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SUMMARY REPORT

# Fish Passage (Habitat Restoration) Feasibility Study for Shepley Mill, River Wandle, Carshalton

Client: SES Water

Reference: PC2812-ZZ-XX-RP-Z-001
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# Table of Contents



## Table of Figures



## Table of Tables

# 1 Shepley Mill Habitat Restoration Project

## 1.1 The need for the project

In-channel water control structures, such as weirs, are common on many UK rivers. However, they often impede the free movement of migratory fish species, including Atlantic salmon (*Salmo salar*), trout (*Salmo trutta*) and European eel (*Anguilla anguilla)*, which is a requirement of the Water Environment (Water Framework Directive) (England and Wales) Regulations 2017 (typically known as the WFD Regulations), as amended by the Floods and Water (amendment etc.) (EU Exit) Regulations 2019.

As a result, many watercourses in the UK are failing to reach the required target of Good Ecological Status (GES) due to physical modifications that adversely impact fish and eels, such as weirs. Consequently, water control structures such as weirs are being removed or modified to help meet the requirements of the WFD Regulations to protect and, where possible, enhance the condition of all bodies of water. In addition to WFD requirements, the Eels (England and Wales) Regulations 2009 require the Environment Agency to prepare and implement Eel Management Plans (EMPs), with the objective of reducing human induced (anthropogenic) impacts on eel stocks. Making rivers passable for juvenile and adult eel is a key element of the Environment Agency's EMPs.

To improve habitats, geomorphology and help meet WFD objectives and the Eels Regulations on the River Wandle, removal of the west weir on the Carshalton branch is being investigated as part of SES Water's Water Industry National Environment Programme (WINEP). Shepley Mill is at the downstream end of the Carshalton branch of the River Wandle, where it meets the Croydon branch (see **Figure 2.1**).


Wilderness Island separates the two branches before they converge downstream to discharge through culverts beneath the mill. The weirs associated with Shepley Mill are a barrier to fish and eels, which is one of the reasons why the Carshalton branch has 'bad' ecological status for fish.

## 1.2 Aims and objectives

As such, SES Water with assistance from Royal HaskoningDHV have undertaken a detailed feasibility assessment which considers alterations to the west weir at Shepley Mill. The study aims were to identify what alterations to the west weir are feasible from an engineering and fish passage perspective, but also whether the impact of the alteration on the upstream reaches are acceptable to stakeholders.

Although the feasibility study for the Shepley Mill Habitat Restoration Project predominantly focused on fish passage improvements directly upstream and downstream of Shepley Mill, benefits to geomorphology and in-channel habitats were also taken into consideration.

# 2 Site Location

Shepley Mill is located on the River Wandle (TQ 28278 65594) approximately 0.4 km north of Carshalton and 5 km west of Croydon, within the London Borough of Sutton (**Figure 2.1**). The mill itself may have been constructed in the early 15th century, as part of a large mill complex consisting of the "Water (leather) Mills" and "Hackbridge (snuff) Mills", which were used in the production of leather and snuff (a smokeless tobacco made from ground or pulverised tobacco leaves.

At the mill, two branches of the River Wandle, the Carshalton and Croydon, converge upon two weirs (west and east weirs) which discharge through separate culverts beneath the mill (**Figure 2.1**).

The west weir on the Carshalton branch, has a crest length of 14 m and is protected by a trash screen (owned by the Environment Agency), with a total width of 11.75 m consisting of 96 bars spaced at 0.16 m apart with a bar width of 0.02 m (**Figure 2.1**). The head drop across the structure is approximately 1.75 m (based on surveyed water levels) between the weir crest and concrete bed of the weir near the entrance to the culvert, which is a 1200 mm x 1200 mm square shaped concrete structure that forms part of the weir wall. The culvert is 64.8 m in length, with a head drop of approximately 0.3 m.

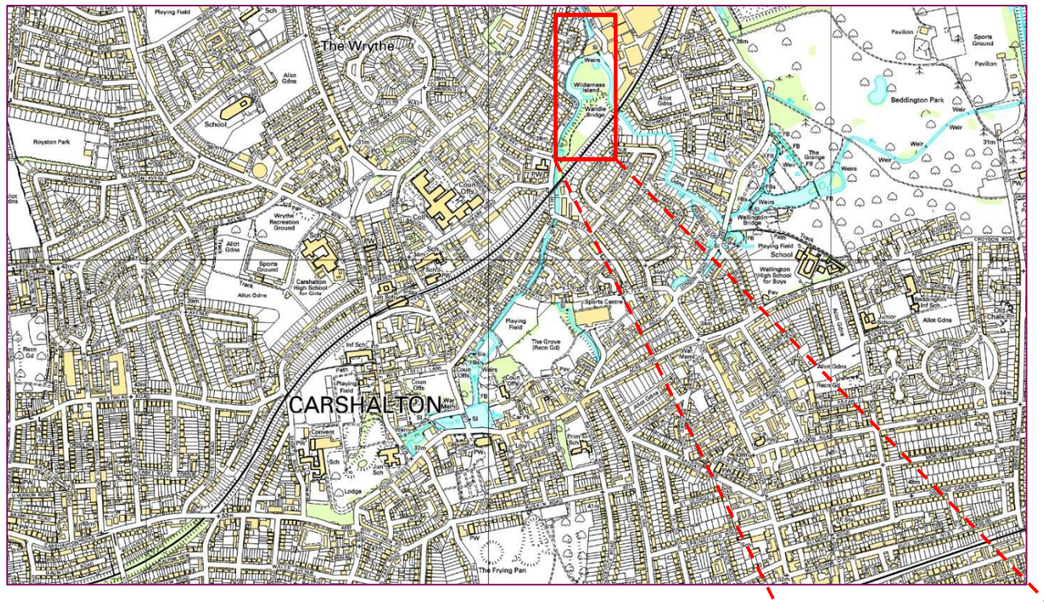
Although the majority of the River Wandle flow (approximately 95%) is from the Croydon branch; 60% of the flow is discharged over the west weir downstream into the River Wandle in response to the weir crest level being approximately 0.2 m lower than the east weir.

The east weir on the Croydon branch also has a crest length of 14 m, with the head drop across the structure approximately 1.4 m (based on surveyed water levels) between the top of weir crest (not the overspill weir) and bottom of the concrete bed, which leads into twin 1100 mm circular concrete pipes (**Figure 2.1**). The pipes, 3.5 m downstream, then converge into a single large 1200 mm circular concrete pipe, which then discharges flows downstream into the River Wandle. The total length of the culvert is 55.2 m, with an overall head drop of approximately 2 m and thus considerably steeper than west weir culvert.

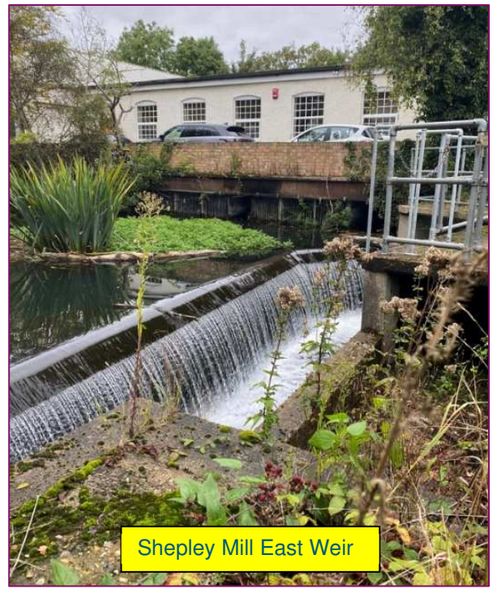
The land lying to the east of the Causeway adjacent the Carshalton branch and Wilderness Island Local Nature Reserve (LNR) (**Figure 2.1**) is owned by the London Borough of Sutton Council. Land adjacent the Croydon branch between Watermill House and the railway bridge is Registered Common Land. The west weir is owned by the Environment Agency, although ownership of the east weir is to be confirmed.

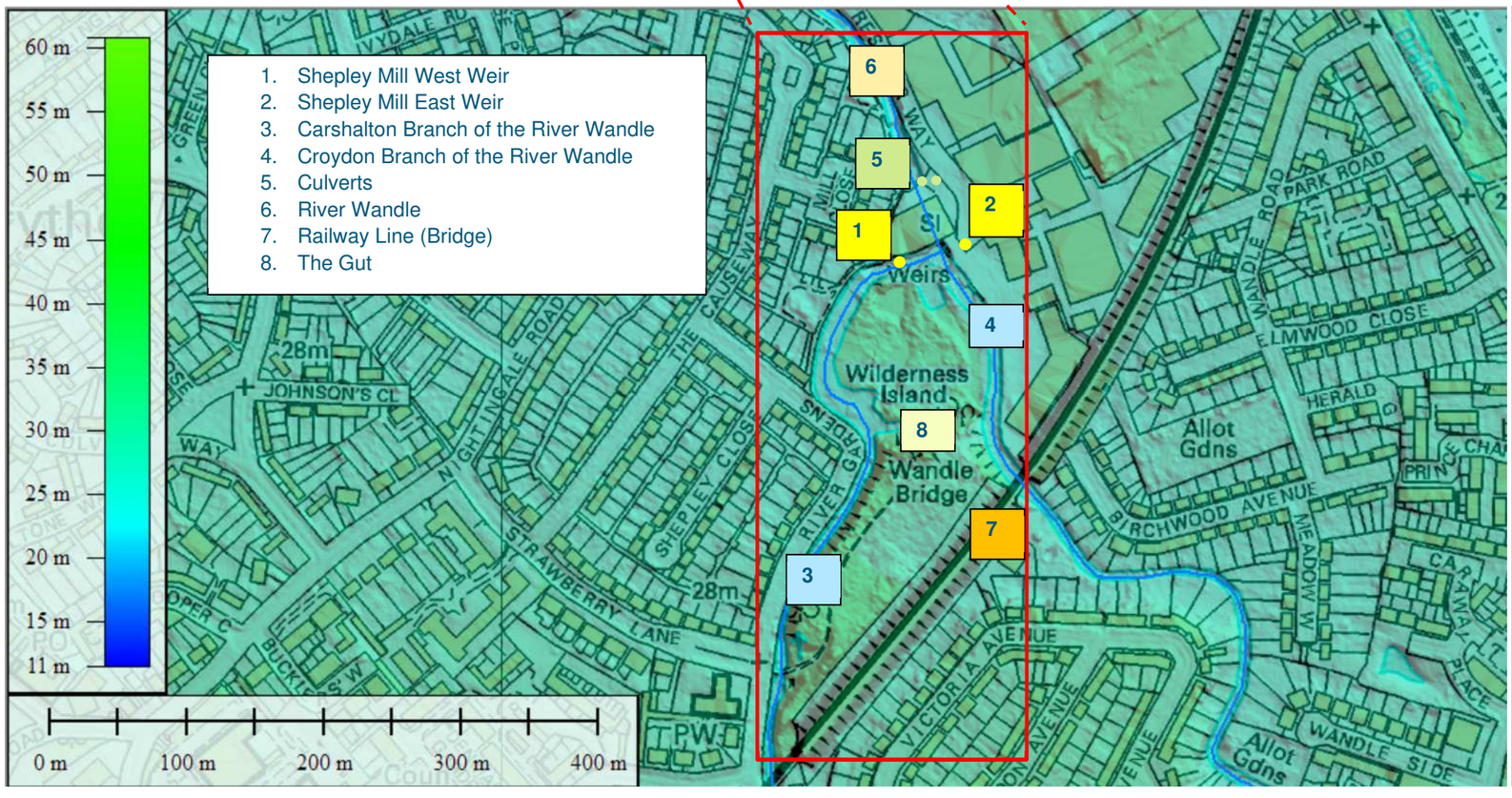
For migratory fish such as salmonids, which include Atlantic salmon and trout; the main limiting upstream passage factor through Shepley Mill are the aforementioned weir structures which are not passable for migratory fish due to the large head drops and potentially the culverts, which may not be hydraulically suited for migratory fish or potentially prone to blockage in particular the east weir culvert. There is also potential impassability for European eel, largely due to the lack of suitable climbing substrate and potentially high water velocities both at the weirs and along the culverts. Downstream passage for migratory fish (e.g. kelts, smolts, multi spawners) may be limited by the steep plunging flows of the weirs, which may cause injury and mortality.

