, topography, and land use
- Site overview and a review of the construction risks associated with each option.
- An assessment of impact/opportunity, based on options construction works, impact/benefit of the final option, and the likely consenting route on relevant surface water bodies and groundwater bodies.
- Future water bodies objectives that include mitigation measures.

Evaluation approach

For the purposes of the study, and to allow for broadly consistent assessment of options, the following qualitative assessment matrix has been developed to assess the option(s) overall.

Table 33: WER Scoring Approach

Description	Qualitative description	Score
Major Risk / Negative Impact	Risk of significant negative impact on one or more features of the water environment from the proposed option relative to the baseline (Do Nothing)	1
Minor Risk / Negative Impact	Risk of minor negative impact on one or more features of the water environment from the proposed option relative to the baseline (Do Nothing)	2
Neutral / Negligible Impact	No impact on one or more features of the water environment from the proposed option relative to the baseline (Do Nothing)	3
Minor Opportunity / Positive Impact	Minor positive impact on one or more features of the water environment from the proposed option relative to the baseline (Do Nothing)	4
Major Opportunity / Positive Impact	Major positive impact on one or more features of the water environment from the proposed option relative to the baseline (Do Nothing)	5

Evaluation

Detailed scoring of the options and their risks/opportunities are outlined in the 'Water Environment Options Appraisal Report' included in Appendix J. Below is a summary of the conclusions from that report and scoring of each option.

Option 1

This option involves major works to the reservoir structures of both the upper and lower dams to fulfil MIOS and extend the lifespan of the assets. This approach would increase the footprint of the structures and marginally reduce the size of the reservoirs to accommodate the increase in spillway structures.

The anticipated temporary impacts of this option would be the typical temporary construction related impacts on all of the WFD quality elements for Ecological Status (i.e. biological, hydromorphological, physico-chemical, specific pollutants) and Chemical Status, such as sediment mobilisation, material spills (e.g. hydrocarbons), watercourse diversion impacts.

Potential permanent impacts include the continuation of a barrier to fish passage (in contrary to the WFD Water Body Level Measures Objectives), the continuation of heavily modified geomorphological processes (e.g. incision, sedimentation, lack of floodplain connection) and the maintenance of an isolated lentic, lacustrine aquatic ecology.

There would also be enhancement / compensation requirements to account for an increase in the spillway footprints and dam embankments which requires the clearance of wet woodland habitat (a water-dependent ecosystem).

Option 2

This option involves reconnecting the watercourse through the upper reservoir and dam to introduce a mixed-habitat (wetland and reedbed) with online pond systems and modifications to the lower dam structures to fulfil MIOS.

The anticipated temporary impact of this option would be the typical temporary construction related impacts on all of the WFD quality elements for Ecological Status (i.e. biological, hydromorphological, physico-chemical, specific pollutants) and Chemical Status, such as sediment mobilisation, material spills (e.g. hydrocarbons), watercourse diversion impacts.

Potential permanent impacts include the continuation of a barrier to fish passage (in contrary to the WFD Water Body Level Measures Objectives) at the lower reservoir. Further, heavily modified geomorphological processes (e.g. incision, sedimentation, lack of floodplain connection) and an isolated lentic, lacustrine aquatic ecology would be maintained at the lower reservoir. The upper reservoir would benefit from potential improvements to aquatic habitats (e.g. species diversity and extent), geomorphological processes (e.g. sediment transport and processing) and potential secondary water quality benefits (e.g. fine sediment management, vegetative filtration of nutrients and chemicals, physico-chemical parameters such as temperature, dissolved oxygen, pH).

Option 3

This option would include the discontinuance of both reservoirs through the reconnection of the watercourse through both dam structures and introduction of embankments within the upper reservoir basin to create multiple smaller pond habitats (wetland) in combination with the re-introduction of the Lower Cannop Brook at the lower reservoir location with leaky dams through the valley.

The anticipated temporary impacts of this option would be the typical temporary construction related impacts on all of the WFD quality elements for Ecological Status (i.e. biological, hydromorphological, physico-chemical, specific pollutants) and Chemical Status, such as sediment mobilisation, material spills (e.g. hydrocarbons), watercourse diversion impacts.

Potential permanent impacts include the re-introduction of fish passage (in alignment with the WFD Water Body Level Measures Objectives) through the restored Cannop Brook. Furthermore natural geomorphological processes (e.g. sediment transport and processing, floodplain reconnection at the lower pond, diversity of geomorphic habitats) would be re-introduced by this option, and a mix of lotic (riverine) and lentic (wetland) aquatic ecology would likely establish, improving the aquatic habitat diversity and extent, and potentially providing secondary water quality benefits (e.g. fine sediment management, vegetative filtration of nutrients and chemicals, physico-chemical parameters such as temperature, dissolved oxygen, pH).

Table 34: Scores for WFD.

	Option 1	**Option 2**	**Option 3**
Score	2 – Minor Risk/ Negative Impact	4 - Minor Opportunity/ Positive Impact	4 - Minor Opportunity/ Positive Impact
Reasoning / Key Driver	Reinstating the reservoir structures will have a minor adverse impact on the Water Environment Regulations (WFD) quality elements	Opportunity for re-naturalising the Upper Cannop Pond, benefiting the Water Environment Regulations (WFD) quality elements.	Opportunity to create online pond systems through Upper Cannop and reinstate Cannop Brook through the valley, benefiting the Water Environment Regulations (WFD) quality elements.

3.14 Environmental Impact Assessment (EIA)

Methodology

The purpose of the EIA review has been to assess the potential consenting risks of each option given in this report. The scoring seeks to provide an indication of the likelihood of each option triggering the need for an EIA. The methodology adopted is the following:

- A Review of the EIA Process.
- A high-level qualitative review of each Option against typical EIA topics including: Ecology, Arboriculture, Heritage, Water Environment, Waste, Ground Conditions, Noise, Traffic, Landscape and Visual, Major Accidents and Disasters, Air and Climate. Full details of the potential risks and opportunities for each option and topic are provided in Appendix K.
- Scoring indicates overall likelihood of EIA/consenting risk.