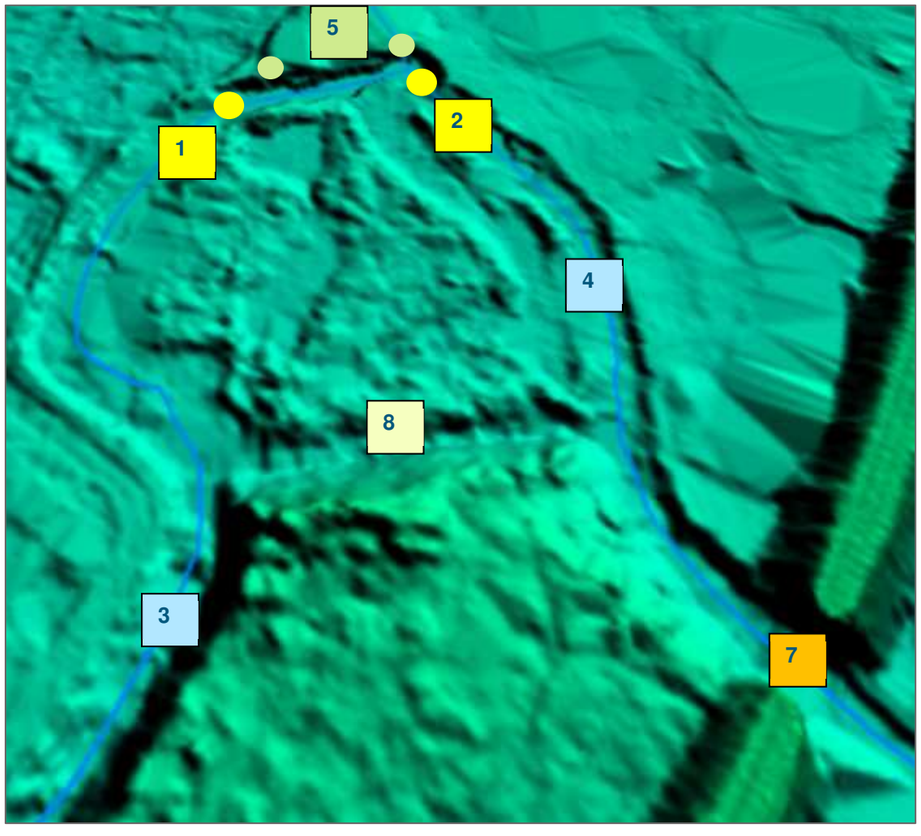
**Figure 2.1 Shepley Mill (Study Area)**







# 3 The Feasibility Approach

The below provides an overview of the approach taken in preparing the feasibility study for the Shepley Mill Restoration Project.

## 3.1 Stage 1 Engineering and Environmental Constraints

A review and validation of existing surveys, data and reports to inform the other stages and overall outcomes of the feasibility study was initially undertaken during Stage 1 for the project. This included compiling baseline information on the following:

- General site characteristics of Shepley Mill, such as the weirs and culverts as presented in **Figure 2.1**, including a desk based site condition assessment of the structures. This provided vital information in confirming the likely suitability of any in-stream structures to accept the potential implementation of a fish pass (or fish pass design); and potential habitat restoration enhancements.
- Site access constraints associated with Shepley Mill, including utilities services search.
- Hydrological, geomorphological and ecological characteristics of the River Wandle, in particular the Carshalton and Croydon branches of the River Wandle.

To complement the above desk based information complied for the project, a river morphology and engineering site walkover along the River Wandle immediately upstream and downstream of Shepley Mill was undertaken in order to gain an appreciation of the constraints and opportunities associated with the project. A validation of the existing surveys, data and reports was also carried out, along with a structural inspection of the Shepley Mill weirs; and a topographic (bathymetric) survey of the Carshalton and Croydon branches of the River Wandle, both upstream and downstream of the weirs. The survey included detailed measurements of the weirs and culverts. An aquatic and terrestrial ecological survey of the Carshalton and Croydon branches of the River Wandle was also undertaken along with sediment sampling of the branches, which was followed by an analysis of the chemical elements of the recovered sediments. The site walkover and all surveys were carried out in October 2021, followed by detailed reporting on geomorphology, ecology, sediment quality, engineering and potential fish passage (habitat) restoration solutions for the project.

## 3.2 Stage 2 Fish Passage Solutions and Concept Designs

Based on the outcomes of Stage 1 above and appropriate fish passage and geomorphology guidelines, a long list of proposed fish passage (and habitat) solutions was derived, with the most viable fish passage solutions short listed and taken forward for further consideration (and appraisal, see Stage 3 below). Potential habitat restoration solutions were also identified which would complement the solutions.

## 3.3 Stage 3 Appraisals of Fish Passage Solutions

The short listed fish passage (habitat) solutions identified in Stage 2 were appraised through a detailed engineering and environmental assessment against key environmental receptors including fish passage, hydrology, geomorphology, environment (e.g. ecology, heritage, and recreation), WFD compliance, condition and practicality.

The appraisal took into consideration a tested philosophy that has been implemented by Royal HaskoningDHV on catchment-scale fish passage appraisal projects throughout the UK, as outlined below:

- The potential to remove any barriers to fish passage entirely will be considered and recommended unless there is clear evidence that this is not feasible.
- If the constraints associated with individual structures are likely to preclude complete removal, the potential to modify the structure to improve fish passage and reduce impoundment will then be considered.
- For any structures that are operable or contain operable components, we will also consider changing the way they are operated if removal or modification is not feasible.
- If modification is unlikely to be feasible, the potential to install a bypass channel designed to reproduce naturally occurring features and flows suitable for the species of concern will be assessed.
- If there is no realistic potential to locate a bypass channel, then a technical fish pass or rock ramp installed onto the existing structure will be considered, or modification of structures will be recommended.

## 3.4 Stage 4 Preferred Fish Passage Solutions

The outcomes of the options appraisals enabled the selection of the preferred fish passage (habitat) solutions which could be taken forward to the next phase of the project. The solutions were chosen based upon their potential to successfully provide upstream and downstream passage for migratory fish/eels without impacting upon the existing hydrological, geomorphological and ecological characteristics of the Carshalton and Croydon branches of the River Wandle.

Confirmation on the preferred fish passage (habitat) solutions to be taken forward for further investigation in order to derive the final preferred solution, was validated through consultation with SES Water, partners and residents of the River Wandle through various stakeholder meetings undertaken in February 2021, January 2022, June 2022 and July 2022.

# 4 Stage 1 Engineering and Environmental Constraints

The below provides an overview of the key baseline information regarding engineering and environmental constraints associated with the Shepley Mill study area (see **Figure 2.1**) which need to be considered in order to identify the most viable fish (habitat) passage solutions for the project.

## 4.1 Designated Sites

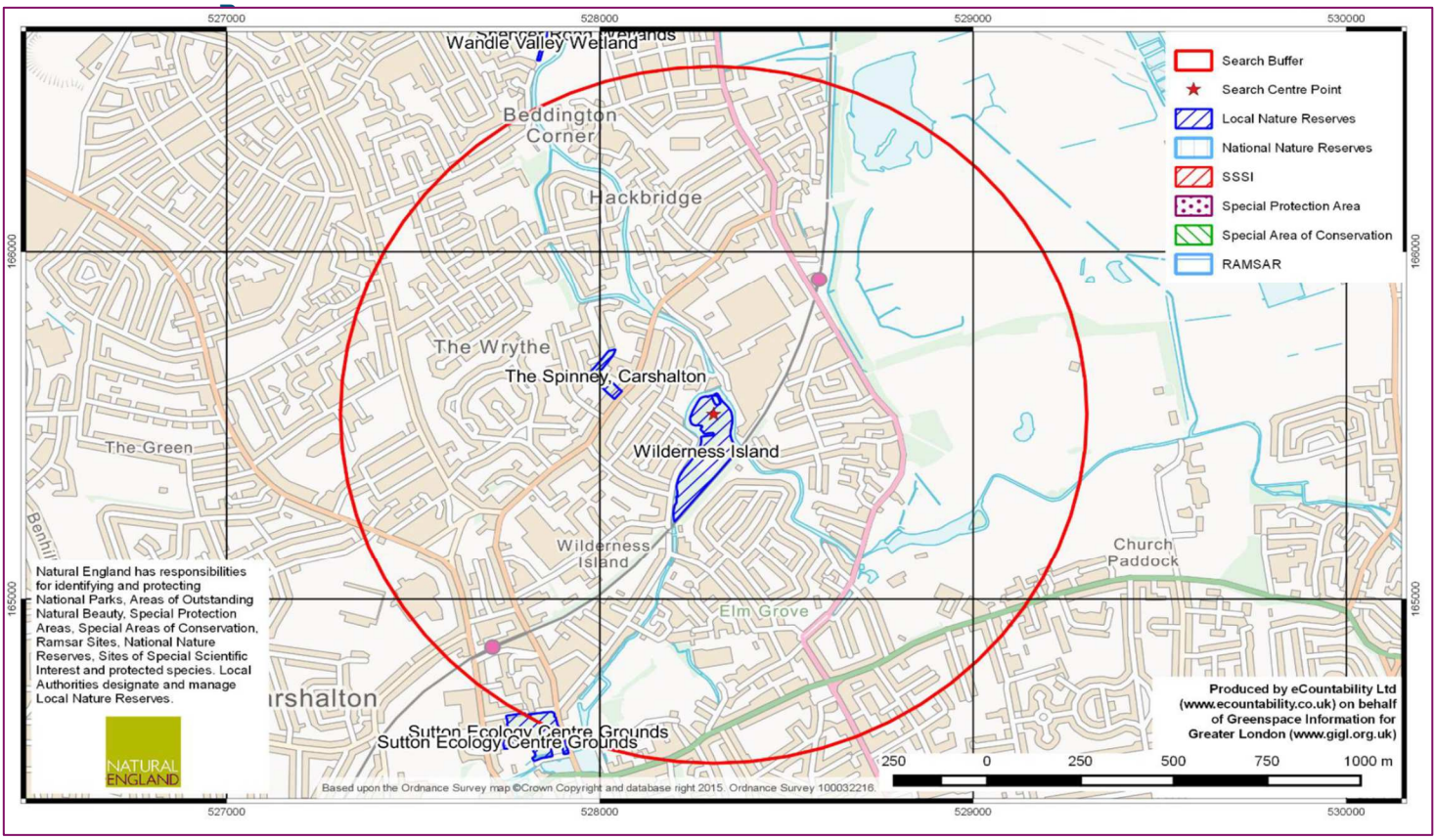
There are no National Site Networks (NSN), Ramsar sites or Sites of Special Scientific Interest (SSSI) within close proximity to the Shepley Mill study area. The following statutory sites and Local Nature Reserves (LNRs) are within 1 km of Wilderness Island (**Figure 4.1**):

- Sutton Ecology Centre Grounds (LNR) (1km from site);
- The Spinney, Carshalton (LNR) (250m from site); and
- Wilderness Island (LNR) (0m from site).

Wilderness Island lies between two arms of the River Wandle (Carshalton and Croydon) and supports a mosaic of different habitats including ponds, a sedge bed, secondary woodland, scrub and neutral grassland. 39 bird species have been recorded and regular sightings include kingfisher (resident on the River Wandle), great spotted woodpecker, whitethroat, bullfinch, goldfinch, grey wagtail and redpoll.


Wilderness Island Pond

**Figure 4.1 Statutory Sites and Local Nature**



There are seven Sites of Importance for Nature Conservation (SINCs) within 1 km of Wilderness Island, such as Upper River Wandle (M091), Beddington Farmlands (M092), Beddington Park (SuBI03), Sutton Ecology Centre (SuBI04), Carshalton Ponds, Grove and All Saints Churchyard (SuBII02) and Spinney (Nightingale Road Bird Sanctuary (SuL08).

## 4.2 Ecology and Geomorphology

Key terrestrial and aquatic flora and fauna species in the Shepley Mill study area include:

- Kingfisher (*Alcedo atthis*);
- Common pipistrelle (*Pipistrellus pipistrellus*);
- Soprano pipistrelle bat(*Pipistrellus pygmaeus*);
- Daubenton's Bat (*Myotis daubentoniid*);
- Japanese Knotweed (*Fallopia japonica*);
- Giant Hogweed (*Heracleum mantegazzianum*);
- Cherry Laurel (*Prunus laurocerasus*);
- Snowberry (*Symphoricarpos albus);*
- Floating Pennywort (*Hydrocotyle ranunculoides*);
- Bullhead (*Cottus gobio*);
- Brown/Sea Trout (*Salmo trutta*);
- European eels (*Anguilla anguilla*);
- Mirror carp (*Cyprinus carpio*);
- Pike (*Esox lucius*);
- Various caddisflies species (up to 18 species found in Wildness Island).

Although fish, such as brown trout may spawn within local reaches of the River Wandle, Shepley Mill is providing a significant barrier preventing all fish species using good quality habitat upstream of the Shepley Mill. There is anecdotal evidence, the actual brown trout population above Shepley Mill are hatchery reared fish.

The aquatic survey undertaken in October 2021 of the Carshalton and Croydon branches of the River Wandle identified low habitat diversity, with few habitat features in common with a natural channel, and a range of bank and channel modifications. The macrophyte species were restricted, and although the survey was out of season, the Environment Agency survey data nearby and previous macrophyte surveys support these findings.

Sedimentation is large issue within the Carshalton and Croydon branches of the River Wandle, with silt deposition evident including a shelf of silt deposited in the channel. Sediment deposition, impoundment and/or barrier movement restrictions are likely to be the influencing factors impacting the aquatic ecology within the river, in particular the macrophytes and fish.

A summary of the fluvial geomorphology of the Shepley Mill study area is provided below in **Figure 4.2**.

**Figure 4.2 Geomorphological Features of the Shepley Mill Study Area**

## 4.3 Water Framework Directive

The River Wandle at Shepley Mill comprises of two different surface water bodies – Wandle (Carshalton Branch at Carshalton) and Wandle (Croydon to Wandsworth); and one groundwater body – Bromley Tertiaries. The boundary of Bromley Tertiaries groundwater body cuts through the middle of Wilderness Island and then extends upstream on both branches of the Wandle. The two surface water bodies are both heavily modified and overall in moderate ecological status (Croydon to Wandsworth water body) and bad ecological status (Carshalton Branch at Carshalton water body), predominantly failing for biology, in particular fish in response to barriers (ecological discontinuity), impounded water bodies, groundwater abstraction, sewage discharge, flood protection – structures. Key issues to which this project will try and address within the study area through the implementation of proposed fish passage (habitat) restoration solutions.

## 4.4 Land and River Sediment Quality

Overall, despite extensive exploitation for public and industrial supply and waste disposal, the River Wandle has enjoyed a long historic reputation for the unusual clarity and quality of its chalk stream water. However, by 1905 the River Wandle in response to new sewage treatment works which provided continuous source of nutrients and chemicals that have not removed by sewage treatment processes, along with abstraction, road run-off and general urbanisation of the catchment has placed considerable pressure on the health of the River Wandle.

There is potential for made ground, containing a range of contaminants, which if disturbed could re-mobilise during flood events and enter the River Wandle, although based on the sediment samples recovered from the bed of the Carshalton and Croydon branches, the chemical determinants overall do not exceed the Generic Assessment Criteria (GAC) limit for Public Open Space, in particular Priority Hazardous Substances, including heavy metals; and the majority Polycyclic Aromatic Hydrocarbons (PAHs), with the exception of one of the PAHs, which does fail – benzo(b)fluoranthene. As such, there is potential that the sediment if removed from the Shepley Mill study area could be re-used for landscaping or habitat restoration work on site, although a risk assessment may be required regarding the re-use of benzo(b)fluoranthene.


However, based on the Canadian Sediment Quality Guidelines for the Protection of Aquatic Life, there are some metals and hydrocarbons which are within a range which could have adverse effects to aquatic life. Thus, any direct habitat restoration works which may involve the substrate of the Carshalton and Croydon branches of the River Wandle, will need careful consideration regarding potential remobilisation of the contaminants.

## 4.5 Recreation and Cultural Heritage

The River Wandle is enjoyed by walkers, bird watchers and recreational activities such as angling; with Wilderness Island owned by Sutton Borough Council and managed by the London Wildlife Trust, providing an urban wildlife haven for all to enjoy. A Public Right of Way (PRoW) (No 62) (and the Wandle Trial) traverses along the left bank of the Charlton branch along River Gardens past Watermill House and towards Nightingale Road, while several footpaths traverse through Wilderness Island. There are no Listed Buildings or Schedule Monuments in close proximity to Shepley Mill.

# 5 Stage 2 Fish Passage Solutions and Concept Designs

The below provides an overview of the potential short listed fish passage (habitat) solutions for the Shepley Mill site in which the solutions have initially been derived from detailed information gathered during Stage 1 of the project, including detailed engineering, fluvial, ecological and bathometric walkovers and surveys, review of existing reports and consultation with the Environment Agency, South East Rivers Trust (SERT), London Wildlife Trust and Sutton Borough Council (the Steering Group).

## 5.1 Solutions

### *Option 1: Full Weir Removal Only*

Full weir removal is on top of the hierarchy of suitable solutions to improve fish passage along the river systems. As such, Option 1 would overall consist of completely removing one or both weirs associated with Shepley Mill, desilting, regrading the bed; and installing trash screens at the entrance of one or both culverts to minimise the risk of debris entering/blocking the culverts. In addition, to ensure the successful migration of fish through either of the culverts, fish friendly modifications to the culverts, such as baffles, could be implemented.

### *Option 2: Full Weir Removal with Pre-Barrages / Step-Pools*

Further down the hierarchy of suitable solutions to improve fish passage along river systems, Option 2 would consist of completely removing one or both weirs associated with Shepley Mill. This would be combined with regrading the bed, desilting, installing trash screens at the entrance of one or both culverts to minimise the risk of debris entering/blocking the culvert; and constructing pre-barrages / step-pools along both the Carshalton and Croydon branches of the River Wandle. In addition, to ensure the successful migration of fish through either of the culverts, fish friendly modifications to the culverts, such as baffles, could be implemented.

### *Option 3: Full Weir Removal & Rock Ramps within the Carshalton & Croydon Branches*

This option consists of either removing one or both weirs associated with Shepley Mill, desilting, regrading the bed, constructing rock ramps within the Carshalton and Croydon branches of the River Wandle to improve fish passage; and installing trash screens at the entrance of one or both culverts to minimise risk of debris entering/blocking the culverts. In addition, to ensure the successful migration of fish through either of the culverts, fish friendly modifications to the culverts, such as baffles, could be implemented.

### *Option 4: Weir Lowering & Rock Weirs within the Carshalton & Croydon Branches*

This option which was originally put forward by CBEC Eco Engineering to improve fish passage and river habitat at Shepley Mill, consists of lowering the west weir by 1 m and constructing two fixed head rock weir/ramp structures on the Carshalton and Croydon branches of the River Wandle. The east weir would not be modified. In addition, to ensure the successful migration of fish through the west weir culvert, fish friendly modifications to the culvert, such as baffles, could be implemented.

### *Option 5: Technical Larinier Fish Pass on West Weir*

This option would consist of a technical fish pass (with super-active baffles i.e. Larinier) installed on the west weir, which as stated takes the dominant river flow with the entrance to its downstream culvert providing the greatest 'lead' for upstream migrating fish. A Larinier fish pass is proposed as it requires a relatively low flow (compared to other types of technical fish passes). The maximum gradient of a Larinier fish pass should be 15% with the length of any one flight limited to 10-12 m for migratory salmonids. Single flights can accommodate head differences up to a maximum of 1.5 m for migratory salmonids. As such, given the head drop at the weir is 1.75 m, a double flight Larinier with a resting pool will be required to meet the criteria for the successful operation of a Larinier. In addition, to ensure the successful migration of fish through the west weir culvert, fish friendly modifications to the culvert, such as baffles, could be implemented.