Evaluation approach

Table 35 EIA scoring approach

Description	Qualitative description	Score
Major Risk / Negative Impact	High likelihood of requiring EIA.	1
Minor Risk / Negative Impact	Moderate likelihood of requiring EIA.	2
Neutral / Negligible Impact	EIA may or may not be required and design development may be able to mitigate the risks	3
Minor Opportunity / Positive Impact	Unlikely to trigger EIA	4
Major Opportunity / Positive Impact	Highly unlikely to require EIA – scope of work does not trigger.	5

Review of the EIA Process

EIA Screening

The Town and Country Planning (Environmental Impact Assessment) Regulations 2017 (as amended), contain schedules of types of projects that either require an EIA to be

undertaken (Schedule 1 Development) or which may require an EIA (Schedule 2 Development).

It is considered that the proposed development options may align with the Schedule 2 description '10. Infrastructure projects (i) Dams and other installations designed to hold water or store it on a long-term basis'. The applicable threshold which introduces the requirement for EIA screening is that the development exceeds 1 hectare in size. As such, all options are likely to meet the threshold criteria for EIA screening.

For any Schedule 2 Development, EIA is more likely to be required if it would be likely to have significant effects on the special character of any 'sensitive area'. Certain designated sites are defined in regulation 2(1) as sensitive areas and the thresholds and criteria in the second column of the table in Schedule 2 are not applied. All developments in, or partly in, such areas should be screened. These are:

- Sites of Special Scientific Interest (SSSI) and European sites;
- National Parks, the Broads and Areas of Outstanding Natural Beauty; and
- World Heritage Sites and scheduled monuments[7].

Nagshead SSSI is located immediately adjacent to the south of the existing Lower dam. Nagshead SSSI provides an excellent example of the broad-leaved woodland habitat typical of the Coal Measures and is noted for its ornithological importance. Options 1, 2 and 3 will require the limited removal of trees within the SSSI boundary in the area of the Lower Pond spillway. Circular 11/99 states however it does not follow that every Schedule 2 Development in (or affecting) these areas will automatically require EIA. In each case, it will be necessary to judge whether the likely effects on the environment of that development will be significant in that particular location.

Schedule 2 Development will only require EIA if the options are considered likely to have a significant effect on the environment, determined by a Schedule 3 Assessment (Screening). Three broad criteria which should be considered for Schedule 3 assessment are outlined in the EIA Regulations:

- Characteristics of development;
- Location of development; and
- Types and characteristics of the potential impact.

[7] Environmental Impact Assessment - GOV.UK (www.gov.uk)

EIA Assessment Stages

If it has been determined (i.e. through screening) that the development falls within the remit of the EIA Regulations and is likely to have a significant effect on the environment and therefore requires an assessment, the principal stages in the preparation of an Environmental Statement (ES) are as follows:

- consultation and engagement;
- baseline data gathering;
- identification of potential impacts;
- embedded mitigation;
- scoping;
- assessment phase 1;
- mitigation (embedded and additional);
- assessment phase 2; and
- reporting (ES).

It should be noted that although consultation is listed as the first stage in the list above, it is inherent in the iterative EIA process. Best practice is for consultation to be undertaken as early as possible and continue as an iterative part of the whole EIA process. This approach ensures that the design project team is informed, and issues and concerns of stakeholders/consultees can be fully explored, practicable alternatives properly considered, environmental issues discussed and potentially scoped out early, and avoids delay due to late redesign of the development in response to consultee comments. The stages of consultation can be summarised as follows:

- Preliminary consultation: screening and scoping;
- Consultation: during the EIA process: information, opinions, public consultation; and
- Formal consultation: after the ES submission.

Planning and Programme Considerations

Should screening identify that a development is likely to have a significant effect on the environment, full planning permission would need to be sought from the local planning authority. In addition, preparation should be made for the determination period of full planning application with EIA rather than standard planning application. A full planning application requiring an EIA has a determination period of 16 weeks from submission.

Evaluation

The following sections highlight the main topics which potentially trigger EIA or would require further assessment for each option. Further detail is provided in Appendix I.

Option 1

The works would mean the loss of historic spillway structures. However, change in land use, geomorphology and habitats will be limited as both ponds will be retained. This option would also be consistent with the Landscape Character Assessment for the area and the present recreational amenity of the site would remain.

The extent of the temporary works are not understood at this time. It is likely the temporary works would require the drain down of the ponds therefore effecting a wider area with additional risks which may require further assessment. This would increase the likelihood of requiring an EIA.

Option 2

Replacement of the Lower Pond spillway would remove the historic spillway structure. However the open water, habitats, geomorphology and landscape features of the pond would be retained. The Upper Cannop spillway would be removed and a series of ponds created in the basin area. The change in land use from the removal of the dam and spillway at Upper Cannop Pond, would change the character from open water to wetland habitat. This would likely result in the loss of some angling recreation, changing the landscape amenity of the site.

The option presents a substantial change to the historic environment, habitats, geomorphology and landscape character of the site, most notably in the Upper Pond area. There are a potential number of environmental risks, and therefore the option will have a high likelihood of requiring EIA.

Option 3

The removal of the spillways at Upper and Lower Ponds would mean the loss of the historic spillway structures. It would also change the character from open water to a series of constructed smaller ponds, changing the landscape amenity of the sites. The removal of the ponds would result in a loss of association with the “Long history of mining and industrial activity”. Careful consideration in the design process and mitigation would be required to retain the connection between the landscape and its historic use. Visual effects are likely to arise from changes of views of open water to narrow views at Lower Cannop Pond, and open views across the smaller ponds at Upper Cannop Pond. Over time these views are likely to change to smaller and shorter views.

The option presents a substantial change to the historic environment, habitats, geomorphology and landscape character of the site in both the Upper Pond and Lower Pond areas. There is a potential number of environmental risks, and therefore the option will have a high likelihood of requiring EIA.

Table 36: EIA Scoring Results

	Option 1	Option 2	Option 3
Score	2 - Moderate likelihood of requiring EIA	1 - High likelihood of requiring EIA	1 - High likelihood of requiring EIA
Reasoning / Key Driver	Loss of historic spillway structures. Open water geomorphology, habitat and landscape character retained.	The loss of open water in the Upper Pond area impacts the landscape character, geomorphology and habitat. Loss of historic spillway structures.	The loss of open water in the Upper & Lower Pond area impacts the landscape character, geomorphology and habitat. Loss of historic spillway structures.