### *Option 6: Technical Larinier Fish Pass or Baffles/Pre-Barrage on East Weir*

This option would consist of either installing a low cost technical fish pass, such as a Larinier; or a low cost baffle (pre-barrage) fish pass on the east weir to improve fish passage. In addition, to ensure the successful migration of fish through the east weir culvert, fish friendly modifications to the culvert, such as baffles, could be implemented

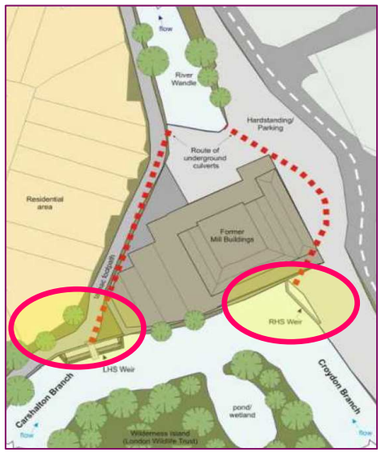
### *Option 7: Cylindrical Bristle Clusters on West or East Weir*

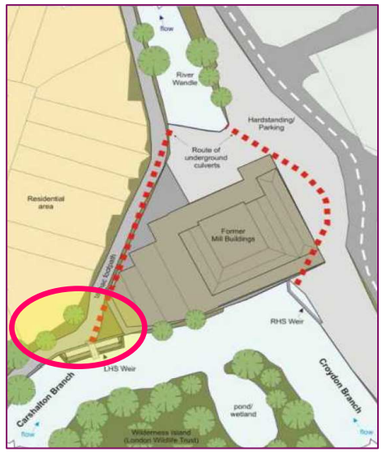
This option would consist of fixing Cylindrical Bristle Clusters (CBCs) on a constructed concrete ramp within either the west or east weir. CBCs have recently been tested by Montali-Ashworth et al (2020), in which an array of CBCs were mounted on the downstream face of a Crump weir, to improve upstream passage of multiple species of fish while maintaining gauging accuracy. Fish essentially utilised the low velocity zones created by the CBBs to facilitate passage. addition, to ensure the successful migration of fish through either of the culverts, fish friendly modifications to the culverts, such as baffles, could be implemented.

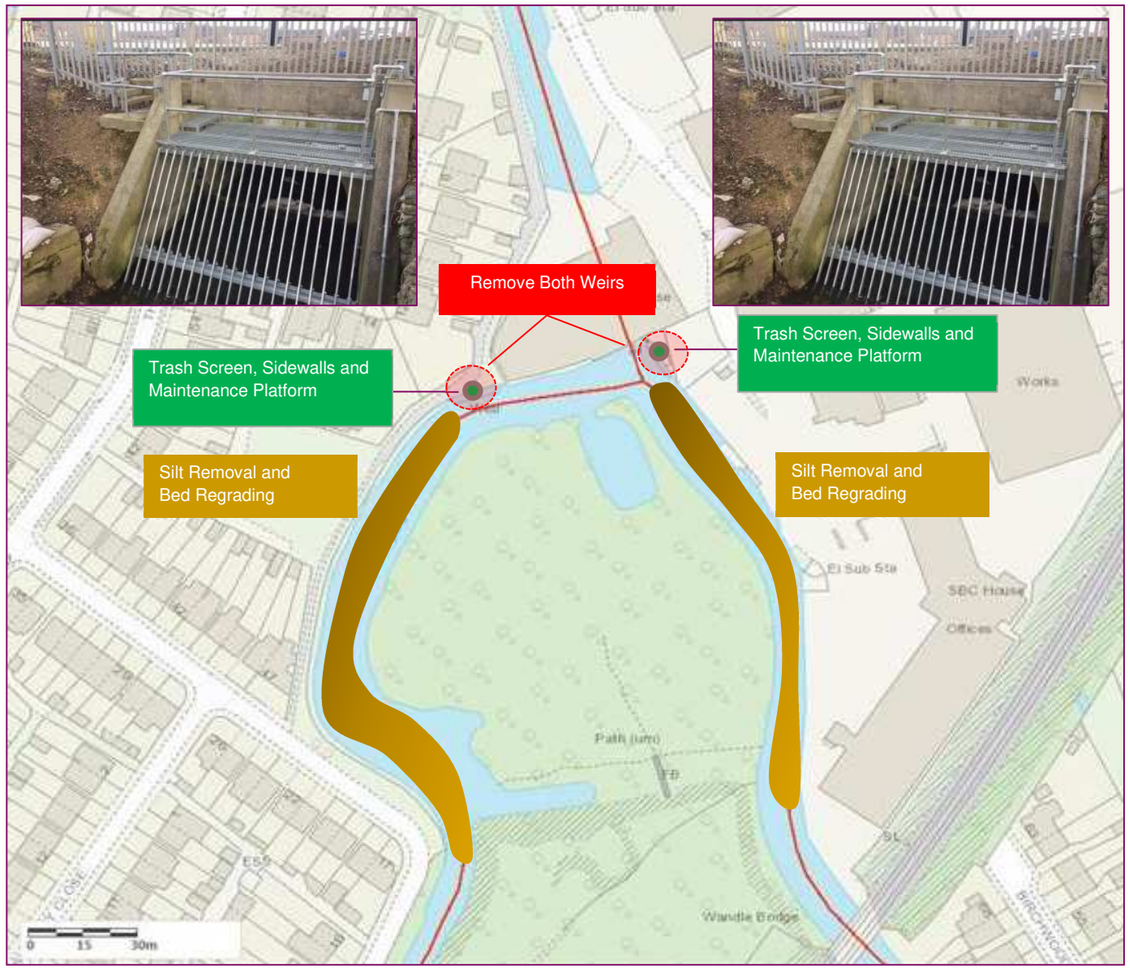
## 5.2 Concept Designs

The above short listed options considered for Shepley Mill site are further detailed by accompanied concept designs / indicative sketches as presented in **Figure 5.1** to **Figure 5.8** overleaf.

**Figure 5.1 Option 1: Full Weir Removal Only**



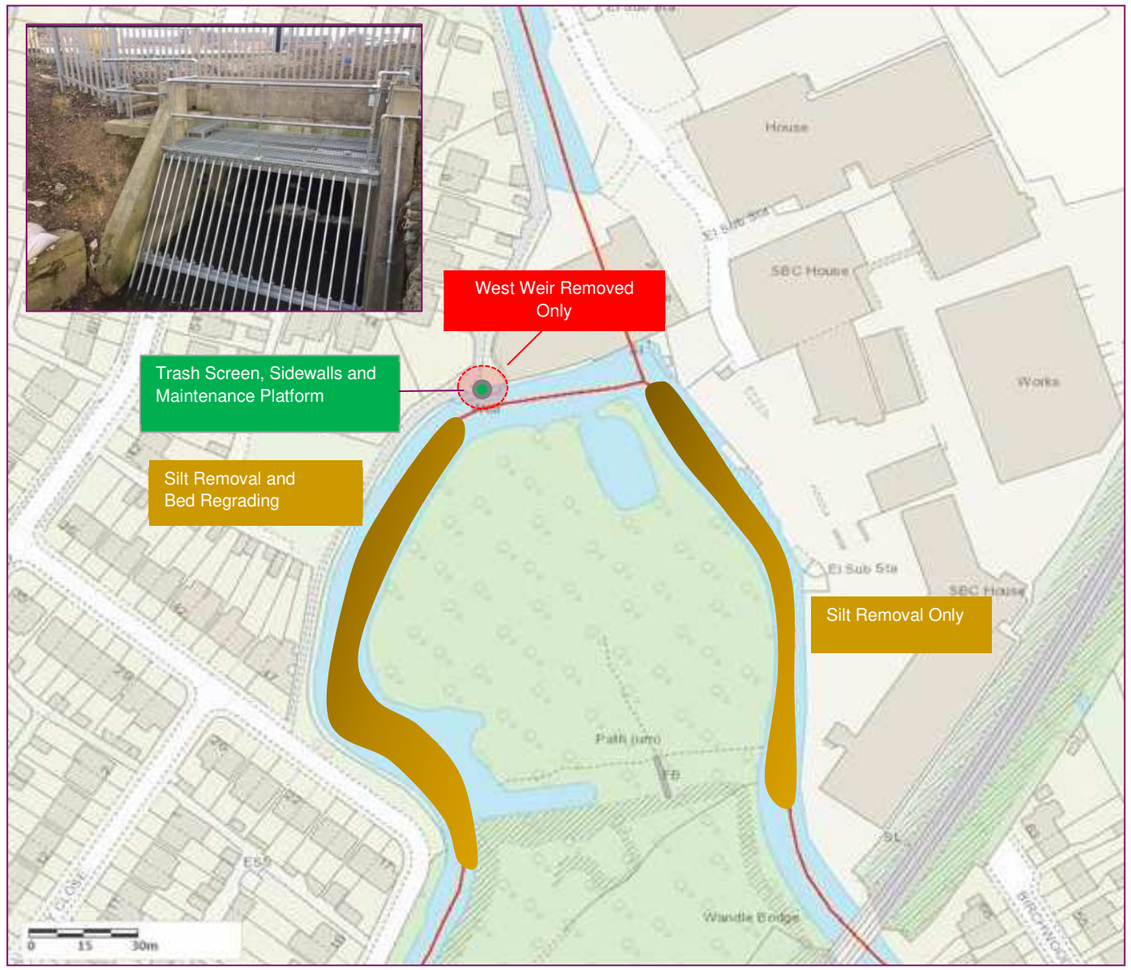
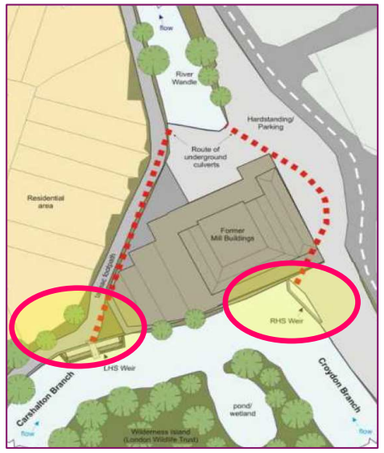
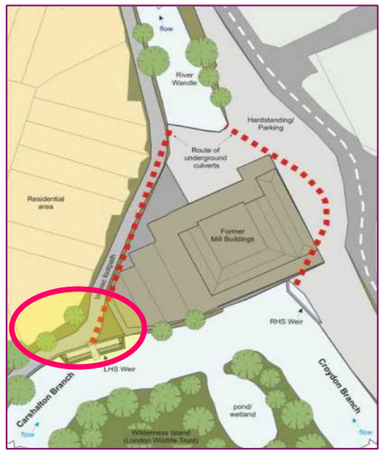
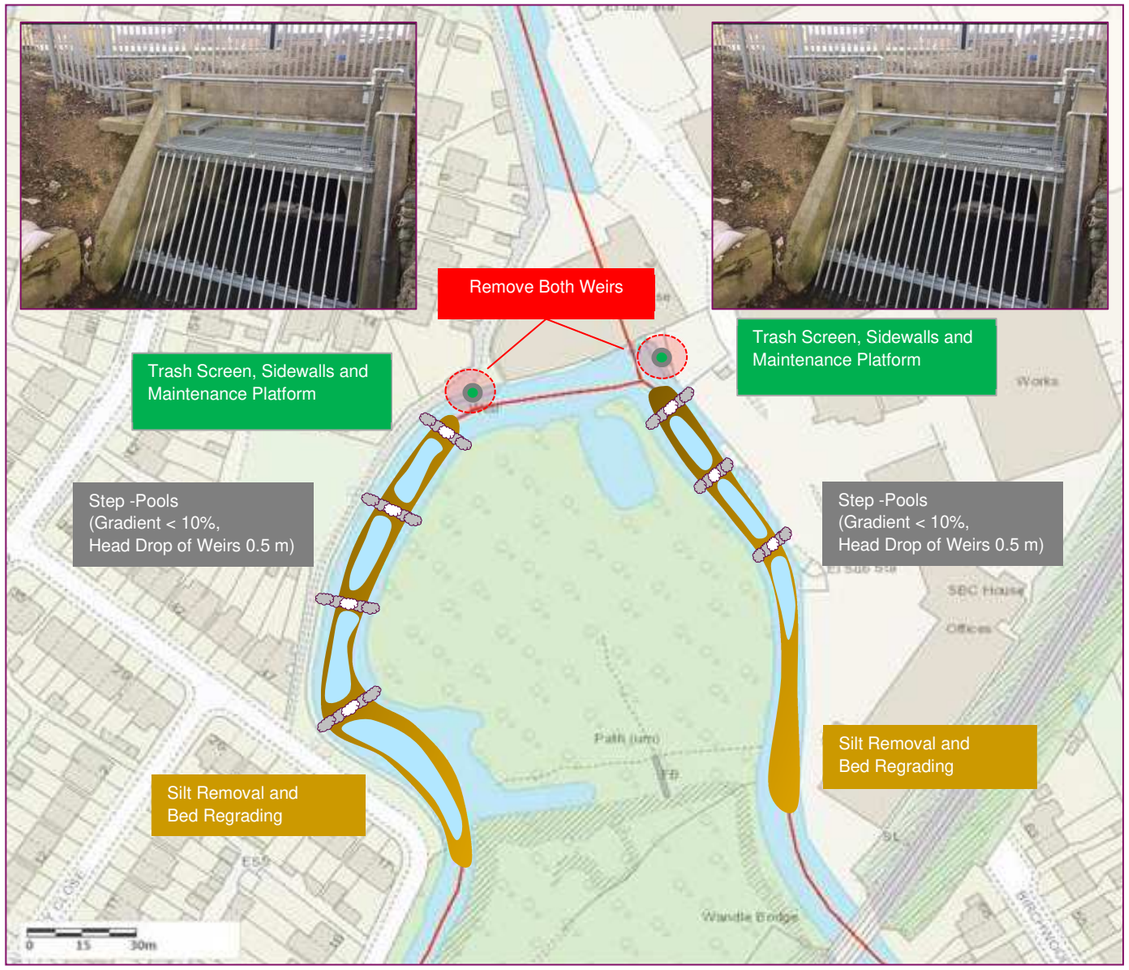