3.15 Planning

Methodology

The following section sets out a study-specific approach to the assessment of planning risks associated with the options and considers:

- Site overview and planning history.
- A review of the planning policy constraints.
- An assessment of risks, based on the overarching principle of development, impact of the likely consenting route on programme and likely validation requirements, and potential impact on programme.

Site Overview and Planning History

The key features of the site which impact on the planning approach and requirements are:

- The reservoirs are located in deciduous woodland, with ancient and replanted woodland to the east and west of the site.
- The site is located immediately to the south of Cannop Bridge Marsh and 5km southwest of Woorgreens, both of which are nature reserves managed by Gloucestershire Wildlife Trust (GWT). The ponds provide habitat to a variety of

freshwater fish including roach, rudd, perch, tench, eels, bream, carp, pike, dace, brown trout, and sticklebacks. As detailed in Section 0 Nagshead SSSI is located immediately adjacent to the south of the existing Lower Pond dam spillway.

- The site is in Flood Risk Zone 3 and forms part of the flood plain.
- The site is located within a Coal Mining Reporting Area, meaning it is an area of known coal mining activity. The site is near probable shallow coal mine workings, is within the abandoned mines catalogue, has around 10 mine entries, and is a surface coal resource area.
- In terms of access, the only access road to the Cannop Ponds car park is off Speech House Road and additional informal parking is provided by few larger laybys on New Road. Pedestrian and cycle access to the site is more widely available.

A summary of the recent planning history of the site is provided in Table 37 below**Error! Reference source not found.**.

Table 37 Planning history

Application Reference	Description	Status
P1801/08/FUL	Installation of a micro hydro electricity generating plant, re using water outfall from Cannop Ponds to provide "green electricity", together with the inclusion of a stream bed.	Granted Permission 22/12/2008
P0046/10/NONMAT	Installation of a micro hydro electricity generating plant, re-using water outfall from Cannop Ponds to provide "Green Electricity" together with the inclusion of a stream bed (non-material amendment).	Granted Permission 12/01/2010

Permitted Development (PD) Rights

A key consideration in developing a strategy for achieving planning consent is to identify whether any of the proposed works would constitute permitted development or not. Given the limited extent of Forestry England's PD rights concerning dams, the scale of the potential works, and reputational risk or proceeding without planning consent, PD rights have not been considered further.

Planning Applications

Where an option is of a scale that would require Full Planning Permission, an application would be made, accompanied by a range of submission documents that review, assess, and identify any necessary mitigations for impacts from the proposals. The statutory determination period of a Full Planning Application is 8 weeks (post validation).

Should the proposals breach the threshold of being a 'Major' Planning Application then a longer determination period of 13 weeks applies.

As has been reviewed in Section 0 of this report, it is likely that any option taken forward will have significant environmental considerations and may be screened as an EIA development. Should the scheme be EIA development, a statutory determination period of 16 weeks would apply to any Major Planning Application submitted for the works.

National Planning Policy Framework

The National Planning Policy Framework (NPPF)[8] sets out the Government's planning policies for England and how these should be applied. It provides a framework within which locally-prepared plans for development can be produced.

Any planning applications are to be determined in accordance with the local development plan unless material considerations indicate otherwise. The NPPF has to be taken into account during the preparation of the local development plan and is a material consideration in planning decisions.

Paragraph 11 of the NPPF outlines that decision-making should apply a presumption in favour of sustainable development. It further states that applications for planning permission must be determined in accordance with an up-to-date development plan. Where there are no relevant development plan policies, or the most important policies for that application are out of date, permission should be granted unless applying NPPF policies to protect areas/assets of importance provides a clear reason for refusing the proposed development, or any adverse impacts of doing so would significantly and demonstrably outweigh the benefits, when assessed against the policies in the NPPF taken as a whole.

The NPPF was most recently updated on 5 September 2023. The sections of the NPPF considered most relevant to Cannop Ponds, and which would apply to all options under consideration, are given in

[8] National Planning Policy Framework (2023) Department for Levelling Up, Housing and Communities. Available at: https://www.gov.uk/government/publications/national-planning-policy-framework--2

Table *38*.

Table 38 Relevant sections of NPPF

Section	
2	Achieving sustainable development
8	Promoting healthy and safe communities
9	Promoting sustainable transport
12	Achieving well-designed places
14	Meeting the challenge of climate change, flooding and coastal change
15	Conserving and enhancing the natural environment
16	Conserving and enhancing the historic environment

Overall, it is likely that all options could be designed to be in accordance with the NPPF.

Forest of Dean Local Plan

Planning legislation holds that the determination of a planning application shall be made in accordance with the Development Plan unless material considerations indicate otherwise. The Forest of Dean Local Development Plan is comprised of three documents: the Core Strategy, the Allocations Plan, and the Cinderford Area Action Plan.

The **Core Strategy (adopted February 2012)**[9] seeks to deliver the needs of the community based on the likely changes in population and seeks to make progress towards delivering a more sustainable Forest of Dean. The Core Policies set out within the Core Strategy are applied district-wide and set out the broad approach to development under key policy areas. Relevant Policies within the Core Strategy are as follows:

Table 39 Relevant policies from the Core Strategy

Policy Reference	
CSP.1	Design, environmental protection and enhancement (strategic objective: providing quality environments)

[9] Core Strategy Adopted Version (2012) Forest of Dean District Council. Available at: https://www.fdean.gov.uk/planning-and-building/planning-policy/our-current-local-plan/

CSP.2	Climate Change Adaptation (Strategic objective: thriving sustainable communities)
CSP.3	Sustainable Energy within Development Proposals (Strategic objective: thriving sustainable communities)
CSP.7	Economy (strategic objective: develop the local economy including tourism)
CSP.9	Recreational and amenity land including forest-waste- protection and provision (Strategic objective: providing quality environments)

Overall, it is likely that all options could be designed to be in accordance with the Core Strategy.

If the proposal is designated as 'major development', CSP3 of the policy requires as a minimum, sufficient on-site renewable energy to reduce carbon dioxide emissions from energy use by 10%. However, given that none of the options lead to energy use, it is likely that this requirement could be omitted subject to justification and agreement with the LPA. These discussions may be complicated by the presence of the existing hydro-scheme feeding the stone works.