**Figure 5.2 Option 2: Full Weir Removal with Pre-Barrages / Step-Pools**



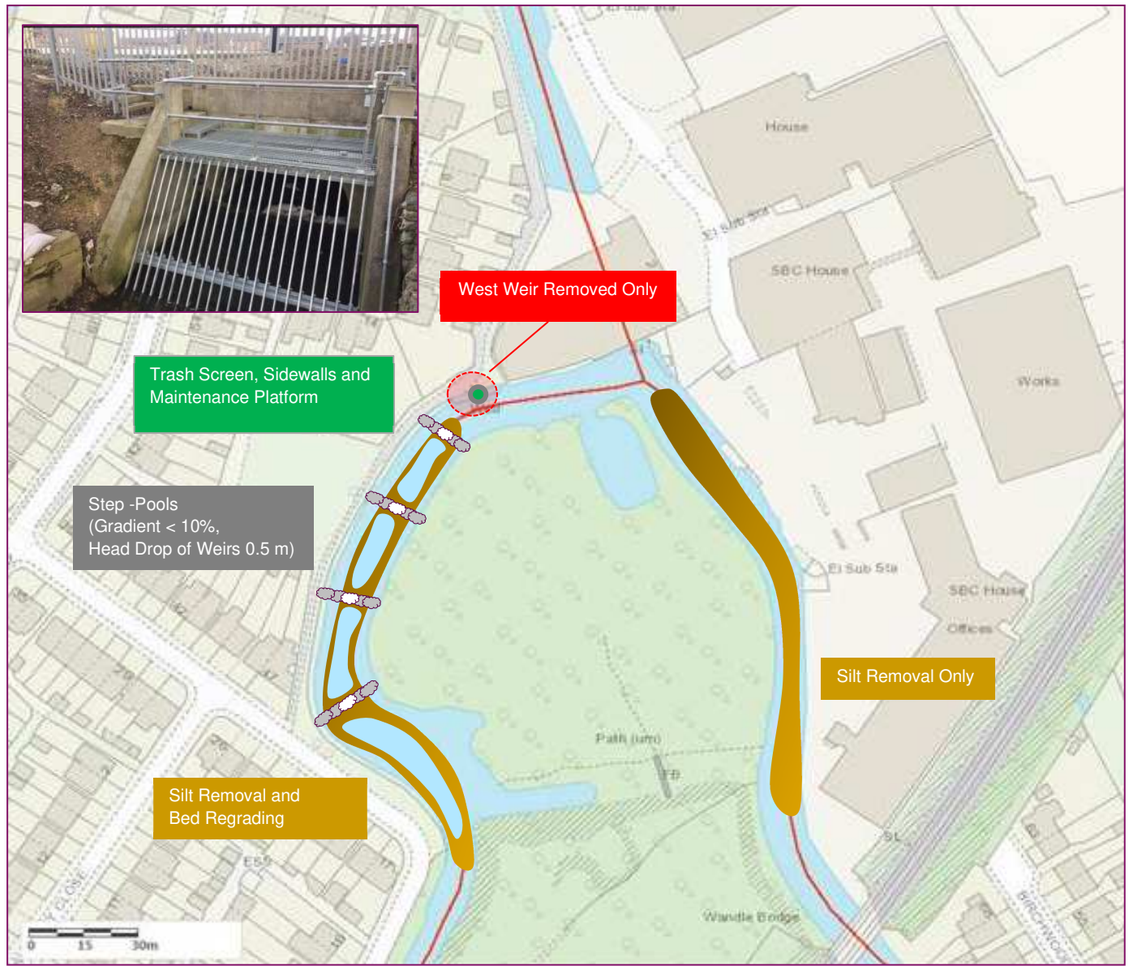
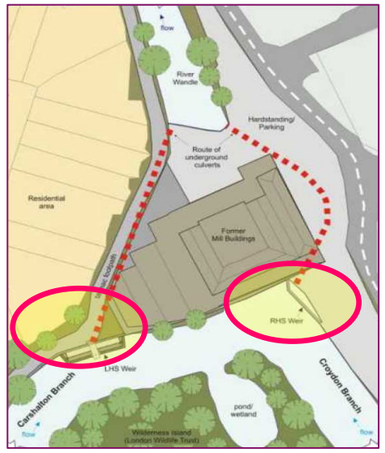
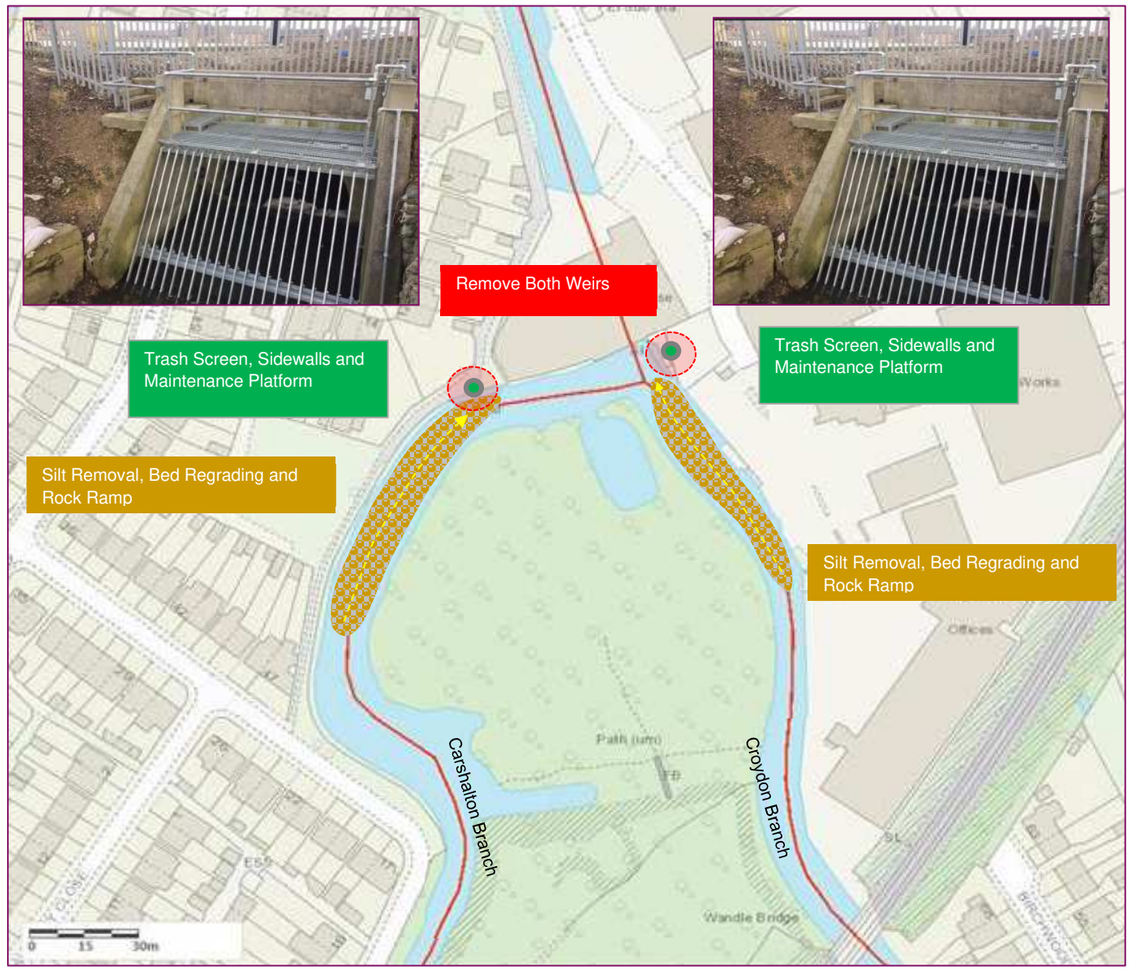



**Figure 5.3 Option 3: Full Weir Removal and Rock Ramps within the Carshalton & Croydon Branches**



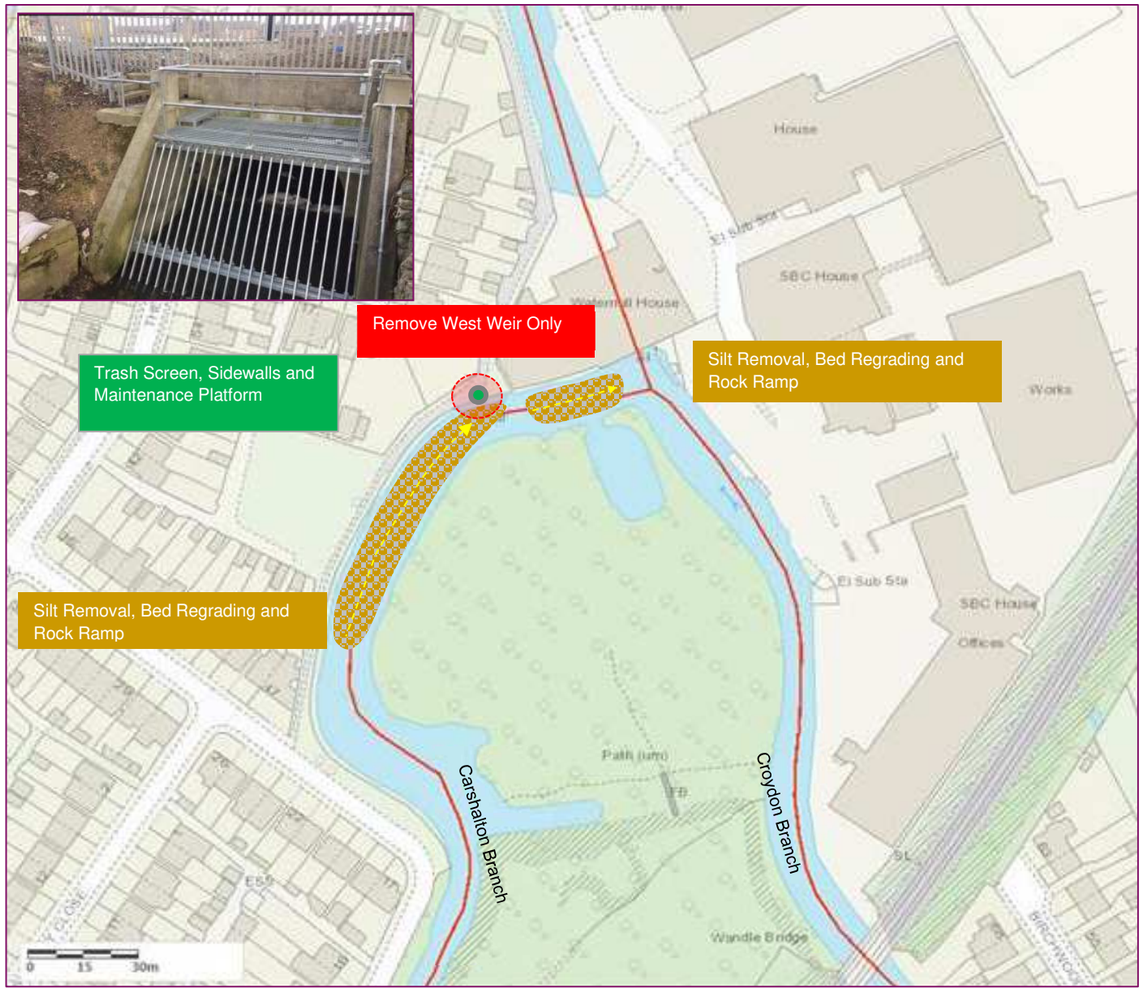
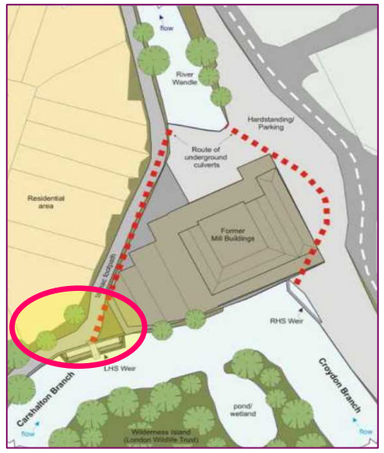



**Figure 5.4 Option 4: Weir Lowering and Rock Weirs within the Carshalton & Croydon Branches**



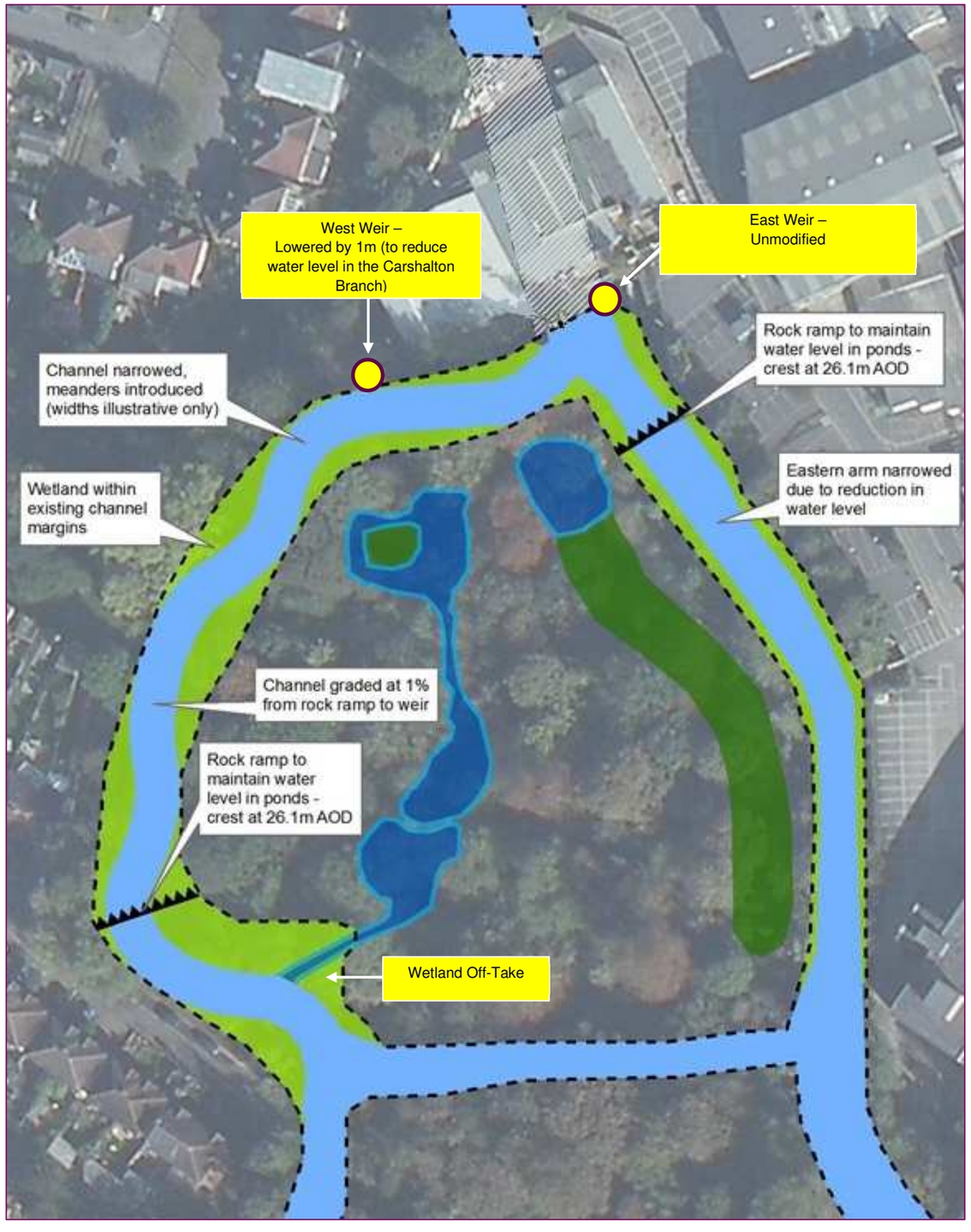
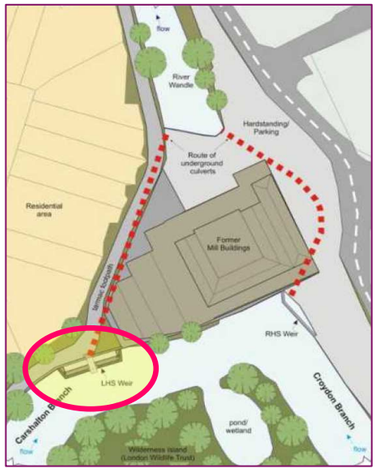
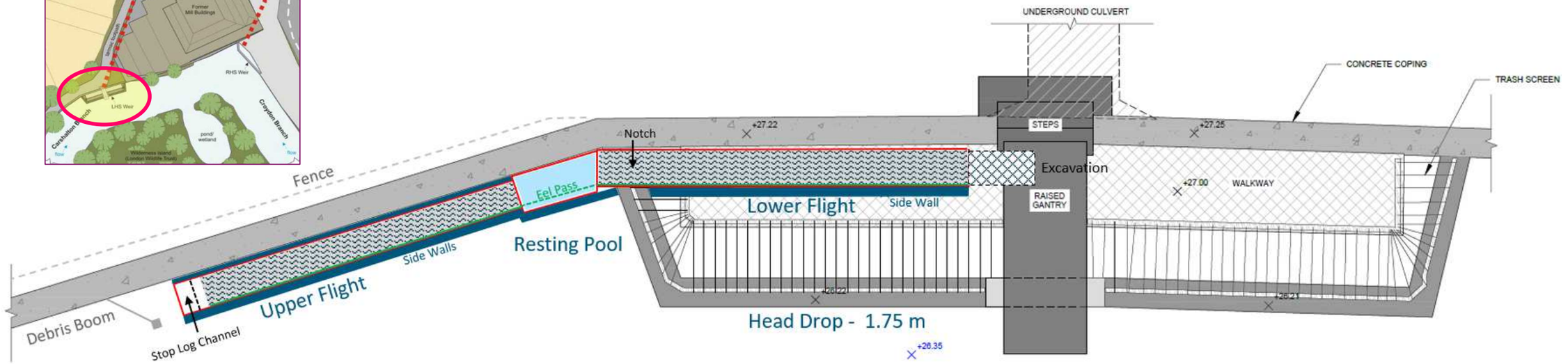