The **Allocations Plan (adopted June 2018)**[10] contains policies aimed at individual sites in the area as well as more detailed policies relating to the overarching core policies of the Core Strategy. The Cannop Depot (AP24) is an allocated site within the plan which is allocated for improved facilities for extensive recreational cycling. However, Cannop Ponds is not included within this.

Table 40 Relevant policies from the Allocations Plan

Policy Reference	
AP1	Sustainable Development
AP4	Design of development
AP5	Historic character and local distinctiveness
AP7	Biodiversity
AP8	Green infrastructure

[10] Allocations Plan 2006 to 2026 Adopted (2018) Forest of Dean District Council. Available at: https://www.fdean.gov.uk/planning-and-building/planning-policy/our-current-local-plan/

Overall, it is likely that all options could be designed to meet the requirements of the Allocation Plan.

Cinderford Area Action Plan[11] provides a blueprint for the regeneration of the northern quarter of Cinderford to improve the area for residents and businesses in order to attract investment. Whilst a Development Plan document, it does not apply to the Cannop Ponds site and is therefore not considered to be relevant to this proposed development.

The **Landscape Supplementary Planning Document (adopted March 2007)**[12] reflects the Forest of Dean District Council's commitment to the protection and enhancement of the district's varied and much valued landscape. The document sets out important principles, involving a character led approach, relating to the environment and more specifically the landscape, and provides guidance, encouraging a more inclusive approach to planning. The design of the confirmed option would need to address the key principles.

Forest of Dean Emerging Local Plan

The Forest of Dean District Council are in the process of developing a replacement local plan. They have most recently undertaken consultation in 2022 to develop the second preferred options strategy.

The next step for the local plan is to create a draft plan and conduct formal consultation by the winter of 2023 and to publish this draft in the spring of 2024. At that stage, the emerging local plan carries 'limited weight'.

The new plan aims to safeguard the environmental assets the district values as well as achieve sustainable design across the district. The plan shall be monitored irrespective of the option taken forward with consideration given to design amendments should the new plan produce relevant additional or changes to policies.

Evaluation approach

For the purposes of this options appraisal, and to allow for broadly consistent assessment of options, the following qualitative matrix has been developed. This is based on professional judgement and does not supplement the need for specific Planning Strategy which will need to be developed once the final option is selected.

Table 41 Planning Scoring Approach

[11] Cinderford Area Action Plan (2012) Forest of Dean District Council. Available at: https://www.fdean.gov.uk/planning-and-building/planning-policy/our-current-local-plan/
[12] Landscape Supplementary Planning Document (SPD) (2007) Forest of Dean District Council. Available at: https://www.fdean.gov.uk/planning-and-building/planning-policy/supplementary-planning-documents/

Likely Consenting Route	Minimum Determination Period	Score
Major Planning Application with EIA	16 Weeks	1
Major Planning Application	13 Weeks	2
Full Planning Application	8 Weeks	3
Minor Planning Application	8 Weeks	4
Permitted Development	Time to seek Certification of Legal Development from LPA	5

Evaluation

In summary, all the proposed options would likely require a Major Planning Application due to the size and complexity of the works. They all perform well in terms of the principles of development and a successful Planning Application should be possible, subject to addressing the principles and incorporating any necessary mitigation measures into the scheme. Each option has slightly different risks and benefits in terms of individual policy sections such as heritage or biodiversity which influences the likely need for EIA and therefore the scoring.

Table 42 Assessment of Planning Consent Required

	Option 1	Option 2	Option 3
Planning Consent Required	2 - Likely Major Planning Application	1 - Likely Major Planning Application with EIA	1 - Likely Major Planning Application with EIA
	Likely to require full planning permission with moderate likelihood of requiring Major Application with EIA.	Likely to be a Major Application requiring EIA.	Likely to be a Major Application requiring EIA.

3.16 Habitats Regulations Assessment (HRA)

The HRA Process

Regulation 63 of the Habitats Regulations requires a competent authority (in this case Forestry England or agreed competent other) to make an 'Appropriate Assessment' of the implications of the plan or project for the site in view of its conservation objectives, before deciding to undertake or give consent for a plan or project which (a) is likely to have a significant effect on a European Site (either alone or in combination with other plans or projects), and (b) is not directly connected with or necessary to the management of that site. In light of the conclusions of the assessment, the competent authority may proceed with or consent to the plan or project only after having ascertained that it will not adversely affect the integrity of the European Site.

The assessment of a project under the Habitats Regulations can be split into four stages, as described below.

Stage 1 is the assessment of the likelihood of a plan or project having a significant effect on a European Site or its features. This is the trigger for the need for an Appropriate Assessment as set out in Regulation 63(1). The Appropriate Assessment (Stage 2) is the detailed consideration of the potential effects of the plan or project in relation to the conservation objectives for the European Site(s) to determine if there is likely to be an adverse effect on the integrity of the site (i.e. an effect that would compromise the site meeting its conservation objectives). Providing it can be demonstrated that with appropriate mitigation measures the plan or project would not give rise to an adverse effect on the integrity of a European Site, the plan or project can proceed.

Where this cannot be demonstrated or there is uncertainty, the assessment would then need to consider if there were any other alternatives to the plan or project (Stage 3) that would not give rise to adverse effects on the integrity of the European Site. If there are alternatives, Stage 4 would then consider if there are any Imperative Reasons of Overriding Public Interest (IROPI), only at this stage can Compensatory Measures be considered. It is very unusual for plans or projects to be considered in Stages 3 or 4, but there is precedent for it with other UK reservoir sites.

Methodology

All European designated sites within 10 km of the site were identified using the Defra Multi-Agency Geographic Information for the Countryside (MAGIC) website[13]. These include the Wye Valley Woodlands Special Area of Conservation (SAC), Wye Valley and Forest of

[13] MAGIC. (2023). Magic interactive Mapping Application. http:/www.magic.gov.uk/MagicMap.aspx. Date accessed, 04 September 2023.

Dean Bat Sites SAC, River Wye SAC, Severn Estuary Ramsar site, Severn Estuary SAC and the Severn Estuary Special Protection Area (SPA). Details of these sites and their designating features are shown in Table 43 below.

Table 43- European Designated Sites within 10 km of Cannop Ponds

Site Name	Designating features	Approximate distance from site (m)
Wye Valley Woodlands SAC	Annex I habitats that are a primary reason for selection of this site: *Asperulo-Fagetum* beech forests, *Tilio-Acerion* forests of slopes, screes and ravines and *Taxus baccata* woods of the British Isles. Annex II species present as a qualifying feature, but not a primary reason for site selection: Lesser horseshoe bat.	2,800m west
Wye Valley and Forest of Dean Bat Sites SAC	Primarily designated for: Lesser horseshoe bat (*Rhinolophus hipposideros*): this complex of sites on the border between England and Wales contains by far the greatest concentration of lesser horseshoe bat in the UK, totalling about 26% of the national population. It has been selected on the grounds of the exceptional breeding population, and the majority of sites within the complex are maternity roosts. The bats are believed to hibernate in the many disused mines in the area. Greater horseshoe bat (*Rhinolophus ferrumequinum*). This complex of sites represents greater horseshoe bat in the northern part of its range, with about 6% of the UK population. The site contains the main maternity roost for bats in this area, which are believed to hibernate in the many disused mines in the Forest.	5,200m south
River Wye SAC	Annex I habitats that are a primary reason for selection of this site: Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation.	6,200m west

	Annex I habitats present as a qualifying feature, but not a primary reason for selection of this site: Transition mires and quaking bogs. Annex II species that are a primary reason for selection of this site: White-clawed (or Atlantic stream) crayfish (*Austropotamobius pallipes*), brook lamprey (*Lampetra planeri*), sea lamprey (*Petromyzon marinus*), river lamprey (*Lampetra fluviatilis*), twaite shad (*Alosa fallax*). Atlantic salmon (*Salmo salar*), Bullhead (*Cottus gobio*) and otter (*Lutra lutra*). Annex II species present as a qualifying feature, but not a primary reason for site selection: Allis shad (*Alosa alosa*).	
Severn Estuary Ramsar	The site qualifies under: Criterion 1 of the Ramsar convention due to its immense tidal range. Criterion 2b due to its unusual estuarine communities, reduced species diversity and high productivity. Criterion 2c, as it is particularly important for the run of migratory fish between the sea and rivers via the estuary and its particular importance for migratory birds during passage periods in spring and autumn. Species using the estuary include salmon, sea trout (*Salmo trutta morpha trutta*), sea lamprey, river lamprey, allis shad, twaite shad and eel (*Anguilla anguilla*). Criterion 3a by regularly supporting in winter over 20,000 waterfowl. Criterion 3c by regularly supporting, during the same period, internationally important populations of five species of waterfowl; European white-fronted goose (*Anser albifrons albifron*), dunlin (*Calidris alpina alpina*), redshank (*Tringa tetanus*), shelduck (*Tadorna tadorna*) and gadwall (*Anas strepera*).	8,100m south-east
Severn Estuary SAC	Annex I habitats that are a primary reason for selection of this site comprise; estuaries, mudflats and sandflats not covered by seawater at low tide and Atlantic salt meadows (Gl*auco-Puccinellietalia maritimae*).	8,100m south-east

	Annex I habitats present as a qualifying feature, but not a primary reason for selection of this site comprise sandbanks which are slightly covered by sea water all the time and reefs. Annex II species that are a primary reason for selection of this site comprise sea lamprey, river lamprey and twaite shad.	
Severn Estuary SPA	The site is designated for: Its internationally important populations of regularly occurring Annex 1 species (Bewick's swan (*Cygnus columbianus bewickii*)); Its internationally important populations of regularly occurring migratory bird species, including European white-fronted goose, dunlin, redshank, shelduck and gadwall; Its internationally important assemblage of waterfowl.	8,100m south-east

The Wye Valley Woodlands SAC has been scoped out of the assessment (excluding lesser horseshoe bats) as no pathways, direct or indirect exist between the SAC and the site. Lesser horseshoe bats of the Wye Valley Woodlands are scoped in because this species of bat can travel large distances from their roosts to forage and it is feasible to expect these bats to be found at Cannop Ponds.

The River Wye SAC has also been scoped out (excluding otters) as the SAC is not hydrologically connected to Cannop Ponds. Therefore, no direct or indirect pathways of impact exist between the SAC the site. Otters have been included as surveys have recorded their presence at Cannop Ponds and otter can travel between catchments.

The Severn Estuary SAC has also been scoped out of this assessment given the large intervening distance between Cannop Ponds and the SAC (over 8 km). Furthermore, fish eDNA sampling has not recorded the presence of sea lamprey, river lamprey nor twaite shad. As such, no pathways of impact are expected.

The impacts of each of the options were assessed against the remaining designated sites and scoped in features (Wye Valley and Forest of Dean Bat Sites SAC, lesser horseshoe bats of the Wye Valley Woodlands SAC, otters of the River Wye SAC, Severn Estuary Ramsar site and SPA). The significance of potential effects was assessed in the absence of any avoidance and/or mitigation measures. The assessment has been made with awareness of the conservation objectives for the features of the European Sites, although as stated in

the relevant guidance the assessment of the project against the conservation objectives is not required until the Appropriate Assessment stage of the HRA process. In the assessment of the significance of effects, professional judgement was applied using the following criteria (as sufficient information about the elements and interests is often unavailable):

- The vulnerability/sensitivity of the receiving environment/features of interest;
- When the risk of effects is likely to occur (e.g. construction and/or operation);
- The likely geographical extent of the effects; and
- Likelihood of significant effects (e.g. those above negligible in magnitude) occurring based on previous experience with similar elements, where available.

Evaluation approach

Table 44: HRA scoring approach

Description	Criteria	Score
Major Risk / Negative Impact	Significant impacts to European designated site(s)	1
Minor Risk / Negative Impact	Minor impacts to European designated site(s)	2
Neutral / Negligible Impact	Negligible or no long term impact to European designated site(s)	3
Minor Opportunity / Positive Impact	Minor benefit to European designated site(s)	4
Major Opportunity / Positive Impact	Significant benefit to European designated site(s)	5

Evaluation

Option 1

This option upgrades the existing dams and spillways, with limited changes to the open water and marginal habitats; some of the wet woodland and lowland mixed deciduous woodland will be lost. However, this is not a significant change that will affect the conservation status of the features of the designated sites within 10 km of the site, largely due to the large intervening distances (minimum of 5.2 km).