**Figure 5.5 Option 5: Technical Larinier Fish Pass on West Weir**

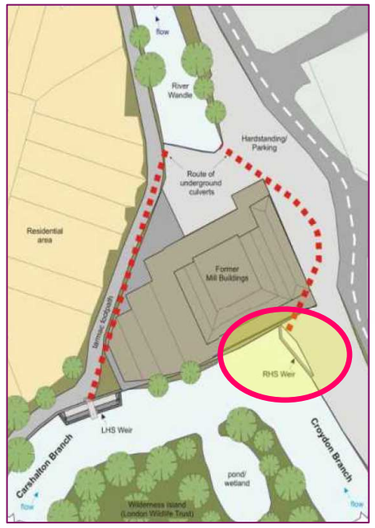


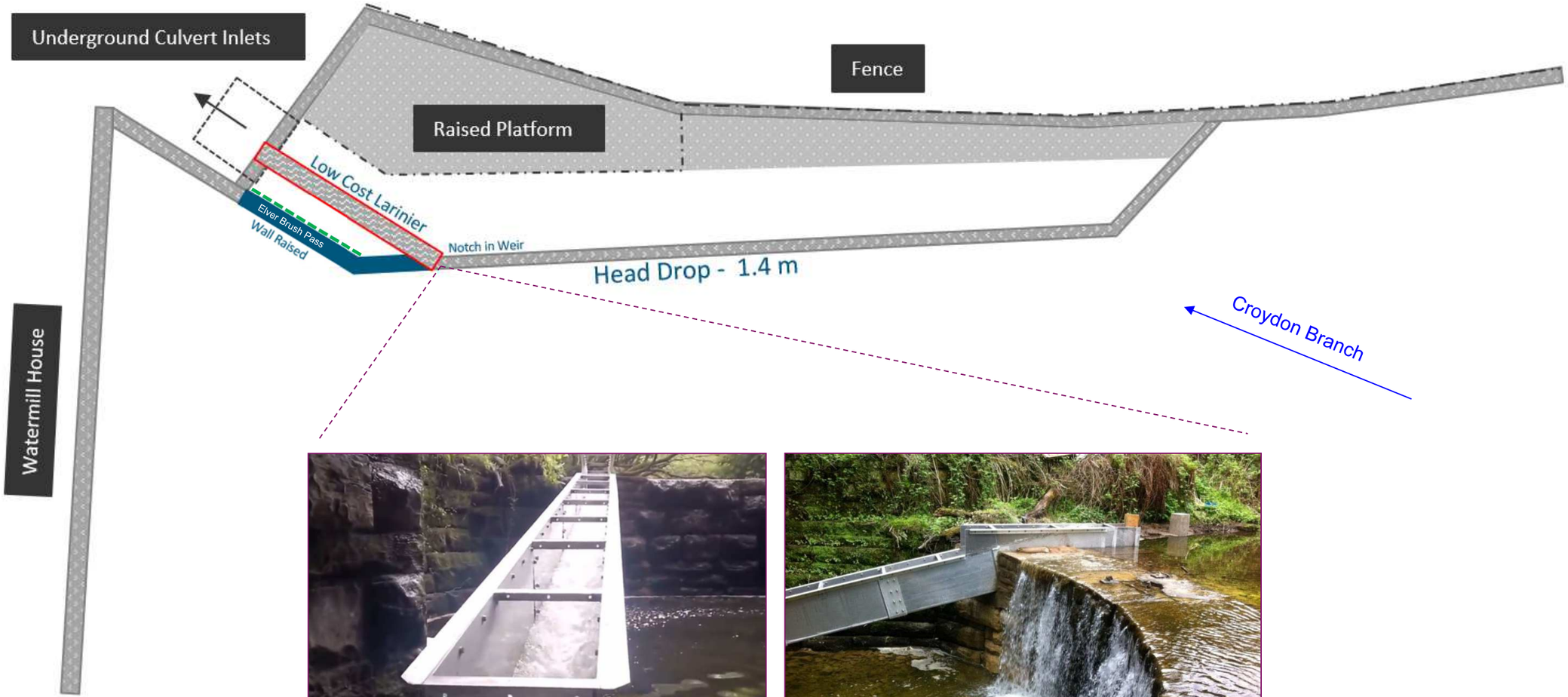



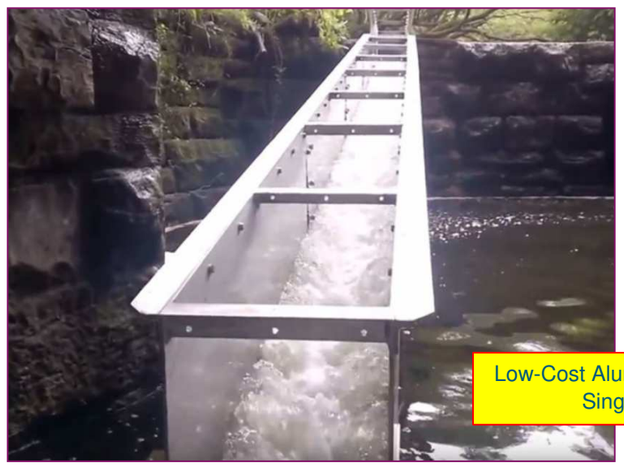

Water Level

Carshalton Branch

**Figure 5.6 Option 6a: Technical Larinier Fish Pass on East Weir**

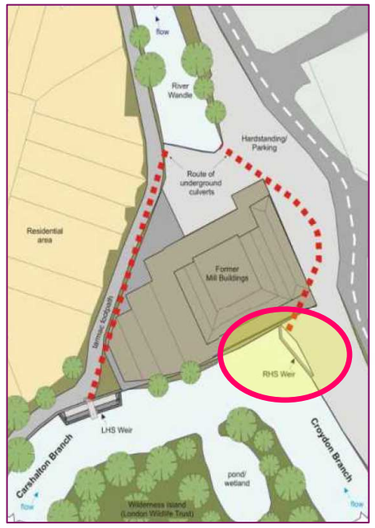


Low-Cost Aluminium Larinier – Single Flight

**Figure 5.7 Option 6b: Low Cost Baffle (Pre-Barrage) Fish Pass on East Weir**



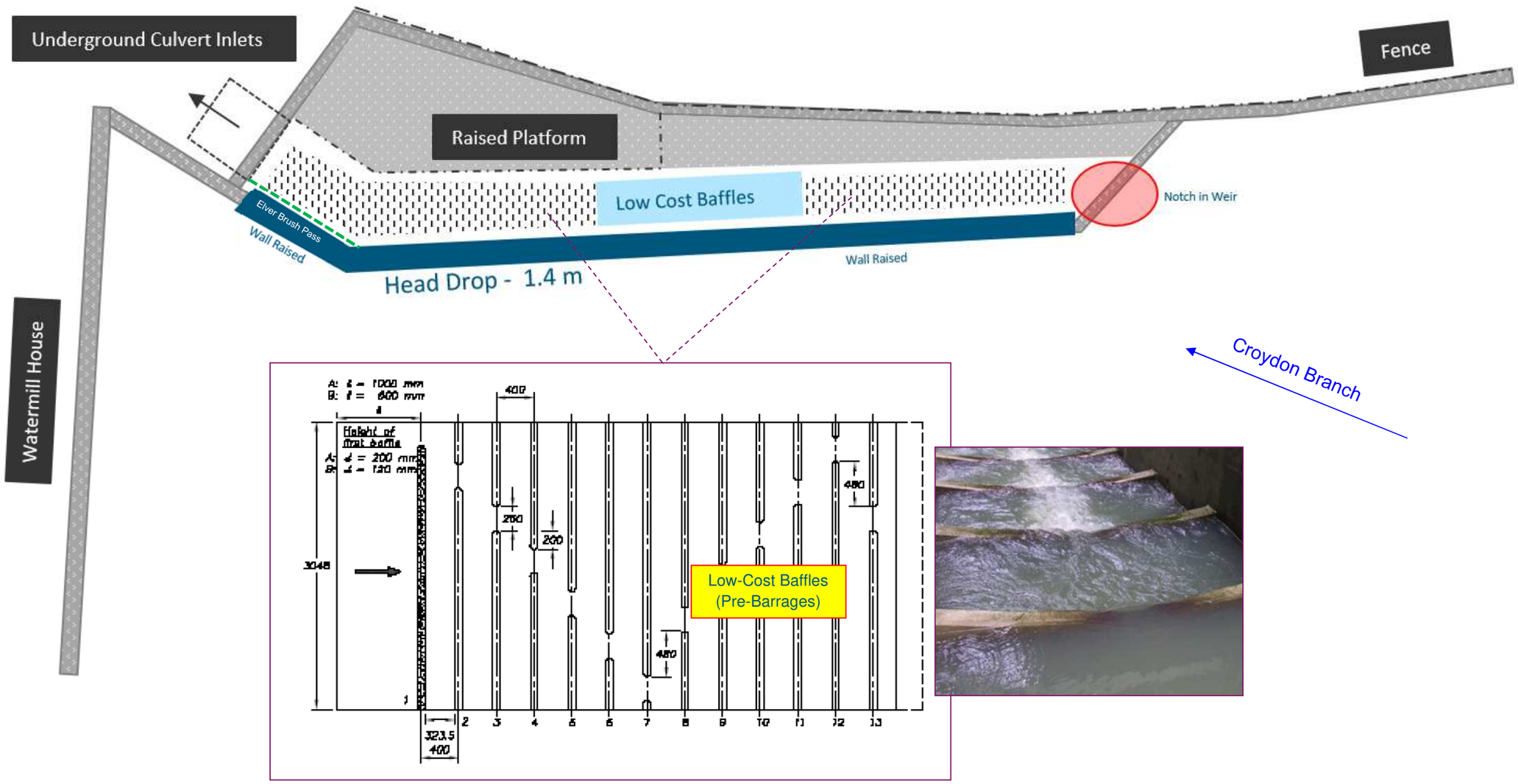
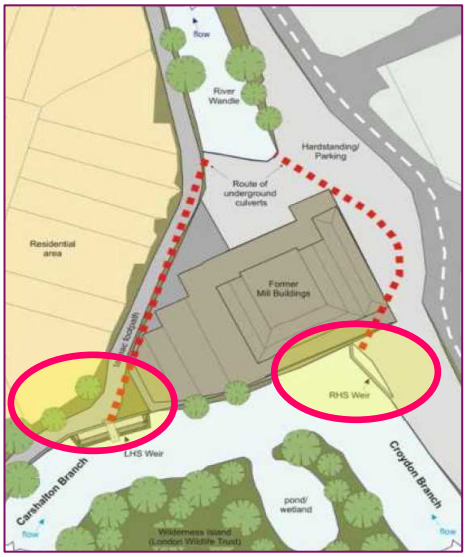
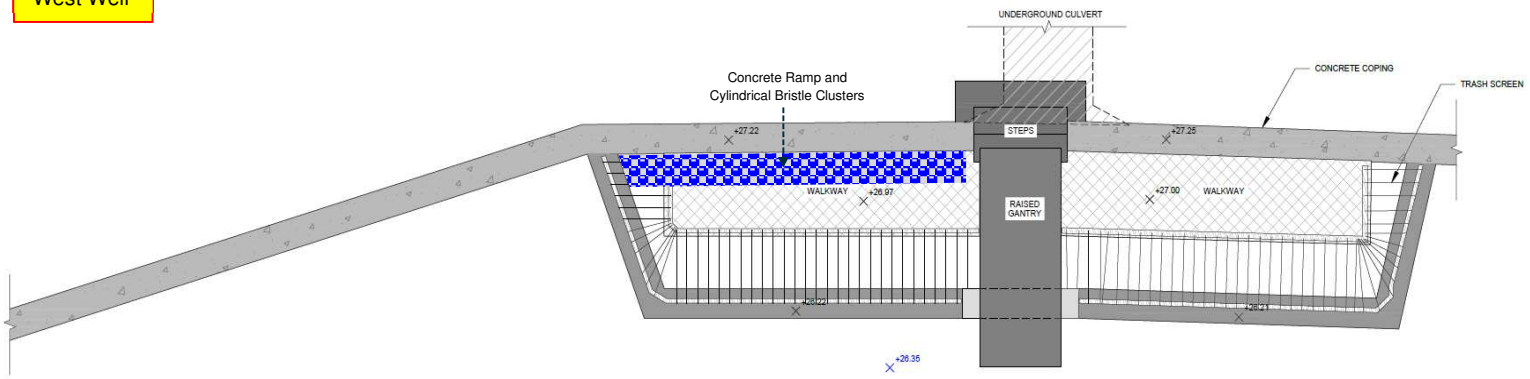