Option 2

This option removes the spillway at Upper Cannop, to create a series of small ponds with an increase in reedbed habitat. While the water level in Lower Cannop would be reduced by one to two metres.

With regard to the bird features of the Severn Estuary Ramsar and SPA, these changes will retain suitable habitat, albeit reduced in size, for those species that are present on the site. The numbers of the qualifying bird species found at Cannop Ponds are relatively low in respect to the numbers found at the Severn Estuary and any changes to the populations at Cannop Ponds is unlikely to have a significant effect on the conservation status of the Severn Estuary Ramsar and SPA sites.

European eels are also a qualifying feature of the Severn Estuary Ramsar site that are present at Cannop Ponds. However, the proposals will retain suitable habitat for eels and are likely to improve connectivity up and downstream. The Severn Estuary Ramsar site is approximately 11.8 km downstream from Cannop Ponds, this large distance between the site and the designated site, combined with standard good construction practices will ensure that no likely significant effects to eels will occur during the construction phase.

The bat features of the Wye Valley Woodlands SAC and the Wye Valley and Forest of Dean Bat Sites SAC (greater horseshoe and lesser horseshoe bats) are not expected to be significantly affected by the proposal as these species of bats are not documented to forage across open water. They use woodland edge habitat to commute and forage, which will be largely unchanged under these proposals.

The otter qualifying feature of the River Wye SAC will benefit from the proposals as they will create a more diverse habitat complex that will increase otter foraging resources.

The wintering bird surveys found that the qualifying bird species for the Severn Estuary Ramsar site and SPA that are found at Cannop Ponds favour Upper Cannop. Therefore, the impact of reducing open water on Upper Cannop may have slightly more of an impact on the Ramsar site and SPA than a reduction in open water habitat at Lower Cannop.

Option 3

Option 3 removes both spillways, creating a series of smaller ponds at Upper Cannop, with more linear, naturalised ponds at Lower Cannop using embankments and leaky wooden structures. This will reduce the amount of open water habitat but will increase the diversity of habitats present.

The reduction in open water habitat may negatively impact the qualifying bird features of the Severn Estuary Ramsar and SPA that are found at Cannop Ponds. However, as stated for Option 2, any changes to the populations of bird species found at Cannop Ponds that are qualifying species of the Ramsar and SPA are unlikely to have a significant effect on the conservation status of the designated sites.

European eels are also a qualifying feature of the Severn Estuary Ramsar site that are present at Cannop Ponds. However, the proposals will retain suitable habitat for eels and are likely to improve connectivity up and downstream. The Severn Estuary Ramsar site is approximately 11.8 km downstream from Cannop Ponds, this large distance between the site and the designated site, combined with standard good construction practices will ensure that no likely significant effects to eels will occur during the construction phase.

Similar to Option 2, greater and lesser horseshoe bats will largely be unaffected by the proposals. Additionally, the more diverse habitat complex will benefit otters in the same way Option 2 does.

The otter qualifying feature of the River Wye SAC will benefit from the proposals as they will create a more diverse habitat complex that will increase otter foraging resources.

The wintering bird surveys found that the qualifying bird species for the Severn Estuary Ramsar site and SPA that are found at Cannop Ponds favour Upper Cannop. Therefore, the impact of reducing open water on Upper Cannop may have slightly more of an impact on the Ramsar site and SPA than a reduction in open water habitat at Lower Cannop.

Table 45- HRA Scores

	Option 1	Option 2	Option 3
Score	3 – Neutral / Negligible Impact	4 - Minor Opportunity / Positive Impact	4 - Minor Opportunity / Positive Impact
Reasoning / Key Driver	Minor habitat changes on site and intervening distance to designated sites.	Increase in habitat diversity a benefit for otters.	Increase in habitat diversity a benefit for otters.

3.17 Recommended Option

Sections 3.6 through to 3.16 in this document set out the various interrelated factors which inform the selection of the recommended option to be taken forwards for design development. These factors are illustrated graphically in the summary table in Section 3.5.

As can be seen from the table, the options all have varying implications for the qualitative and quantitative factors which have been assessed. The recommended option is therefore determined based on the solution which strikes the best balance between the competing priorities of the projects decision making criteria, as described in Section 3.1.

Option 1

Option 1 is the option that is closest to maintaining the status quo of the existing reservoirs and represents the least change to the area. In this option the reservoirs will maintain their existing size and volume. Significant works will be undertaken to rebuild and increase the size of both spillways at Upper and Lower Cannop and install cut off walls to prevent further seepage through the existing dams. Both reservoirs will also require the installation of a low level draw down facility and works will be undertaken to Upper Cannop to strengthen the existing dam.

The significant civil engineering works required under this option also lead to this solution having the highest construction and carbon costs. From a flood risk perspective this option is considered neutral, as the new spillway structures will be designed to replicate the flood storage performance of the existing reservoirs as closely as possible. There is a minor negative impact on biodiversity net gain, resulting from the additional habitat which will be lost through the increased spillway sizes and the need to stabilise and reprofile the Upper Cannop embankment dam.

This option has strong support from the public and politically driven stakeholders, which rightly reflects the important part the reservoirs play in the landscape of the Forest of Dean. When considering broader social value considerations there are no significant additional benefits, beyond the status quo, in terms of recreational use, connection to nature and the associated physical and mental health benefits.

Option 2

Option 2 retains a significant body of water at Lower Cannop, whilst replacing the reservoir at Upper Cannop with wetland habitat. The reduced volume and surface area of Lower Cannop will still necessitate significant civil engineering works, including replacing the existing spillway and substantial works to prevent seepage through the dam. The spillway at Lower Cannop will be designed to allow greater fluctuation of water levels in Lower Cannop thereby significantly increasing it's surface water storage capability.

As for Option 1, the costs and carbon associated with these civil engineering works are still significant. There is a substantial overall reduction in cost and carbon in comparison to Option 1, due to the reduced extent of heavy civil engineering work required at Upper Cannop. This option will have a significant impact on reducing flood risk downstream in Parkend due to the increased storage at Lower Cannop and the optimisation of the spillway design. A positive biodiversity net gain is achieved through the creation of the wetland habitat at Upper Cannop and also the additional marginal habitat created due to the reduced water levels in Lower Cannop.

This option provides improved access to the Cannop Ponds site and seeks to incorporate additional facilities such as viewing platforms, resting places and improved trail infrastructure. This leads to significant associated public health benefits. There is limited public support for this option, although it is perceived as the ‘next best’ after Option 1.

Option 3

This option replaces the existing reservoirs with a series of smaller cascading water bodies. These all act individually to attenuate surface water flows and thereby recreate the flood benefit provided by the existing reservoirs. Option 3 limits the extent of heavy civil engineering work further in comparison to Options 1 and 2, although significant works

are still required. These include creating the 'notches' through the existing dams to reconnect the watercourse, as well as the works to construct the smaller cascading waterbodies.

This option is a significant reduction in cost and carbon in comparison to Options 1 and 2, due to the further reduced extent of heavy civil engineering works. The impact on flood risk is expected to be similar to Option 1. As for Option 2, Option 3 achieves a positive biodiversity gain through the creation of reedbed and wet grassland habitat in place of Upper and Lower Cannop. By removing the barrier to fish passage presented by the two dams, Option 3 performs best when assessed against the WFD.

Option 3 maximises the public health potential of the site through the creation of new walking and nature trails. This option also incorporates new viewing platforms, resting places and the potential for facilities such as bird hides. Similarly to Option 2, there is limited public support, however there are significant public health benefits, despite the removal of the larger bodies of open water.

Recommendation

Based on the analysis of the three options, summarised above and set out in detail in the other sections and appendices of this report, Option 2 strikes the optimum balance between the risks, benefits and investment required to secure the future of Cannop Ponds. This option provides a unique opportunity to contribute towards a downstream flood risk improvement for Parkend, as well as demonstrating an overall positive impact for biodiversity and accessibility at the site. This option is therefore recommended to be taken forward for design development and consenting.

4 Commercial Case

4.1 Technical consultants

Forestry England has ecology and heritage expertise in house, although capacity is limited. Specialist technical advice is therefore needed from an external source. Services required include and are not limited to:

- Reservoir engineering services (including All Reservoirs Panel Engineer support)
- Flood modelling and hydraulics
- Civil engineering
- Ecology services
- Heritage services
- Geotechnical and geo-environmental services
- Stakeholder engagement and communications support
- Planning and other consenting support

Ove Arup & Partners Ltd (Arup) have provided professional services to date on this project via the Environment Agency's Collaborative Delivery Framework (CDF). This call off contract ends at the point of construction. This existing contract will either need to be extended to cover the additional scope required, or a new contract to support the next phase of the project will be needed.

Whilst a direct award to Arup using CDF remains a procurement route available to Forestry England, other routes will be explored to establish the most appropriate contract to support the rest of the project. Options include:

- Other frameworks.
- Competitions via DPS, which have been used successfully for technical advice on other investment projects.
- Open competition

4.2 Construction

The recommended option requires the procurement of complex civil engineering works with significant design elements. This includes complex temporary works which are needed to control and manage water during the works. There are several ways these could be procured.

Traditional Construction Contract

In this route the design would be procured via a contract with a consultant. The construction contract is separately tendered with a full design provided to the contractor to price. If contractor input is required during the design stage this would have to be provided through a separate contract. There is therefore a risk that the contractor appointed to complete the construction work is different to the contractor advising on the design stage which brings potential risks.

Design and Build

A design and build contract with a single contractor responsible for design, management, and delivery of the project. This allows integration of design and construction to address buildability. Success from this type of contract requires a fully detailed brief from Forestry England.

Early Contractor Involvement (ECI)

A step further than Design and Build, ECI is one contract with two distinct stages. Stage 1 involves design development and construction planning, which is aimed at meeting our objectives and which leads to the agreement of a target price. Stage 2 covers the period of detailed design and construction. This is most appropriate for large and complex contracts.

The final procurement strategy for both technical consultants and construction contracts will be developed in conjunction with Commercial Services as part of the Full Business Case, reflecting the most suitable route to market for the chosen option. This will also consider continuity of our advice team when determining an appropriate procurement strategy.

5 Financial Case

Per workings detailed in Section 3.10, short-term cash requirements (excluding the impact of inflation) range from £5.7m (Option 3) to £10.3m (Option 1).

These significant levels of expenditure would put Forestry England reserves under considerable pressure to the extent that other, planned works would have to be scaled accordingly. It is therefore paramount that, once a final option is agreed upon, sources of funding are explored.

All expenditure associated with this project would impact Forestry England's statement of comprehensive income as an expenditure item. Other than the potential impact on cash reserves, Forestry England's balance sheet should be unaffected by this project. Per

Forestry England's application of IAS41 – Property, Plant and Equipment, infrastructure works such as reservoirs are not capitalised, but are instead expensed as they occur.

Confirmation of stakeholder (e.g. Forestry Commission / DEFRA) support will be a priority as the confirmed option is further developed in future stages.

Consultation has taken place with a tax consultant and it is anticipated that the works required to Cannop Ponds will be considered a business activity. An application will be made to HMRC for a ruling to confirm this position.

6 Management Case

The Future of Cannop Ponds project is a major undertaking for Forestry England and sits outside the scope of business-as-usual activities. Consequently Forestry England have appointed a dedicated project manager to support the project.

This project manager is responsible for coordinating the overall delivery of the project, including the management of external supporting consultants, who provide the necessary specialist technical expertise.

The project team is supported by a strong team of operational Forestry England staff from within the West England Forest District. Due to staff commitments to normal day to day activities there is limited further capacity to support the project from within the district team. Key resources such as communications support and other specialisms will be kept under review as the project develops and further external resource brought in as needed.

6.1 Project Management Plan

A detailed project management plan already exists for the Cannop Ponds project. This plan is currently under review and is being revised by the project team. The existing plan is available on request, although hasn't been included as an appendix as it is currently under revision.

Part 4 – Key Assessments

Risk Assessment

The project Risk Assessment is detailed in Appendix L. This identifies the key active project risks to date, together with their respective mitigating actions.

At this stage of the project there are a significant number of risks, which are anticipated to reduce once the decision on the recommended option has been made.

The risk register is reviewed regularly and will be updated once the recommended option has been selected, regularly thereafter, and resubmitted with the FBC submission.