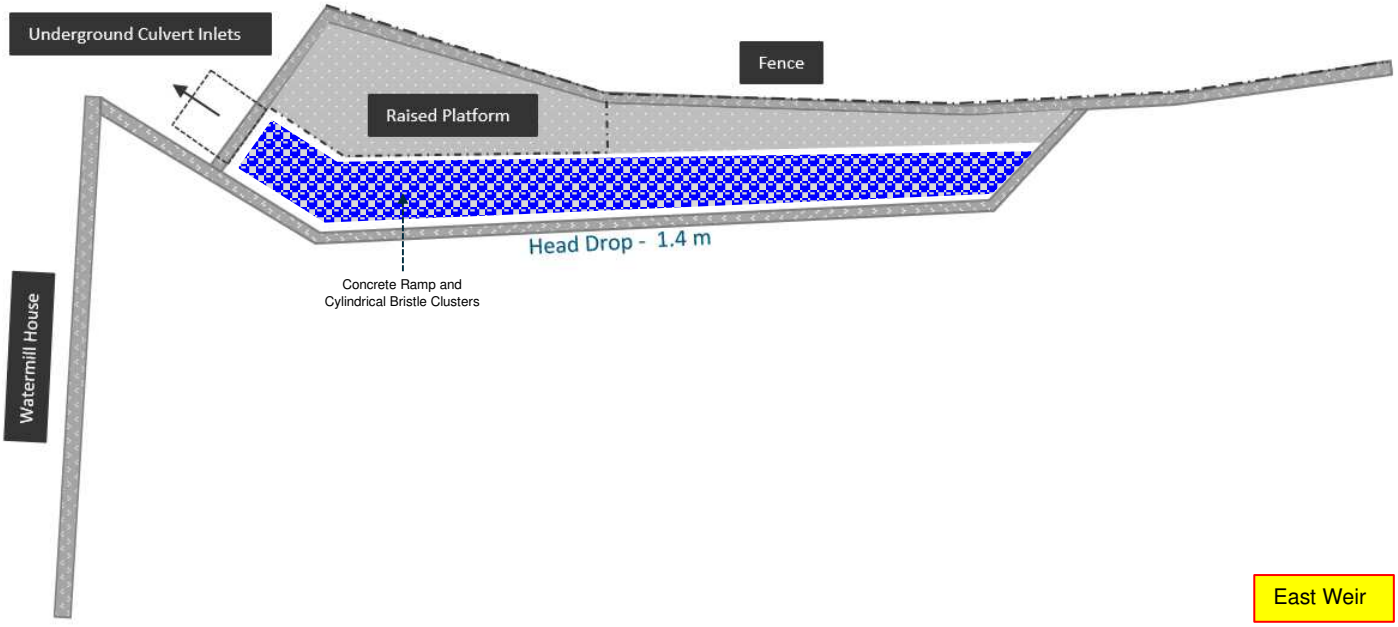
**Figure 5.8 Option 7: Cylindrical Bristle Clusters on West or East Weir**





West Weir




East Weir

# 6 Stage 3 Appraisals of Fish Passage Solutions

Based on the outcomes of Stage 2 in regard to the development of conceptual designs for the short listed solutions for the Shepley Mill Habitat Restoration Project, these were appraised against the key criteria listed below:

- **Fish Passage**, for example the option allows upstream and downstream migration for all fish species, including eels.
- **WFD**, for example the option has the ability to contribute to the WFD objectives.
- **Hydrology**, for example the option has the ability to maintain upstream water levels.
- **Geomorphology**, for example the option does not cause increased scour or deposition.
- **Environment**, for example, the option contributes to ecological diversity and/or does cause harm to the environment.
- **Technical Feasibility**, for example the option has limited construction constraints.
- **Health and Safety**, for example the option does not increase flood risk.

A summary of the appraisal is provided below for the short listed solutions as presented in **Figure 5.1** to **Figure 5.8** (see **Section 5** above).

## *Option 1: Full Weir Removal Only*

Option 1 has the potential to allow for the safe passage of fish and eels through Shepley Mill, contribute to Good Ecological Potential (GEP) under the WFD; comply with the Eels Regulations. However, this option would potentially impact upstream water levels, in particular during low flows (with potential fish passage implications), change existing flow habitats used by wildlife, impact the hydrological connection with Wilderness Island and increase flood risk. **Overall the suitability of this option to meet the project objectives is considered Low**.

## *Option 2: Full Weir Removal with Pre-Barrages / Step-Pools*

Option 2 has the potential to allow for the safe passage of fish and eels through Shepley Mill, contribute to GEP under the WFD and comply with the Eels Regulations. It is also predicted that the construction of the pre-barrages along the Carshalton and Croydon branches, if one or both weirs were removed, would maintain the upstream water levels and head drop differences of the west and east weirs i.e. maintain hydrological status quo. As such, it is anticipated this option would not impact upstream water levels, fish passage and existing habitats of Wilderness Island, in particular during low flow conditions. **Overall the suitability of this option to meet the project objectives is considered High** (if the west weir only is removed).

## *Option 3: Full Weir Removal & Rock Ramps within the Carshalton & Croydon Branches*

Although Option 3 has the potential to allow for the safe passage of fish and eels through Shepley Mill, contribute to GEP under the WFD and comply with the Eels Regulations, a similar hydrological outcome (and associated impacts) is predicted as that for Option 1. **Overall the suitability of this option to meet the project objectives is considered Low**.

### *Option 4: Weir Lowering & Rock Weirs within the Carshalton & Croydon Branches*

Although Option 4 has the potential to allow for the safe passage of fish and eels through Shepley Mill, contribute to GEP under the WFD and comply with the Eels Regulations, it is unclear the impacts of low flows on pond inundation on Wilderness Island and flood risk, with the need for fish passage solutions most likely required downstream of the rock ramps/weirs. **Overall the suitability of this option to meet the project objectives is considered Moderate**.

### *Option 5: Technical Larinier Fish Pass on West Weir*

Option 5 has the potential to allow for the safe passage of fish and eels through Shepley Mill, contribute to GEP under the WFD and comply with the Eels Regulations. It also predicted that the construction of a two flight Larinier, which may require a small notch of approximately 200 mm for operation, would maintain the upstream water levels and existing habitats of Wilderness Island, in particular during low flow conditions. **Overall the suitability of this option to meet the project objectives is considered High**, although would need additional habitat restoration solutions, such as channel narrowing, desilting and bed regrading, planting of silt deposition bars, flow deflectors and refuge areas.

### *Option 6: Technical Larinier Fish Pass or Baffles/Pre-Barrage on East Weir*

Option 6 has the potential to allow for the safe passage of fish and eels through Shepley Mill, contribute to GEP under the WFD and comply with the Eels Regulations, although the hydraulics of the east culvert may not be suitable for fish passage even with baffles, which may not be achievable to retrofitted in response to the confined constraints of the culvert. In addition, the culvert appears to have higher velocities (than the west weir culvert) in response to a steeper slope which may limit upstream fish migration even if baffles could be retrofitted. **Overall the suitability of this option to meet the project objectives is considered Moderate – Low**. Would need additional habitat restoration solutions, such as channel narrowing, desilting and bed regrading, planting of silt deposition bars, flow deflectors and refuge areas.

### *Option 7: Cylindrical Bristle Clusters on West or East Weir*

Option 7 has the potential to allow for the safe passage of fish and eels through Shepley Mill, contribute to GEP under the WFD and comply with the Eels Regulations, although Cylindrical Bristle Clusters (CBCs) have been predominately tested for coarse fish, although could be applicable to salmonoids and eels and most likely only work during high flows, unless notches are placed in either west or east weir. **Overall the suitability of this option to meet the project objectives is considered Moderate**. Would need additional habitat restoration solutions, such as channel narrowing, desilting and bed regrading, planting of silt deposition bars, flow deflectors and refuge areas.

# 7 Stage 4 Preferred Fish Passage Solutions and Next Steps

Based on Stage 3 and consultation with the Environment Agency, SERT, London Wildlife Trust and Sutton Borough Council, the following options have been identified as the most suitable fish passage solutions for this project, although further investigation on the options will be requited (see Next Steps, **Section 6**):

- **Option 2 – Full Weir Removal with pre-barrages / step-pools,** with preference for only the west weir being removed combined with pre-barrages / step-pools. It should be noted this option would require the installation of a trash screen at the entrance of the west weir culvert; and baffles in the west weir culvert.
- **Option 4 – Weir Lowering and rock weirs,** with the option of a single flight Larinier fish pass on the west weir and baffles in the west weir culvert.
- **Option 5 –Technical Larinier Fish Pass on west weir,** with preference for a two flight over a one flight Larinier, to ensure upstream water levels are maintained along the Carshalton and Croydon branches of the River Wandle. This option would include baffles in the west weir culvert.

Based on the above three options and given the potential for high costs, Option 5 may be the most cost-effective solution, which would also have no impacts upon existing water levels, flood risk; and could be combined with complementary river restoration works.

However, there is potential for a **Hybrid Option** in between Option 2,3 &4 which would effectively reduce the head drop to achieve fish passage, while maintaining water levels. This option would also significantly improve the overall habitat of the River Wandle.

Based on consultation with the Steering Group, Option 1 (Full Weir Removal), will be discounted from the project, due to a number of constraints. Option 6 (Cylindrical Bristle Clusters on West or East Weir); and Option 7 (Technical Larinier Fish Pass or Baffles/Pre-Barrage on East Weir), have also both been discounted in response to other options being more appropriate for this particular project.

## 7.1 Next Steps

The following next steps will be undertaken as part of the Shepley Mill Habitat Restoration Project:

- Further investigations and assessments, such as Hydraulic Modelling and Biodiversity Net Gain (BNG) Assessments to support the selection of the preferred fish passage option for the project. The Hydraulic Modelling will particularly focus on how the options may influence the hydrological connectivity between the Carshalton and Croydon branches; and the ecological features of Wildness Island such as the ponds and wetlands.
- Detailed design of the of preferred option, which will be agreed with the Steering Group and local residence of the River Wandle based upon the outcomes of the Hydraulic Modelling and BNG Assessments.
- Preparation of consents and construction of the preferred option for the Shepley Mill Habitat Restoration Project.

## 7.2 Proposed Programme

**Table 7.1** below provides a proposed programme of works for completing the remaining phases of the Shepley Mill Habitat Restoration Project.

**Table 7.1 Proposed Programme – Shepley Mill Fish Passage (Habitat Restoration) Project.**

| Phase of Works | November – December 2022 | Jan – March 2023 | April – Dec 2023 | Jan – May 2024 | June – August 2024 |
|---|---|---|---|---|---|
| Further Investigations, Assessments and Developed Design | | | | | |
| Updated Developed/Outline Design, Detail Design and Consents | | | | | |
| Construction Tenders | | | | | |
| Construction Works | | | | |  |

Please note: Programme subject to change and only indicative at this stage.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