Reputation Assessment

The positive reputational benefits of the recommended option are:

- Reducing the risk of a dam failure at Lower Cannop to be as low as reasonably practicable. The risk of a dam failure at Upper Cannop is removed. This represents active management of infrastructure and reservoir risk management and being responsible stewards of these assets.
- Reduction of flood risk in Parkend, downstream of Cannop Ponds. This is positive both for the communities who are at risk of flooding from the Cannop Brook, as well as key stakeholders such as the Environment Agency and local authority.
- Improving the range of complex habitats at the site and creating an overall gain for biodiversity. This will be positive for wildlife focussed stakeholders and those in the local community who have a broad wildlife focus as opposed to specific interests in individual species.
- Retaining a significant open body of water at Lower Cannop. This will retain the character of the existing Lower Cannop area, albeit with a reduced water level. This will also enable the potential for Lower Cannop to remain as a fishable body of water.
- Improved public health benefits by increasing access through provision of viewing platforms, resting places and improved trail infrastructure.

The negative reputational aspects of the recommended option are:

- Any option other than retaining the reservoirs as they currently are (Option 1), will be perceived negatively by local campaign groups and members of the local community.
- The expenditure of significant financial resources on implementing an option which public engagement suggests doesn't have the broad support of the local community.

- The removal of the existing hydropower facility at the site. The existing hydro scheme is a low head scheme and therefore doesn't generate significant amounts of renewable electricity. As such it is relatively inefficient in comparison to other forms of renewable generation. All options will result in the loss of the existing hydroelectric facility.
- The loss of historic infrastructure in the form of the existing spillways and the change to the landscape through the removal of Upper Cannop as one large waterbody. All options will result in the loss of the existing historic spillway structures.
- The perceived 'loss' of the existing reservoir habitats and species. Whilst ecology surveys have shown these to be of relatively limited value, this is not the perception of the wider community.
- The visual impact on the surrounding area during the construction stage. This will be significant and whilst temporary, will require careful consideration from a communications perspective.
- The removal of public access to the area during the construction works.
- The removal of access for fishing during the works, as well as permanently, if fishing isn't reinstated post completion. The management of the existing fish stocks and their removal to facilitate the works will also be perceived negatively, even if restocked post completion.
- The temporary impact on the existing catering trailer provider and other businesses who will not be able to use the site during the construction stage.

Diversity and Inclusion Assessment

An equality and impact assessment will be required as part of the development of the recommended option.

At this stage, the likely impacts of all of the options presented are related to physical access to the Ponds. The Our Shared Forest plan commits Forestry England to ensuring all way-marked trails provided are designed and maintained as being tramper friendly. However, this is only one element of accessibility, and the development of the recommended option, especially any access and interpretative elements, provides for all with recognition of sight, hearing and mobility impairments. Growing the Future sets the ambition of reaching across society so the nation's forests are welcoming to all, and this should include this major project.

Assessment of the Constraints

This is / will be a technically challenging and potentially controversial project.

The primary constraints have been discussed in outline above, and are summarised as bullet points below:

- Compliance with the 1975 Reservoir Act – whichever option is taken forward needs to discharge the existing MIOS, and be undertaken in compliance with the Act, and to the satisfaction of EA as the enforcement authority for the Act.
- Water Framework Directive – the chosen option needs to be compatible with the WFD, both long-term and during delivery phases.
- Habitats Regulation Assessment / Environmental Impact Assessments
- Biodiversity Net Gain – changes to the planning regulations will require the project to deliver a 10% net gain, and demonstrate that enhancement is secured for 30-years.
- Existing leases and licences – There are three tenants who will be directly impacted by whichever option is selected. Forest of Dean Stone Firms occupy a site immediately adjacent to Lower Cannop dam, with inclusion of the infrastructure for the hydro-electric scheme. Yorkley & District Angling Club have held a short-term lease of the fishing rights for several decades. A catering trailer operates from the Cannop Ponds car park adjacent to Upper Cannop on a short-term licence basis.
- Yorkley & District Angling Club have a separate agreement with the EA to stock Upper and Lower Cannop Ponds with fish (native and non-native). On cessation of the lease of the fishing rights the Club may leave the fish in situ, so that management of the fish stocks will revert to Forestry England. Oversight of the relevant fishery regulations sits with the EA.
- Protected species regulations – although matters pertaining to the protected species regulations will mainly be addressed through the HRA and EIA processes, it is important to recognise the constraints likely to result from the presence of Eels, Otters, and Bats (of all species).
- Community concern – delivery of any of the options has potential for significant community concern. Whilst Option 1 is clearly the most widely supported option, aspects of that, such as draining the Ponds to allow the major civil engineering works to proceed will be contentious. This concern may result in protest, that may manifest itself through harassment and / or bullying of Forestry England staff in general, or individuals directly involved in the project in particular.

Assessment of the Dependencies

There are several dependencies external to the project, but the key considerations are:

- EA regulation / enforcement – the EA's reservoir safety and fisheries teams are very aware of the project and steps being taken. They are currently satisfied that we are progressing as fast and professionally as reasonably possible to discharge the outstanding MIOS. However, there is the potential for their stance to change.
- Funding – it is recognised that at present the costs associated with all options cannot be readily covered by Forestry England capital investment funds or reserves. Separate funding streams will need to be bid for / negotiated. This dependency links to the wider economic situation, through inflationary pressures in the construction industry and pressures on Government spending.
- Local Planning Authority – whilst the local planning process is robust, the strong likelihood is that the scheme will need to go through planning at the Forest of Dean District Council. The Council has previously passed a motion supporting retention of the Ponds, whilst acknowledging reducing downstream flood risk is important. There is a possibility that political interests, linked to the community concern constraint flagged earlier may negatively impact the planning process.

List of Appendices

Appendix A – Cannop Ponds Dam Safety Assessment

Appendix B – Plans and illustrations of Options

Appendix C – Flood risk modelling results

Appendix D – Public engagement event feedback

Appendix E – Biodiversity Net Gain technical note

Appendix F – CIRIA B£ST scoring assessment

Appendix G – Capital construction cost estimates

- Financial options appraisal – Option 1
- Financial options appraisal – Option 2
- Financial options appraisal – Option 3

Appendix H – Carbon technical note

Appendix I – Heritage Impact Assessment

Appendix J – Water environment options appraisal report

Appendix K – EIA High level review

Appendix L – Project risk register